

#### Recommended assessment framework, method and characterisation and normalisation factors for ecosystem impacts of eutrophying emissions: phase 3 (report, model and factors)

Azevedo, L.B.; Cosme, Nuno Miguel Dias; Hauschild, Michael Zwicky; Henderson, A.D.; Huijbregts, M.A.J.; Jolliet, Olivier ; Larsen, Henrik Fred; van Zelm, R.

Publication date: 2013

Document Version Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):

Azevedo, L. B., Cosme, N. M. D., Hauschild, M. Z., Henderson, A. D., Huijbregts, M. A. J., Jolliet, O., Larsen, H. F., & van Zelm, R. (2013). *Recommended assessment framework, method and characterisation and normalisation factors for ecosystem impacts of eutrophying emissions: phase 3 (report, model and factors).* 

#### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.

- · You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.





## **DELIVERABLE FRONTPAGE**

1

Project number:	243827 FP7-ENV-2009-1
Project acronym:	LC-IMPACT
Project title:	Development and application of environmental Life Cycle Impact assessment Methods for imProved sustAinability Characterisation of Technologies.
Deliverable number:	D3.7 (T3.1: Aquatic eutrophication)
Deliverable name:	Recommended assessment framework, method and characterisation and normalisation factors for ecosystem impacts of eutrophying emissions: phase 3 (report, model and factors)
Version:	Final
WP number:	3
Lead beneficiary:	DTU
Nature:	R + O <sup>1</sup>
Dissemination level:	PU <sup>2</sup>
Delivery date:	Month 41
Actual delivery date:	01/05/2013
Authors:	Azevedo LB, Cosme N, Hauschild MZ, Henderson AD, Huijbregts MAJ, Jolliet O, Larsen HF, van Zelm R

Comments:

<sup>&</sup>lt;sup>1</sup> Please indicate the nature of the deliverable using one of the following codes: **R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

 <sup>&</sup>lt;sup>2</sup> Please indicate the dissemination level using one of the following codes: PU = Public, PP = Restricted to other programme participants (incl. the Commission Services), RE = Restricted to a group specified by the consortium (incl. the Commission Services), CO = Confidential, only for members of the consortium (incl. the Commission Services)





## List of abbreviations

#### Used for freshwater eutrophication:

AEF	Average effect factor
CF	Characterisation factor
cPNOF	Calculated potentially not occurring fraction
EF	Effect factor
ePNOF	Empirical potentially not occurring fraction
FEOW	Freshwater ecoregions of the world
FF	fate factor
LCIA	Life cycle impact assessment
LEF	Linear effect factor
MEF	Marginal effect factor
MHT	Major freshwater habitat types
Р	Phosphorus
PNOF	Potentially not occurring fraction
SR	Species richness

2

TP Total phosphorus

## Used for marine eutrophication:

BOD	Biological Oxygen Demand
BGE	Bacterial Growth Efficiency
CF	Characterisation Factor
DO	Dissolved Oxygen
DO	Dissolved Oxygen
EE	Effect Factor
FF	Fate Factor
HC50	Hazard Concentration with 50% of the population exposed above its EC50
LC50	Lethal Concentration with effect on 50% of the population
LCA	Life Cycle Assessment
LCIA	Life Cycle Impact Assessment
LME	Large Marine Ecosystem
LT <sub>50</sub>	Median Lethal Time required to 50% of population to die
Ν	Nitrogen
NIE	Nitrogen Incorporation Efficiency
NOEC	No-Observed-Effect Concentration
PAF	Potentially Affected Fraction of species
a. <b>a</b>	

- SLC<sub>50</sub> Sub-Lethal Concentration with effect on 50% of the population
- SSD Species Sensitivity Distribution
- VCC Volume Correction Coefficient
- XF Exposure Factor





# **Table of contents**

DE	LIVERA	ABLE FRONTPAGE	1
Lis	t of ab	breviations	2
Tal	ble of o	contents	3
1.	EXE	CUTIVE SUMMARY	6
	1.1	Overall summary	6
	1.2	The environmental mechanism of freshwater eutrophication	7
	1.2.1	Spatial aggregation of CF	8
	1.2.2	Spatial aggregation of normalization factors	8
	1.2.3	Species and freshwater type aggregation	8
	1.3	Main findings of the freshwater eutrophication method	8
	1.4	The environmental mechanism of marine eutrophication	9
	1.5	Main findings of the marine eutrophication method	10
:	1.6	References	10
2.	SPA <sup>-</sup>	FIALLY-EXPLICIT CHARACTERISATION FACTORS FOR FRESHWATER EUTROPHICATION ON A	
GL	OBAL S	SCALE	11
,	Abstrac	t	.11
	2.1	Introduction	12
	2.2	Material and methods	12
	2.2.1	Characterisation models	12
	2.2.2	Fate factors	13
	2.2.3	Effect factors	13
	2.2.4	Input data	.14
	2.2.5	Normalization	15
	2.3	Results	18
	2.4	Discussion	18
	2.4.1	Differences between characterisation factor types	18
	2.4.2	Effect factor uncertainties	19
	2.4.3	Relevance, applicability and further research recommendations	20
	2.4.4	Concluding remarks	20
	2.5	Published peer-reviewed deliverables	21
2	2.6	Tables and figures	22
	2.7	Supporting information	
		ix 2-I: Allocation of grids to their respective region	
,	Append	ix 2-II: Environmental concentration data	39
		ix 2-III: Comparison between characterisation factors types for lake heterotrophs and stream autotrophs erotrophs	.42
	Append	ix 2-IV: Grid, country, continent, and world characterisation factors	53
	Append	ix 2-V: Grid, country, continent, and world emission estimates	54
,	Append	ix 2-VI: Grid, country, continent, and world normalization factors	55





2.	8 F	References for freshwater eutrophication	56
3.	SPAT	ALLY-EXPLICIT CHARACTERISATION FACTORS FOR MARINE EUTROPHICATION	
Ał	ostract		58
3.	1 I	ntroduction	59
	3.1.1	Background	59
	3.1.2	Eutrophication as a function of nutrients or organic matter enrichment?	60
	3.1.3	Marine productivity and eutrophication	60
	3.1.4	Organic loading	61
	3.1.5	Nutrients enrichment	62
	3.1.6	Nitrogen cycle	62
	3.1.7	Effects of nitrogen in marine waters	63
	3.1.8	Data search	65
	3.1.9	Research goals	66
3.	2 1	Aethodology	66
	3.2.1	Framework	66
	3.2.2	Unit areas for spatial differentiation	68
	3.2.3	Fate Factors (FF) and the fate model	69
	3.2.4	Exposure Factors (XF)	72
	3.2.5	Effect Factors (EF)	76
	3.2.6	Normalisation	79
	3.2.7	Sensitivity analysis	79
	3.2.8	Uncertainty analysis	80
3.	3 F	Results	81
	3.3.1	Fate Factors (FF)	81
	3.3.2	Exposure Factors (XF)	81
	3.3.3	Effect Factors (EF)	81
	3.3.4	Characterisation Factors (CF)	81
	3.3.5	Normalization References (NR)	82
	3.3.6	Sensitivity test	82
	3.3.7	Uncertainty estimation	83
3.	4 C	Discussion	84
	3.4.1	Estimations and modelling	84
	3.4.2	The biogeographical classification system	85
	3.4.3	Issues concerning biological data	85
	3.4.4	Comparison with existing and recommended methods	85
	3.4.5	Analysis of the spatial differentiation of the Characterisation Factors (CF)	86
	3.4.6	Normalisation References (NR)	88
	3.4.7	Environmental relevance, completeness, and consistency	89
	3.4.8	Sensitivity and uncertainty	89
3.	5 F	inal considerations	93
3.	6 F	References for the Marine Eutrophication chapter	93





Appendices	99
endix 3-I. Large Marine Ecosystems (LMEs)	99
endix 3-II: Climate Zones	
endix 3-III. Nitrogen losses in the marine compartment	
endix 3-IV: Nitrogen conversion in the photic zone	
endix 3-V: Testing normality of species sensitivity data: goodness-of-fit test	
endix 3-VI: Generation of Species Sensitivity Distributions (SSD)	
endix 3-VII: Species Sensitivity Distribution (SSD) curves	
endix 3-VIII: Residence time variation range	114
endix 3-IX: Fate	
endix 3-X: Exposure	
endix 3-XI: Effect	122
endix 3-XII: Characterisation Factors	
endix 3-XIII: Aggregation of Characterisation Factors	142
endix 3-XIV: Normalisation	144
endix 3-XV: Uncertainty quantification	149
	endix 3-I. Large Marine Ecosystems (LMEs) endix 3-II: Climate Zones endix 3-III. Nitrogen losses in the marine compartment endix 3-IV: Nitrogen conversion in the photic zone endix 3-V: Testing normality of species sensitivity data: goodness-of-fit test endix 3-VI: Generation of Species Sensitivity Distributions (SSD) endix 3-VII: Species Sensitivity Distribution (SSD) curves endix 3-VIII: Residence time variation range endix 3-IX: Fate endix 3-XI: Effect endix 3-XII: Characterisation Factors endix 3-XII: Aggregation of Characterisation Factors endix 3-XIV: Normalisation





Recommended assessment framework, method and characterisation and normalisation factors for ecosystem impacts of eutrophying emissions

## **1. EXECUTIVE SUMMARY**

## 1.1 Overall summary

The eutrophication process of aquatic ecosystems, either marine or freshwater, is characterized by an excessive growth and accumulation of algae and other aquatic plants in response to an increased input of nutrients (Seppälä et al. 2004). Once the plant nutrients, mainly nitrogen (N) and phosphorous (P) are available to assimilation and growth, the excessive biomass produced can decrease the water quality and bring undesirable effects to resident biological communities (OSPAR 2008).

Nutrients availability acts as a limiting factor in freshwater, estuarine and marine ecological systems. In principle, the concept of 'limiting nutrient' states that one nutrient is limiting the growth (size and number) of a resident population and that all other nutrients are available in excess. If an additional amount of the limiting nutrient is introduced into the system, this will promote an increase in growth. On the other hand, an introduction of any of the other nutrients will have no reflection on growth as they are already in excess (Finnveden & Potting 1999).

Freshwater systems are often limited by phosphorous, marine systems by nitrogen, and estuarine systems by either or both. For modelling purposes the 'limiting nutrient' concept is a simplification, as exceptions can be found, other nutrients can be limiting in specific conditions, variations along the annual seasons, and different species can show different requirements (Finnveden & Potting 1999).

Excessive nutrients enrichment is likely to stimulate an undesirable growth of phytoplankton and macroalgae. The senescence and decay of this plant biomass will use a large amount of oxygen during bacterial degradation, especially in bottom waters, where degradation is more intense and reaeration less effective.

Life Cycle Assessment is an environmental assessment tool used to address and evaluate the exchanges between the technosphere and the environment, and thus the resulting potential impacts of a product or service from 'cradle to grave', i.e. the entire life cycle.

Life Cycle Impact Assessment (LCIA) is a crucial phase because it quantifies the potential for environmental impacts by an evaluation of impact scores ( $S_i$ ) for each impact category that result from the multiplication of the emission inventories by the specific characterisation factor (CF). The evaluation can take place either at the midpoint or endpoint level: midpoints (e.g. amount of nutrients in the water) correspond to early links in the cause-effect chain that potentially evolve into individual impacts, or endpoints (e.g. loss of biodiversity) (Bare et al. 2000).

Data from the inventory (i.e. emitted quantities) are thus converted into impact category indicators by application of the CFs.





Even though aquatic eutrophication has worldwide repercussions (Björklund *et al.*, 2009), the currently recommended method in the context of LCIA is only available for European emissions (Struijs *et al.*, 2009; Struijs *et al.*, 2011).

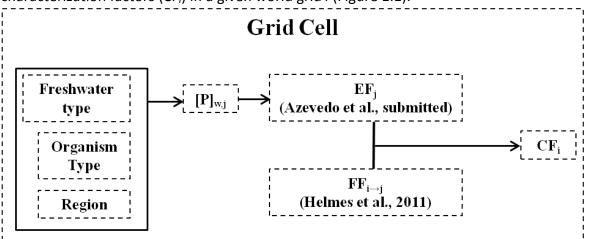
Here, we developed spatially-explicit global CFs for freshwater eutrophication impacts related to phosphorus emissions. Differences in hydrological, climatic, and ecological processes across regions at a 0.5° x 0.5° spatial resolution were taken into account in the CF development.

On its turn, marine eutrophication is still lacking a sound methodology in LCIA to link the midpoint and endpoint indicators in an overall model to assess the potential impact of the overenrichment of marine ecosystems by nitrogen.

Here, a new endpoint model with global applicability is presented to account for the potential impacts of nitrogen loadings to coastal marine waters, translated into oxygen consumption and in effect to resident biota, at a country-to-receiving ecosystem resolution scale.

## 1.2 The environmental mechanism of freshwater eutrophication

The fate factor includes three pathways by which phosphorus can be transported downstream. These are: retention, advection, and water use (Fig. 1). Retention occurs due to biological uptake of phosphorus and adsorption to suspended particles. Advection and water use are the processes of downstream transport and water withdraw from freshwaters. Effect factors were separately derived for four regions [(sub)tropical, xeric, temperate, and cold], two species groups (which perform and do not perform photosynthesis, respectively), and two freshwater types (lakes and streams). The transport mechanism (described by fate factors) and the ecological impact (described by the effect factors) are then combined to derive spatially-explicit characterization factors (CF<sub>i</sub>) in a given world grid *i* (Figure 1.1).



**Figure 1.1:** Main pathways by which phosphorus in transported downstream and ecological components (region and species group and freshwater type) considered in the endpoint characterization factors. The concentration of phosphorus in freshwater type w in grid j, the effect factor in grid j, the net transport of phosphorus from emitting grid i to receiving grid j, and the characterization factor of emitting grid I are described as, respectively,  $[P_{w,j}]$ , LEF<sub>j</sub>, FF<sub>i->j</sub>, and CF<sub>i</sub>.

The characterization factors are derived by summing the individual products of the partial fate factor from emitting grid *i* in grid *j* ( $PFF_{i\rightarrow j}$ ) with the linear effect factor type  $LEF_{j,s,w}$ ) in grid *j* of species group *s* (autotrophs or heterotrophs) in freshwater type *w* (lake or stream) as





$$CF_{i,s,w} = \sum_{j} \left( PFF_{i \to j} \cdot LEF_{j,s,w} \right)$$

(1)

The effect factors  $LEF_{j,s,w}$  depend upon the species group *s*, freshwater type *w*, and region of the receiving grid *j* [(sub)tropical, xeric, temperate, or cold].

### 1.2.1 Spatial aggregation of CF

We calculated region-specific (i.e. country, continent, and world) CFs as the mean of CF of grids within them. Note that we also report grid-specific CFs.

## 1.2.2 Spatial aggregation of normalization factors

We estimated region-specific (i.e. country, continent, and world) emissions by summing estimates of emission across grids within each region. Finally, we calculated normalization factors per region (i.e. country, continent, and world) by multiplying the CF and the emission estimate relative to the region. Note that we also report grid-specific emission and normalization factors.

## 1.2.3 Species and freshwater type aggregation

Given that we provide up to four types of CF (based on lake autotrophs, lake heterotrophs, stream autotrophs, and stream heterotrophs), in this work we propose that they are aggregated as

$$CF_i = \sum_{j,s,w} \left( PFF_{i \to j} \cdot LEF_{j,s,w} \cdot v_{j,w} \right)$$
<sup>(2)</sup>

where  $v_{j,w}$  is the fraction of water volume in grid *j* residing in freshwater type *w*. The aggregation based on all four biotic endpoints, however, was only possible in temperate regions. In (sub)tropical and xeric regions, the CF is based on one biotic endpoint only (i.e. stream autotrophs and lake autotrophs, respectively). In cold regions, the CF is based on aggregating heterotrophs and autotrophs in lakes.

## 1.3 Main findings of the freshwater eutrophication method

We were able to provide more spatially-detailed CFs (per grid, country, and continent) than those available up to now (only European-generic CFs). However, as opposed to the current recommended method by ILCD (Struijs *et al.*, 2009), we were not able to account for the transport of phosphorus in the terrestrial compartment prior to its discharge to water bodies, e.g. via surface runoff. This means that CFs for emissions to agricultural soils are currently lacking and warrant further research. In addition, the transport of nitrogen is not considered since we assumed that nitrogen does not play a role in the damage to freshwater ecosystems.

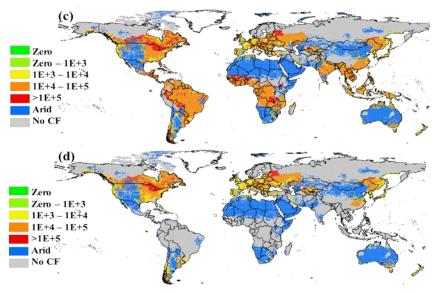
We were also able to include ecosystem damages to lakes in addition to streams, which were the only freshwater body taken into account in the current recommended method. We also include an important taxonomic group (autotrophs) as part of the species influences by phosphorus surpluses. Furthermore, we added fish species and other invertebrates to the existing macroinvertebrate species group upon which the current recommended method is currently based.

There are, however, also constraints to the method we propose in LC-IMPACT. Although these constraints are also present in the current recommended method, it is important to emphasize





where further research efforts by LCIA should be. First, we do not further differentiate effect factors in more specific species groups, such as cyanobacteria and macrophytes with the broad species group of autotrophs. Furthermore, we do not further differentiate in the ecological variability within a given region. Third, although we are able to provide species and freshwater type aggregated endpoint CF for freshwaters outside Europe, effect factors are not available for all organisms and freshwater types (Figure 1.2). For example, we were not able to determine the effect of phosphorus in streams in the cold region but only in lakes.



**Figure 1.2:** Characterization factors (CFs) for autotrophs and heterotrophs in streams using the linear effect factor (LEFa), independent of phosphorus concentration levels. CFs for lakes are not shown. Units are given as day·kgP<sup>-1</sup>·m<sup>3</sup>. Note that no CFs are available for high latitude regions of the Northern Hemisphere.

## **1.4** The environmental mechanism of marine eutrophication

The estimation of the potential impacts for marine eutrophication for use in LCIA is built on the application of Characterisation Factors (CF, unit:  $(PAF \cdot)[m^3 \cdot d/kgN]$ ), defined by:

$$CF_{ij} = FF_{ij} \times XF_j \times EF_j$$

Where FF is the Fate Factor (unit: [d]) for emission route *i* to receiving ecosystem *j*, XF is the Exposure Factor (unit: [kgO<sub>2</sub>/kgN]) in receiving ecosystem *j*, and EF is the Effect Factor (unit: (PAF·)[ $m^3/kgO_2$ ]) in receiving ecosystem *j*.

The emission routes of N include "N to air", "N to surface freshwater", "N to groundwater" and "N to coastal marine waters", and the receiving ecosystems considered are the Large Marine Ecosystems (LME) spatial units developed by NOAA (Sherman, 1991)

The FF estimates the N fraction exported to marine waters and the N losses in the marine compartment, thus expressing how N loadings into this compartment vary. The FF depends on the N fate in soil, the atmospheric fate, the fate in freshwater systems, and on the losses once in the marine compartment (denitrification, advection and sedimentation).

The XF expresses the conversion from nitrogen to organic matter (phytoplankton biomass) in the photic zone and to dissolved oxygen consumption in bottom waters.





The EF represents the change in the potentially affected fraction of species (PAF) in the receiving marine ecosystem due to the change in dissolved oxygen.

The marine eutrophication model framework can be seen as a combination of an environmental mechanism that governs the N fate processes and delivers the FF, and another environmental mechanism that governs the exposure from N to OM and oxygen depletion, delivering the XF. The processes that lead to the impacts on biota deliver the EF.

## 1.5 Main findings of the marine eutrophication method

The model delivers CFs for the "N to air", "N to freshwater", "N to groundwater", and "N to marine coastal waters" inventory flows for 214 countries-to-LME combinations, 143 countries, 13 aggregated regions/continents, and a global default.

Sensitivity analysis shows higher contribution of Primary Production (PP) rate datasets to the resulting CFs. The uncertainty arising from choosing the correct fractions of N emissions for each of receiving ecosystems (for countries exporting to multiple receiving LMEs) and the PP rate datasets are the most significant.

The combination of sensitivity and uncertainty have been identified as key issues for improvement of the model framework, the PP rate datasets, N-export splitting rules for multiple receiving ecosystems, and the residence time in the marine compartment.

The proposed methodology covers all the processes of relevance to the marine eutrophication of N-emissions and delivers CFs at a considerably high geographic applicability, with good environmental relevance and reproducibility.

## 1.6 References

Bare JC, Hofstetter P, Pennington DW, Udo de Haes HA. 2000. Midpoints versus Endpoints: The Sacrifices and Benefits. The International Journal of Life Cycle Assessment 5(6): 319-326.

Björklund G, Burke J, Foster S, Rast W, Vallée D, van der Hoek W. 2009. 3rd UN World Water Development Report: Water in a Changing World (WWDR-3). Chapter 8: Impacts of water use on water systems and the environment. (ed. by Unesco), pp 432. UN World Water Assessment Programme.

Finnveden G, Potting J. 1999. Eutrophication as an Impact Category – State of the Art and Research Needs. The International Journal of Life Cycle Assessment 4(6): 311-314.

OSPAR. 2008. Second Integrated Report on the Eutrophication Status of the OSPAR Maritime Area. OSPAR Commission. Eutrophication Series 372/2008, 107 pp.

Seppälä J, Knuuttila S, Silvo K. 2004. Eutrophication of Aquatic Ecosystems: A New Method for Calculating the Potential Contributions of Nitrogen and Phosphorus. International Journal of Life Cycle Assessment 9: 90-100.

Sherman K. 1991. The Large Marine Ecosystem Concept: Research and Management Strategy for Living Marine Resources. Ecological Applications 1(4): 350-360.

Struijs J, Beusen A, de Zwart D, Huijbregts M. 2011. Characterization factors for inland water eutrophication at the damage level in life cycle impact assessment. International Journal of Life Cycle Assessment, 16, 59-64.

Struijs J, Beusen A, van Jaarsveld H, Huijbregts, MAJ. 2009. Chapter 6. ReCiPe 2008 A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level. Report I: Characterisation factors, first edition. Aquatic Eutrophication (ed. by M Goedkoop, R Heijungs, MAJ Huijbregts, A De Schryver, J Struijs, R Van Zelm).





## 2. SPATIALLY-EXPLICIT CHARACTERISATION FACTORS FOR FRESHWATER EUTROPHICATION ON A GLOBAL SCALE

11

Ligia B. Azevedo<sup>\*1</sup>, Andrew D. Henderson<sup>2,3</sup>, Rosalie van Zelm<sup>1</sup>, Olivier Jolliet<sup>2</sup>, Mark A. J. Huijbregts<sup>1</sup>

<sup>1</sup> Department of Environmental Science, Institute for Water and Wetland Research, Radboud University Nijmegen, P.O. Box 9010, 6500 GL, Nijmegen, The Netherlands

<sup>2</sup> Department of Environmental Health Sciences, School of Public Health, University of Michigan, 1415 Washington Heights, Ann Arbor, MI 48109, USA

<sup>3</sup> Division of Epidemiology, Human Genetics and Environmental Sciences, School of Public Health, The University of Texas Health Science Center at Houston, 1200 Herman Pressler, Houston, Texas 77030, USA

\*Corresponding author:

Ligia B. Azevedo; Tel: +31 (0)243653291; Fax:+ 31 (0)243553450; e-mail: l.azevedo@science.ru.nl

#### Abstract

This study derives spatially-explicit endpoint characterisation factors (CF) for freshwater eutrophication for phosphorus (P) on a global scale and on an European scale. The CF were derived separately for autotrophs and heterotrophs residing in lakes and streams as the change in the potentially not occurring fraction (PNOF) of species relative to a change in the emission of P. Additionally, we tested how three different effect models, i.e. linear (LEF), marginal (MEF), and average (AEF) effect factors, representing the change in the potentially not occurring fraction of species (PNOF) with changing total P levels, would affect CFs in P emitting areas of Europe. The effect models differed in respect to their assumption of linear/non-linear responses of PNOF to P increases, inclusion of an environmental target and of monitored total P levels, and their biotic endpoints (species richness of autotrophs and heterotrophs in lakes and streams). Although we successfully derived CF using the three effect factor methods for Europe, the effect factors elsewhere were limited to the linear effect factor method, which does not require the concentration of P as an input parameter. For Europe, we derived CF for the two organisms in the two freshwater types. Our results show that colder areas, i.e. of high latitude and altitude, comprising large quantities of lacustrine water bodies have higher CF due to the high sensitivity of freshwater organisms in these areas plus the long residence time of P in lakes. In Europe, CFs based on the effect models generally differed up to two orders of magnitude, with AEF-based CFs generally lower than those based on MEF and on LEF (with the exception of those based on lake autotrophs). This study points towards the deviations between current effect models currently used in life cycle impact assessment.

# OLC-IMPACT



## 2.1 Introduction

The flow of phosphorus through the Earth's surface has increased dramatically (Liu et al., 2008). As a result, aquatic eutrophication is currently the primary water quality issue worldwide (Björklund et al., 2009). In freshwaters, algal growth is mainly attributed to phosphorus (P) but shifts in taxa richness as a result of increasing P levels may also occur (Schindler, 1977; Struijs et al., 2011b).

Given that the relationship between species richness and P concentrations differ across world's regions (Amarasinghe and Welcomme, 2002; Azevedo et al., in press), it is important that spatial specificity is taken into account in estimating the ecological effects of eutrophication. Currently, spatially-explicit models of the ultimate effects of emissions of P to species richness in freshwaters are not available on large spatial scales (i.e. continent or worldwide).

The goal of this study was to develop spatial-explicit quantitative relationships between the emisssion of P and relative species richness losses in inland freshwaters on the global scale, described in life-cycle impact assessment (LCIA) by the use of characterisation factors (Udo de Haes et al., 2002). Endpoint CF are available for European freshwaters yet they are site-generic and do not address potential differences across regions exposed to nutrient increases (Payet, 2006; Struijs et al., 2011a). This step is crucial to understanding the extent of the potential effects of P discharges to freshwater biodiversity and to identifying which world's regions may trigger the highest impacts via eutrophication. For that reason, it is important to consider site-specificity in LCIA (Seppälä et al., 2004).

Given that characterisation factors can be determined in different ways, their results may depend on which method was employed. For example, the relationship between the levels of a stressor and the ecological effects may be considered to be linear or not (Pennington et al., 2004). In addition, the target levels of a stressor may have been specified or not (Huijbregts et al., 2011); or the actual level of a stressor in the environment may be known or not.

## 2.2 Material and methods

#### 2.2.1 Characterisation models

We derived endpoint CFs  $(day \cdot m^3 \cdot kg^{-1})$  for four different biotic endpoints: autotrophs in lakes, autotrophs in streams, heterotrophs in lakes and heterotrophs in streams. The CFs were derived for total phosphorus (TP) with a 0.5° x 0.5° grid resolution as

$$CF_{i,s,w} = \sum_{j} \left( FF_{i \to j} \cdot EF_{j,s,w} \right)$$
<sup>(1)</sup>

where  $CF_{i,s,w}$  is the characterisation factor of emitting grid *i* for species group *s* (autotrophs or heterotrophs) in freshwater type *w* (lake or stream),  $FF_{i\rightarrow j}$  (day) is the partial fate factor for grid *i* to downstream grid *j* and  $EF_{j,s,w}$  is the effect factor for species group *s* in freshwater type *w* (lake or stream) in grid *j* (m<sup>3</sup>·kg<sup>-1</sup>). Hereafter, all references to P stand for the total P (TP), which is the summation of dissolved and particulate fractions of organic and inorganic P fractions.

Within LC-IMPACT, we also derived midpoint CFs (days), described by Helmes et al. (2012) as  $CF_i = \sum_j (FF_{i \to j})$ 





#### 2.2.2 Fate factors

The partial fate factors ( $FF_{i \rightarrow j}$ , unit: day) were derived by Helmes et al. (2012) and they describe the transport of P emitted to water compartment as

$$FF_{i \to j} = f_{i \to j} \cdot \tau_j \tag{2}$$

where  $f_{i \rightarrow j}$  is the fraction of P transported from emitting grid *i* to downstream grid *j* and  $\tau_j$  is the persistence of P in grid cell *j* (days). The fraction of P transported from *i* to *j* was defined by Helmes et al. (2012) as

$$f_{i \to j} = \prod_{l=i}^{j-1} \frac{k_{adv,l}}{k_{adv,l} + k_{ret,l} + k_{use,l}}$$
(3)

and

$$\tau_j = \frac{1}{k_{adv,l} + k_{ret,l} + k_{use,l}} \tag{4}$$

where advection  $(k_{adv,l})$  is the rates at which water volume in rivers and lakes is transported to a downstream grid, retention  $(k_{ret,l})$  is the rate of biotic uptake and particle adsorption or sedimentation, and water use  $(k_{use,l})$  is the withdraw rate of human water consumption (Helmes et al., 2012). The transport of P from an emitting grid *i* to *j* could have occurred into and through one or both freshwater types *w* (lakes or streams) within a given grid. A more detailed description of the derivation of  $FF_{i\rightarrow j}$  is described by Helmes et al. (2012).

#### 2.2.3 Effect factors

Three types of effect factors were developed based on observational field observations described as the potentially not occurring fraction (PNOF, dimensionless) (van Zelm et al., 2007) of freshwater species and total P (TP) concentrations. PNOF – TP log-logistic relationships are reported as

$$PNOF_{j,s,w} = 1 - RSR_{j,s,w}$$
(6)

and

$$RSR_{j,S,W} = \frac{1}{1 + e^{-\left(\frac{\log_{10} C_{j,S,W} - \alpha_{j,S,W}}{\beta_{j,S,W}}\right)}}$$
(7)

where  $RSR_{j,s,w}$  is the relative species richness of group *s* in freshwater type *w* in grid *j*;  $C_{j,w}$  is the TP concentration in freshwater *w* in grid *j* (kgP·m<sup>-3</sup>),  $\alpha$  is the <sup>10</sup>log concentration of TP at which PNOF equals 0.5,  $\beta$  is the slope of the log-logistic function. RSR is described for the two freshwater types (lakes and streams), two species groups (autotrophs and heterotrophs), in four different world's regions [cold, temperate, (sub)tropical, and xeric] by Azevedo et al. (in press). We





allocated each region to its respective grid *j* using their geographical location in ArcGIS (see Appendix 2-I of the Supporting Information for the description of the allocation procedure).

The linear *EF* model, hereafter named *LEF* (unit:  $m^3 \cdot kgP^{-1}$ ), assumes a linear change of PNOF with increasing TP levels. It is commonly used in ecotoxicology (Rosenbaum et al., 2008) and it represents the average effect between the TP concentration at which PNOF equals to 0.5 and a TP target level equal to zero. It is described as

$$LEF_{j,s,w} = \frac{\Delta PNOF_{j,s,w}}{\Delta C_{j,w}} = \frac{(0.5-0)}{(10^{\alpha_{j,s,w}}-0)}$$
(8)

where  $10^{\alpha_{j,s,w}}$  is the TP concentration that affects 50% of the species *s* in freshwater *w* in grid *j* (kg P·m<sup>-3</sup>).

The marginal effect factor model, hereafter named MEF (m<sup>3</sup>·kgP<sup>-1</sup>), is the change in PNOF with a marginal increase in TP in  $C_{j,w}$  (kgP·m<sup>-3</sup>) (Van de Meent and Huijbregts, 2005). It is described as

$$MEF_{j,s,w} = \frac{\partial PNOF_{j,s,w}}{\partial C_{w,j}} = PNOF_{j,s,w} \cdot \left(1 - PNOF_{j,s,w}\right) \frac{1}{\frac{C_{j,w}}{10^{\alpha_{j,s,w}} \beta_{j,s,w} \cdot \ln(10)}} \cdot \frac{1}{10^{\alpha_{j,s,w}}}$$
(9)

The average EF, AEF (m<sup>3</sup>·kgP<sup>-1</sup>), assumes a linear change in PNOF with increasing TP as does *LEF*. However, as opposed to *LEF*, where the default concentration in the environment is  $10^{\alpha_{j,s,w}}$ , *AEF* employs the actual concentration of TP in grid *j* (Huijbregts et al., 2011) to estimate the average distance between PNOF at  $C_{j,w}$  and at the TP target level. It is described as

$$AEF_{j,s,w} = \frac{\Delta PNOF_{j,s,w}}{\Delta C_{j,w}} = \frac{(PNOF_{j,s,w}-0)}{(C_{j,w}-0)}$$
(10)

#### 2.2.4 Input data

The input data for the fate factors necessary to compute the  $FF_{i \rightarrow j}$ , which include water use, water advection, and phosphorus retention rates, are described in detail by Helmes et al. (2012). The input parameters for the EF are the log-logistic regression coefficients  $\alpha_{j,s,w}$  and  $\beta_{j,s,w}$  and TP levels  $C_{j,w}$  and they are described below.

We allocated each region, i.e. cold, temperate, xeric, and (sub)tropical, to its respective grid *j*. This classification of regions was based on the work by Azevedo and colleagues (in press) (see Appendix 2-I of the Supporting Information for the description of the allocation procedure). The input parameters  $\alpha$  and  $\beta$  relative to species group *s* in freshwater *w* in each region are shown in Table 2.1. Grid-specific EFs were not computed in case log-logistic regression parameters ( $\alpha$  and  $\beta$ ) were not available for the organism group in the given freshwater type and region. That was the case for autotrophs in (sub)tropical lakes and in xeric and cold streams and heterotrophs in (sub)tropical and xeric lakes and in (sub)tropical, xeric, and cold streams.

For the calculation of the CFs based on *MEF* and the *AEF*, mean TP concentrations of lakes and streams were used as the concentration in freshwater *w* in grid *j* ( $C_{j,w}$ ). For that, we obtained the annual mean TP concentration data measured at lake and stream monitoring stations reported by the European Environment Agency (EEA), see Appendix 2-II. Grid-specific  $C_{j,w}$  are shown in Figure 2.5 (Appendix 2-II).





We compared how  $CF_{i,s,w}$  results across the three types of effect factors (*LEF*, *MEF*, and *AEF*) using spearman correlation. We used the ratio between  $CF_{i,s,w}$  results to compare the relative difference between the EF types.

#### 2.2.5 Normalization

The CFs described above relate to the fraction of P that is discharged into the water compartment hence the transport of P in the terrestrial compartment, i.e. before P is discharged to water bodies, is not taken into account in the characterization model (Eq. 1). Of the two emission sources contributing to freshwater eutrophication (i.e. point and non-point), the fate of P in the terrestrial compartment is relevant for non-point sources, which can be further divided into manure and industrial agricultural fertilizers. In the following, we describe how the transport of P within the soil compartment can be included in order to derive normalization scores (NS) for non-point sources. In addition, we describe the methodology and the data employed to derive NS for urban wastewater plants and manure and synthetic fertilizers.

#### Emission data - Point sources

We calculated emissions from sewage treatment plants to the water compartment ( $E_{Sew}$ , kgP· day<sup>-1</sup>) for the year 2000 for three different urban wastewater sources, i.e. human sewage and laudry and dishwasher detergent (Van Drecht et al., 2009) in each grid (0.5° x 0.5° spatial resolution).  $E_{Sew}$  can be described as

$$E_{Sew} = E_{Hum} + E_{Det} + E_{Dish} \tag{11}$$

The emissions from human waste  $(E_{Hum})$ , laundry detergent  $(E_{Det})$ , and dishwasher detergent  $(E_{Dish})$ , kgP· day<sup>-1</sup>, depend on the fraction of the population that is connected to a wastewater treatment plant (D, dimensionless), efficiency of P removal rate at the wastewater treatment plant (R, dimensionless), the load of sewage entering the treatment plant, i.e.  $S_{Hum}$ ,  $S_{Det}$ , and  $S_{Dish}$  (kgP·person<sup>-1</sup>·day<sup>-1</sup>), the number of inhabitants in the grid (Pop), among other factors (Van Drecht et al., 2009). They can be individually calculated as

$$E_{Hum} = \left(\frac{S_{Hum}}{D}\right) \cdot (1-R) \cdot Pop \tag{12}$$

for human sewage emissions

$$E_{Det} = \left(\frac{S_{Det}}{D}\right) \cdot (1-R) \cdot Pop \tag{13}$$

for laundry detergent and

 $E_{Dish} = S_{Dish} \cdot (1-R) \cdot Pop \tag{14}$ 

for dishwashwer detergent.





(15)

(16)

Grid-specific population count data (Pop, unit: person) was obtained with the CIESIN and CIAT (2005) raster dataset for the year 2000. We used the spatial analyst tool in ArcGIS to sum the UN-adjusted 2.5'-resolution raster dataset to acquire 0.5° x 0.5° grid-specific Pop data.

Since van Drecht et al. (2009) report country-specific emissions, we employed the UNadjusted 2.5'-resolution population density data for the year 2000 (CIESIN and CIAT 2005) to weight the emission sources across grids within each individual country and to obtain grid-specific emission data from the dataset from van Drecht et al. (2009). Thus, we assume that emissions of P to the water compartment from sewage treatment plants occur proportionally to the density of the population of a country.

#### Emission data - Non-point sources

The emission of manure and synthetic fertilizer to soil (kgP· day<sup>-1</sup>) is given as

$$E_{Fert,soil} = E_{Man} + E_{fert}$$

In the case of non-point emissions of P applied into soil (via manure and synthetic fertilizer applications, unit: kgP· day<sup>-1</sup>), we should estimate the fraction of P which is lost from the soil into the water compartment. The fate factor *SF* (dimensionless) represents the fraction of P emitted from non-point source (i.e. manure or synthetic fertilizer) from the terrestrial to the freshwater compartments. Here, we consider *SF* equals to 0.1 (Bouwman et al., 2009) and it has been recently used as a default global transfer fraction elsewhere, i.e. Sattari (2012). A *SF* equal to 0.1 implies that 10% of the P fertilizer applied into agricultural soils is lost to freshwater bodies while the remaining fraction can be either taken up by crops as nutrient or retained in the soil compartment after adsorption to soil particles. As opposed to nitrogen, P does not have a relevant fraction that is transported via the atmospheric compartment. We assume the lost of P from the terrestrial to the freshwater compartment occurs immediately after its application as fertilizer. Thus, the emission from the two fertilizer types to water can be given as

$$E_{Fert,water} = SF \cdot E_{Fert,soil}$$

We collected data on synthetic P fertilizer consumption (kgP<sub>2</sub>O<sub>5</sub> yr<sup>-1</sup>) in 2010 from the FAOSTAT database (http://faostat.fao.org) on March 12<sup>th</sup>, 2013. We converted the FAO data from kgP as P<sub>2</sub>O<sub>5</sub> (containing 43.7% in atomic weight of P) to kgP. We here assume that all the consumed synthetic P fertilizer in 2010 was emitted to soil ( $E_{NP}$ , kgP·yr<sup>-1</sup>) in the same year. Similarly to van Drecht et al. (2009), the FAO does not report consumption per grid but per country. Hence, we calculated the relative contribution of synthetic fertilizer consumption across grids within each individual country by employing a dataset of 0.5°-specific yearly synthetic P fertilizer application rates (Potter et al. 2011).

For manure fertilizers, we employed the 0.5°-specific yearly manure P fertilizer application rates (Pottery et al. 2011), relative to the period of 1994 to 2001 (kgP·ha<sup>-1</sup>). We converted the unit of the application rate from kgP·ha<sup>-1</sup>·yr<sup>-1</sup> to kgP<sup>-1</sup>·day<sup>-1</sup> in a given grid using the relationship of 0.5° equal to 1.852 km.





#### Normalization scores

#### Not weighted by inhabitant

Non-weighted grid-specific normalization scores (NS, unit: m<sup>3</sup>) for the three types of point sources of P are described as:

## $NS_{Non-weight} = (E_{Sew} + E_{Fert,water}) \cdot CF_{s,w}$ <sup>(17)</sup>

where  $CF_{s,w}$  (day·m<sup>3</sup>·kg<sup>-1</sup>) is the average of the available linear effect factor (LEF) based characterization factors for species group *s* in freshwater type *w* in a given grid. The number of available CFs in a grid can be one, i.e. in (sub)tropical and xeric grids, two, i.e. in cold grids, or four, i.e. in temperate grids (Table 2.2). In this study, we report  $CF_{s,w}$  based on three effect factor types (*LEF*, *MEF*, and *AEF*) and for four biotic endpoints (autotrophs and heterotrophs in lakes and streams). For individual life cycle impact assessments on a global scale, we recommend the use of the CF based on the linear effect factor *LEF* since it is the only of the three effect factors described above which could be determined on a global scale. The choice between the groud biotic endpoints will depend on the location of the emission. For example, if the emission occurred in northern Canada, it can be based in either autotrophs or heterotrophs in lakes while those occurring in (sub)tropical South America would be based on autotrophs in streams.

To obtain NS on the country, continent, and world resolution, grid-specific NS located within the spatial unit of interest (e.g. country), should be summed. The geographical location of the grid is given in the excel file, with latitude and longitude data on the grid's centroid.

**Table 2.2** Available CFs for each world region. The CF  $(day \cdot m^3 \cdot kg^{-1})$  to be used to derive normalization scores is the average of the available CFs for the grid, which depends on the species group, freshwater type, and region where the grid is located.

	Autotroph		Hetero	otroph
Region	Lake	Stream	Lake	Stream
(Sub)tropical	Not available	Available	Not available	Not available
Xeric	Available	Not available	Not available	Not available
Temperate	Available	Available	Available	Available
Cold	Available	Not available	Available	Not available

#### Weighted by inhabitant

Inhabitant-weighted grid-specific normalization scores (NS, unit: m<sup>3</sup>·person<sup>-1</sup>) are described

as:  

$$NS_{Weight} = \frac{NS_{Non-weight}}{Pop}$$
(18)

Similarly to non-weighted NS, grid-specific NS values should be summed across the grids located within the spatial unit of interest, i.e. country, continent, and world, in order to obtain country, continent, or world-specific NS.

# OLC-IMPACT



## 2.3 Results

Our results show that the *LEF* in the temperate region ranged from 397 to 1733 d·kgP<sup>-1</sup>·m<sup>3</sup> for lake autotrophs and stream heterotrophs, respectively (Figure 2.1). The highest *MEF* and *AEF* occur at TP concentrations ranging from 3.2E-4 to 1.0E-3 kgP·m<sup>-3</sup> for lake heterotrophs (Figure 2.1b). and 3.0E-4 to 5.0E-4 kgP·m<sup>-3</sup> for stream organisms (Figure 2.1c-d). Given that a high frequency of grids comprised  $C_{j,w}$  levels below the level which maximizes *MEF* and AEF (Figure 2.1b-d), our results show that CFs based on *LEF* are generally higher than those based on *MEF* and AEF (Figure 2.3 and Appendix 2-III). The differences between CFs based on *LEF* and those based on *MEF* and *AEF* were up to two orders of magnitude (Figure 2.9, Figure 2.10, Figure 2.11, and Figure 2.12 in Appendix 2-III). At  $C_{j,w}$  between 1.0E-3 and 1.0E-2 kgP·m<sup>-3</sup>, *AEF* was higher than *MEF* despite the fact that such TP levels were not frequent. This resulted in *MEF* and *AEF* differences within one order of magnitude in European grids.

As opposed to the other biotic endpoints, the lowest EFs for temperate lake autotrophs were found at the most eutrophic conditions (i.e. high  $C_{j,w}$ , Figure 2.1a). This is caused by a rapid decrease in PNOF values at decreasing  $C_{j,w}$  as opposed to the slower decrease in PNOF in other biotic endpoints. The four biotic endpoints generally differed up to two orders of magnitude for the concentration-dependent CFs, i.e. *MEF* and *AEF*, with heterotrophs comprising lower CFs than those for autotrophs in streams (Figure 2.14 and Figure 2.15 in Appendix 2-III).

CFs results based on *LEF* show that the highest impacts on lakes due to discharge of P to freshwaters would occur from emissions in high latitudes of the northern hemisphere, mountainous areas such as the Andes, the Himalayas, and the Zagros, and world's regions comprising high fractions of lake water, e.g. lakes Victoria and Baikal (Figure 2.2a-b). Grid, country, continent, and world CFs, emission data, and normalization scores can be found in Appendix 2-IV, Appendix 2-V, and Appendix 2-VI, respectively.

## 2.4 Discussion

We derived 0.5° x 0.5° endpoint CFs for freshwater eutrophication using three different types of EFs, i.e. linear (*LEF*), marginal (*MEF*), and average (*AEF*). The types differed in respect to the slope of the PNOF changes following TP increases, inclusion of a target TP level, and consideration of TP levels in the environment. In the following, we discuss the main factors driving (1) the differences between the CF types in a given region and (2) the differences of CFs results across regions. We also discuss the main uncertainties of our study and provide recommendations on the most appropriate effect factor to be used in LCIA methodology. Given that the *LEF* method is the only one that does not require that the actual P concentration in the environment  $C_{j,w}$  is known, comparisons of CFs across regions were limited to those based on *LEF*. Additionally, we limited the comparison between CFs based on *LEF*, *MEF*, and *AEF* to Europe, where  $C_{j,w}$  were widely available.

#### 2.4.1 Differences between characterisation factor types

The EFs based on *LEF* were mostly larger compared to those based on actual TP levels, which resulted in higher CFs. That occurred because the majority of grids comprise  $C_{j,w}$  below the level which maximizes EFs. That reveals that, at current trophic conditions, the *LEF* method is a





conservative approach to quantify the impacts of P emissions to freshwaters. Ultimately, the choice of which EF to be employed drives is therefore crucial in determining CFs.

The *MEF* represents the change in PNOF due to a marginal change in  $C_{j,w}$  and, as opposed to *AEF*, it does not specify a target TP level ( $C_{j,w}$ =0). As a result, for P increases in already eutrophic freshwaters (i.e.  $C_{j,w}$  above 1.0E-3 kgP·m<sup>-3</sup>), *AEF*-based CFs of generally one order of magnitude higher than CFs based on *MEF*. Ultimately, a LCIA practitioner employing *MEF* might find little damage from further P discharges into freshwaters that were already subjected to past eutrophication (Huijbregts et al., 2011). Such eutrophic conditions, nevertheless, were seldom reported by the EEA.

The regional differences in CFs based on *LEF* for a similar biotic endpoint (i.e. autotrophs or heterotrophs in lakes or streams) are due to the differentiated fate factors in each grid cell and thermal differences in freshwaters. Given the slow flow of waters in lakes compared to rivers, P is retained for a longer period of time before being transported downstream (Helmes et al., 2012). In addition, environmental impacts may be reduced if species are exposed to more mild temperatures, as observed in fish in Finish lakes (Posch et al., 2012). Ultimately, regions of the world comprising large fractions of lake water, e.g. the African or North American Great Lakes areas, or with more adverse temperature regimes, e.g. cold regions, will encompass larger CFs.

#### 2.4.2 Effect factor uncertainties

The effect models of this study imply that the best-case scenario for P control in freshwaters is at environmental target ( $C_{j,w}$ ) equals zero. Nevertheless, a qualitative interpretation of what this target stands for is vital. In the *MEF* and *AEF*, the environmental footprint of eutrophication decreases with decreasing  $C_{j,w}$  (with the exception of temperate lake autotrophs). However, P is also an essential nutrient that is necessary at levels above zero (Azevedo et al., in press). In this study, we do not employ the target TP level as defined by Azevedo and colleagues (Unpublished) as this would imply that no environmental impact takes place following a TP level increase from current oligotrophic conditions to a target TP level. Furthermore, it is important to note that PNOF should be strictly interpreted as the inverse of relative species richness and it does not take into account specific changes to species composition, e.g. favoring of cyanobacteria or competitive exclusion of endemic species.

We used annual mean TP data per grid to represent  $C_{j,w}$ . Especially in cold regions (i.e. high latitude and altitude areas) there can be considerable variability in TP exposure throughout the year. As opposed to warmer freshwaters, the ecological damage in cold areas is mostly occurring in the summer months, when biological uptake is activated (Carpenter et al., 2001). For reasons of consistency, we employed mean annual concentration data despite the fact that colder regions may comprise larger temporal variability in their effect factors than warmer areas.

We used  $C_{j,w}$  from neighboring monitoring stations to account for the lack of monitoring data in certain grids. 32.14% and 60.16% of European grids contained at least one lake or stream monitoring station within it, respectively (Figure 2.4 in Appendix 2-II). The extrapolation of monitoring TP data to adjacent grids lacking monitoring stations was a necessary step since a CF is the summation of the impact to downstream grids and, by not accounting for grids where TP was not reported, their associated emitting grid would be underestimated compared to emitting grids having monitored downstream water bodies.





The results for heterotrophs in European streams obtained in this study can be compared with existing European-generic endpoint CFs based on MEF for stream macroinvertebrates (Struijs et al., 2011a). The TP levels used to derive our EFs (average TP in grids equals 0.06 mg P·L<sup>-1</sup>) were generally lower TP levels than did Struijs and colleagues (average TP in river catchments equals 2.1E-4 kg P·m<sup>-3</sup>) (Struijs et al., 2011a). We attribute that to the fact that Struijs and colleagues (Struijs et al., 2011a) use the main river catchments in Europe, that encompass stronger stream flow and higher quantities of (P-rich) soil particles than less polluted upstream tributaries (Nour et al., 2006) included in our study. Even so, the average MEF they find (average of 163 m<sup>-3</sup>·kg P) is considerably lower than the *MEF* reported in our study (average in European grids equaled 323) kg·m<sup>-3</sup>). An important model choice difference between our study and the study of Struijs and colleagues is that they attribute a no-effect (MEF = 0) to TP levels below the optimum of 1.0E-4 kg  $P \cdot m^{-3}$  while we still derive *MEF* for changes in PNOF due to marginal changes in TP in oligotrophic conditions. A second motive is attributed to the fact that the PNOF is not based on richness of genera but on a lower taxonomic level (i.e. species). Biological monitoring also reported a lack of sensitivity to stream impairment at the family taxonomic level but not at the species level (Lenat and Resh, 2001). This discrepancy was attributed to intensive adaptive radiation (Lenat and Resh, 2001).

20

### 2.4.3 Relevance, applicability and further research recommendations

This work derived endpoint CFs for freshwater eutrophication on a global scale using linear effect factors and, on an European scale, using linear, marginal, and average effect factors. The results of this work are relevant for the assessment of the impacts of P-triggered eutrophication in freshwaters. In the context of LCIA, the added value of this work compared to the currently recommended endpoint characterisation model (Struijs et al., 2011a) is (1) that it extends endpoint characterisation models to the global scale, which, up to know, were restricted to Europe, (2) it includes effects to autotrophs as well as heterotrophs and lakes as well as streams, and (3) it provides region-dependent effect factors. On a global scale, we were able to derive CFs based on linear effect factors that did not require the environmental concentration of P as an input parameter. On the European level, we were able to derive CFs based on two species types (autotrophs and heterotrophs) and two freshwater types (lakes and streams).

#### 2.4.4 Concluding remarks

Despite the increase in model complexity and parameter requirement compared to the *LEF*, we recommend that future LCIA methodologies take into account the actual TP concentration in freshwater by using the TP-dependent effect factors (*MEF* or *AEF*) in the derivation of CFs because the EFs are highly dependent on the actual TP levels. Meanwhile, the use of the concentration-independent *LEF* may be used for LCIA on a global scale until the thorough monitoring of TP levels in freshwaters is made. Finally, it is important for disparate water quality monitoring efforts worldwide to expand their geographic scope and improve data sharing.

We suggest that future research for effect factors for freshwater eutrophication should include (1) an expanded water quality monitoring data to non-European freshwaters, (2) a further description of the PNOF – TP relationships that were not available in this study, e.g. heterotrophs in (sub)tropical freshwaters, and, as already recommended by others (Helmes et al., 2012), and (3)





a thorough discussion on what the target P level should be and if species richness is an appropriate biotic endpoint in LCIA (Curran et al., 2010).

## 2.5 Published peer-reviewed deliverables

Azevedo, L.A., Van Zelm, R., Elshout, P.M.F., Hendriks, A.J., Leuven, R.S.E.W., Struijs, J., de Zwart, D., Huijbregts, M.A.J., In press. Species richness – phosphorus relationships for lakes and streams worldwide. Global Ecology and Biogeography.

Helmes, R.J.K., Huijbregts, M.A.J., Henderson, A.D., Jolliet, O., 2012. Spatially explicit fate factors of phosphorous emissions to freshwater at the global scale. International Journal of Life Cycle Assessment 17, 646-654.

Struijs, J., De Zwart, D., Posthuma, L., Leuven, R.S.E.W., Huijbregts, M.A.J., 2011. Field sensitivity distribution of macroinvertebrates for phosphorus in inland waters. Integrated Environmental Assessment and Management 7, 280-286.



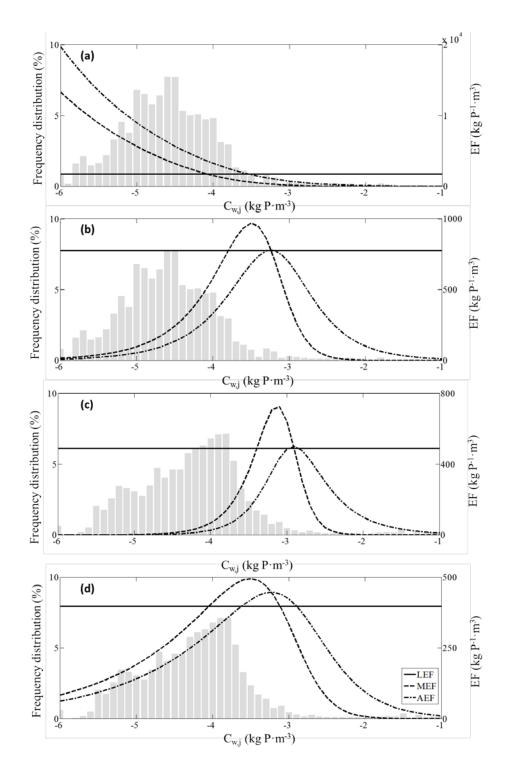


## 2.6 Tables and figures

**Table 2.1**: Coefficients  $\alpha$  and  $\beta$  for autotrophs and heterotrophs based on TP concentrations (kg P·m<sup>-3</sup>) reported by Azevedo and colleagues (Unpublished).

Region	α	β	
Lake autotrophs			
Temperate	-3.52 (-3.66 to -3.38)	-0.63 (-0.78 to -0.48)	
Cold	-3.64 (-3.76 to -3.52)	-0.53 (-0.67 to -0.40)	
Xeric	-2.97 (-3.07 to -2.86)	-0.39 (-0.50 to -0.28)	
Lake heterotrophs			
Temperate	-3.19 (-3.23 to -3.15)	-0.24 (-0.281 to -0.21)	
Cold	-4.37 (-4.43 to -4.31)	-0.12 (-0.18 to -0.07)	
Stream autotrophs			
(Sub)tropical	-3.56 (-3.64 to -3.48)	-0.41 (-0.50 to -0.33)	
Temperate	-2.99 (-3.02 to -2.96)	-0.17 (-0.20 to -0.15)	
Stream heterotrophs			
Temperate	-2.87 (-3.02 to -2.71)	-0.32 (-0.36 to -0.29)	

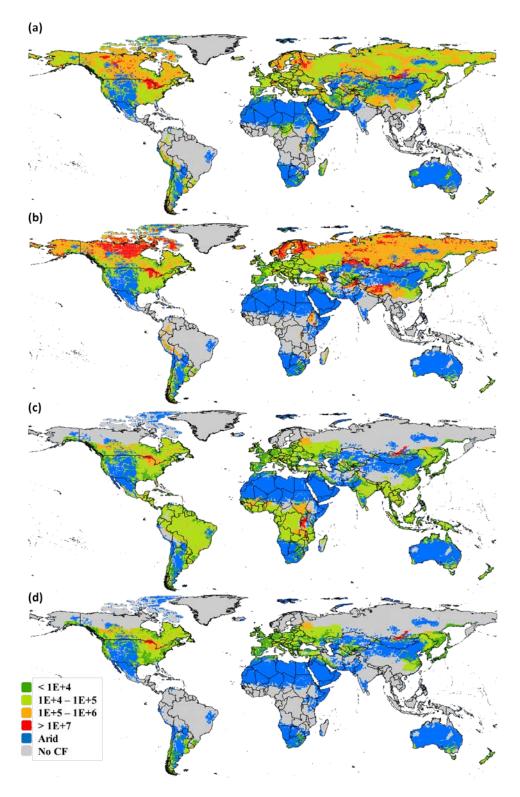




**Figure 2.1**: The linear (*LEF*), marginal (*MEF*), and average (*AEF*) effect factors (EF, right axis) represented by the continuous, dashed, and dot-dashed lines, respectively for (a) lake autotrophs, (b) lake heterotrophs, (c) stream autotrophs, and (d) stream heterotrophs along TP levels ( $^{10}\log C_{w,j}$ ) in temperate European grids. The frequency distribution (left axis,) of TP concentration in temperate lakes (a-b) and streams (c-d) in European grids is shown by the grey bars.



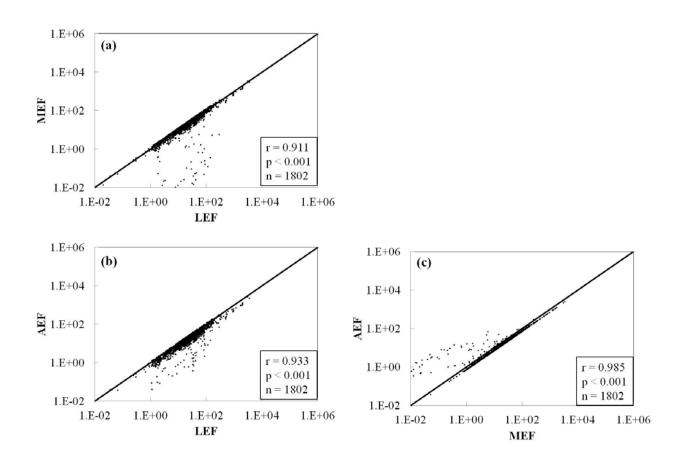




**Figure 2.2**: Characterisation factors (CFs, day·kg·P<sup>-1</sup>·m<sup>3</sup>) using the linear effect factors (*LEF*) for (a) lake autotrophs, (b) lake heterotrophs, (c) stream autotrophs, and (d) stream heterotrophs. For grey areas log-logistic regression coefficients were not available.







**Figure 2.3**: Comparison between characterisation factors (CFs, day·kgP<sup>-1</sup>·m<sup>3</sup>) using the linear (*LEF*), marginal ((*MEF*), and average (*AEF*) effect factors in each emitting grid for stream heterotrophs. Results of the spearman correlation (correlation coefficient, sample size, and p value) are shown on the bottom right of each graph. The same comparisons for lake autotrophs and heterotrophs and stream autotrophs are shown in Appendix 2-III.





## 2.7 Supporting information

#### Appendix 2-I: Allocation of grids to their respective region

First, each 0.5° x 0.5° grid was allocated to its respective freshwater ecoregion using the map provided by Robin Abell and colleagues (2008) in ArcGIS 9.2 and classified each MHT type into four regions following Azevedo and colleagues (Unpublished). The list of freshwater ecoregions, their respective MHT class, and the re-classified habitat type is shown in Table 2.2 of this appendix. All oceanic islands MHT classes were re-classified to the (sub)tropical region. The ecoregions within large lakes and large river deltas MHT classes were re-classified based on their closest ecoregion.

26

Ecoregion as defined by Abell and colleagues (2008)	Original MTH name as defined by FEOW	Region
Aceh	tropical and subtropical coastal rivers	(sub)tropical
Aegean Drainages	temperate coastal rivers	temperate
Alaska & Canada Pacific Coastal	temperate coastal rivers	temperate
Alaskan Coastal	polar freshwaters	cold
Albertine Highlands	montane freshwaters	cold
Amatolo - Winterberg Highlands	montane freshwaters	cold
Amazonas Estuary & Coastal Drainages	large river deltas*	(sub)tropical
Amazonas Guiana Shield	tropical and subtropical upland rivers	(sub)tropical
Amazonas High Andes	montane freshwaters	cold
Amazonas Lowlands	tropical and subtropical floodplain rivers and wet	(sub)tropical
Ameca - Manantlan	tropical and subtropical coastal rivers	(sub)tropical
Anadyr	polar freshwaters	cold
Andaman Islands	oceanic islands*	(sub)tropical
Apalachicola	temperate floodplain rivers and wetlands	temperate
Appalachian Piedmont	temperate coastal rivers	temperate
Arabian Interior	xeric freshwaters and endorheic (closed) basins	xeric
Arafura - Carpentaria	tropical and subtropical coastal rivers	(sub)tropical
Aral Sea Drainages	large lakes*	temperate
Argun	temperate upland rivers	temperate
Ashanti	tropical and subtropical coastal rivers	(sub)tropical
Atacama	xeric freshwaters and endorheic (closed) basins	xeric

**Table 2.2:** Allocation of each ecoregion to its respective original MHT (following the Freshwater Ecoregions

 Of The World definition, http://www.feow.org) and the new habitat name for the purpose of this study.





Ecoregion as defined by Abell		
and colleagues (2008)	Original MTH name as defined by FEOW	Region
Atlantic Northwest Africa	temperate coastal rivers	temperate
Bahama Archipelago	tropical and subtropical coastal rivers	(sub)tropical
Balkash - Alakul	xeric freshwaters and endorheic (closed) basins	xeric
Baluchistan	xeric freshwaters and endorheic (closed) basins	xeric
Bangweulu - Mweru	tropical and subtropical floodplain rivers and wet	(sub)tropical
Barents Sea Drainages	polar freshwaters	cold
Bass Strait Drainages	temperate coastal rivers	temperate
Bight Drainages	tropical and subtropical coastal rivers	(sub)tropical
Bismarck Archipelago	tropical and subtropical coastal rivers	(sub)tropical
Bonaerensean Drainages	temperate coastal rivers	temperate
Bonneville	xeric freshwaters and endorheic (closed) basins	xeric
Borneo Highlands	tropical and subtropical upland rivers	(sub)tropical
Canadian Arctic Archipelago	polar freshwaters	cold
Canadian Atlantic Islands	temperate coastal rivers	temperate
Cantabric Coast - Languedoc	temperate coastal rivers	temperate
Cape Fold	temperate coastal rivers	temperate
Caspian Highlands	xeric freshwaters and endorheic (closed) basins	xeric
Caspian Marine	large lakes*	temperate
Central & Eastern Java	tropical and subtropical coastal rivers	(sub)tropical
Central & Western Europe	temperate floodplain rivers and wetlands	temperate
Central Anatolia	xeric freshwaters and endorheic (closed) basins	xeric
Central Andean Pacific Slopes	xeric freshwaters and endorheic (closed) basins	xeric
Central Arctic Coastal	polar freshwaters	cold
Central Prairie	temperate upland rivers	temperate
Chaco	tropical and subtropical floodplain rivers and wet	(sub)tropical
Chagres	tropical and subtropical coastal rivers	(sub)tropical
Chao Phraya	tropical and subtropical floodplain rivers and wet	(sub)tropical
Chesapeake Bay	temperate coastal rivers	temperate
Chiapas - Fonseca	tropical and subtropical coastal rivers	(sub)tropical
Chin Hills - Arakan Coast	tropical and subtropical coastal rivers	(sub)tropical
Chiriqui	tropical and subtropical coastal rivers	(sub)tropical
Chuya	montane freshwaters	cold
Coastal Amur	temperate coastal rivers	temperate
Coastal East Africa	tropical and subtropical coastal rivers	(sub)tropical





Ecoregion as defined by Abell and colleagues (2008)	Original MTH name as defined by FEOW	Region
Coastal Fujian - Zeijang	tropical and subtropical coastal rivers	(sub)tropical
Coastal Levant	xeric freshwaters and endorheic (closed) basins	xeric
Coatzacoalcos	tropical and subtropical coastal rivers	(sub)tropical
Colorado	xeric freshwaters and endorheic (closed) basins	xeric
Columbia Glaciated	temperate upland rivers	temperate
Columbia Unglaciated	temperate floodplain rivers and wetlands	temperate
Crimea Peninsula	temperate coastal rivers	temperate
Cuanza	tropical and subtropical coastal rivers	(sub)tropical
Cuba - Cayman Islands	tropical and subtropical coastal rivers	(sub)tropical
Cumberland	temperate upland rivers	temperate
Cuvette Centrale	tropical and subtropical floodplain rivers and wet	(sub)tropical
Cuyan - Desaguadero	montane freshwaters	cold
Dalmatia	temperate coastal rivers	temperate
Death Valley	xeric freshwaters and endorheic (closed) basins	xeric
Dnieper - South Bug	temperate floodplain rivers and wetlands	temperate
Dniester - Lower Danube	temperate floodplain rivers and wetlands	temperate
Don	temperate floodplain rivers and wetlands	temperate
Drakensberg - Maloti Highlands	montane freshwaters	cold
Dry Sahel	xeric freshwaters and endorheic (closed) basins	xeric
Dzungaria	xeric freshwaters and endorheic (closed) basins	xeric
East Chukotka	polar freshwaters	cold
East Texas Gulf	temperate coastal rivers	temperate
Eastern Borneo	tropical and subtropical floodplain rivers and wet	(sub)tropical
Eastern Coastal Australia	tropical and subtropical coastal rivers	(sub)tropical
Eastern Gulf of Thailand Drainages	tropical and subtropical coastal rivers	(sub)tropical
Eastern Hudson Bay - Ungava	temperate coastal rivers	temperate
Eastern Iberia	temperate coastal rivers	temperate
Eastern Taiwan	tropical and subtropical coastal rivers	(sub)tropical
Eastern Yellow Sea Drainages	temperate coastal rivers	temperate
Eastern Zimbabwe Highlands	montane freshwaters	cold
Eburneo	tropical and subtropical coastal rivers	(sub)tropical
English - Winnipeg Lakes	large lakes*	temperate
Er Hai	montane freshwaters	cold
Esfahan	xeric freshwaters and endorheic (closed)	xeric





Ecoregion as defined by Abell	Original MTH name as defined by FEOW	Region
and colleagues (2008)	-	
	basins	/ 1
Essequibo	tropical and subtropical upland rivers	(sub)tropical
Estero Real - Tempisque	tropical and subtropical coastal rivers	(sub)tropical
Ethiopian Highlands	montane freshwaters	cold
Etosha	xeric freshwaters and endorheic (closed) basins	xeric
Fiji	oceanic islands*	(sub)tropical
Florida Peninsula	tropical and subtropical coastal rivers	(sub)tropical
Fluminense	tropical and subtropical coastal rivers	(sub)tropical
Fouta - Djalon	montane freshwaters	cold
Galapagos Islands	oceanic islands*	(sub)tropical
Ganges Delta & Plain	tropical and subtropical floodplain rivers and wet	(sub)tropical
Ganges Himalayan Foothills	tropical and subtropical upland rivers	(sub)tropical
Gila	xeric freshwaters and endorheic (closed) basins	xeric
Grijalva - Usumacinta	tropical and subtropical coastal rivers	(sub)tropical
Guapore - Itenez	tropical and subtropical upland rivers	(sub)tropical
Guianas	tropical and subtropical upland rivers	(sub)tropical
Gulf of St.Lawrence Coastal Drainages	temperate coastal rivers	temperate
Gulf of Venice Drainages	temperate coastal rivers	temperate
Guzman - Samalayuca	xeric freshwaters and endorheic (closed) basins	xeric
Hainan	tropical and subtropical coastal rivers	(sub)tropical
Hamgyong - Sanmaek	temperate coastal rivers	temperate
Hawaiian Islands	oceanic islands*	(sub)tropical
Helmand - Sistan	xeric freshwaters and endorheic (closed) basins	xeric
Hispaniola	tropical and subtropical coastal rivers	(sub)tropical
Honshu - Shikoku - Kyushu	temperate coastal rivers	temperate
Horn of Africa	xeric freshwaters and endorheic (closed) basins	xeric
Huang He Great Bend	temperate floodplain rivers and wetlands	temperate
Iceland - Jan Mayen	polar freshwaters	cold
lguassu	tropical and subtropical upland rivers	(sub)tropical
Indian Ocean Slope of Sumatra & Java	tropical and subtropical coastal rivers	(sub)tropical
Indus Himalayan Foothills	tropical and subtropical upland rivers	(sub)tropical
Inner Mongolia Endorheic Basins	xeric freshwaters and endorheic (closed) basins	xeric
Inner Niger Delta	tropical and subtropical floodplain rivers and wet	(sub)tropical





Ecoregion as defined by Abell and colleagues (2008)	Original MTH name as defined by FEOW	Region
Ionian Drainages	temperate coastal rivers	temperate
Irgyz -Turgai	xeric freshwaters and endorheic (closed) basins	xeric
Isthmus Caribbean	tropical and subtropical coastal rivers	(sub)tropical
Italian Peninsula & Islands	temperate coastal rivers	temperate
Jamaica	tropical and subtropical coastal rivers	(sub)tropical
Jordan River	xeric freshwaters and endorheic (closed) basins	xeric
Kafue	tropical and subtropical floodplain rivers and wet	(sub)tropical
Kalahari	xeric freshwaters and endorheic (closed) basins	xeric
Kamchatka & Northern Kurils	polar freshwaters	cold
Kapuas	tropical and subtropical floodplain rivers and wet	(sub)tropical
Karoo	xeric freshwaters and endorheic (closed) basins	xeric
Karstveld Sink Holes	xeric freshwaters and endorheic (closed) basins	xeric
Kasai	tropical and subtropical floodplain rivers and wet	(sub)tropical
Kavir & Lut Deserts	xeric freshwaters and endorheic (closed) basins	xeric
Khorat Plateau (Mekong)	tropical and subtropical floodplain rivers and wet	(sub)tropical
Kimberley	tropical and subtropical coastal rivers	(sub)tropical
Kolyma	polar freshwaters	cold
Koryakia	polar freshwaters	cold
Kratie - Stung Treng (Mekong)	tropical and subtropical floodplain rivers and wet	(sub)tropical
Kuban	montane freshwaters	cold
Kura - South Caspian Drainages	montane freshwaters	cold
Laguna dos Patos	temperate coastal rivers	temperate
Lahontan	xeric freshwaters and endorheic (closed) basins	xeric
Lake Baikal	large lakes*	temperate
Lake Chad	xeric freshwaters and endorheic (closed) basins	xeric
Lake Eyre Basin	xeric freshwaters and endorheic (closed) basins	xeric
Lake Issyk Kul - Upper Chu	large lakes*	temperate
Lake Malawi	large lakes*	(sub)tropical
Lake Onega - Lake Ladoga	large lakes*	temperate
Lake Rukwa	large lakes*	(sub)tropical





Ecoregion as defined by Abell and colleagues (2008)	Original MTH name as defined by FEOW	Region
Lake Tana	montane freshwaters	cold
Lake Tanganyika	large lakes*	(sub)tropical
Lake Turkana	large lakes*	(sub)tropical
Lake Van	xeric freshwaters and endorheic (closed) basins	xeric
Lake Victoria Basin	large lakes*	(sub)tropical
Laurentian Great Lakes	large lakes*	temperate
Lena	polar freshwaters	cold
Lerma - Chapala	xeric freshwaters and endorheic (closed) basins	xeric
Lesser Sunda Islands	oceanic islands*	(sub)tropical
Liao He	temperate floodplain rivers and wetlands	temperate
Llanos El Salado	xeric freshwaters and endorheic (closed) basins	xeric
Lower & Middle Indus	tropical and subtropical floodplain rivers and wet	(sub)tropical
Lower & Middle Salween	tropical and subtropical upland rivers	(sub)tropical
Lower & Middle Syr Darya	temperate upland rivers	temperate
Lower Amur	temperate floodplain rivers and wetlands	temperate
Lower Congo	tropical and subtropical floodplain rivers and wet	(sub)tropical
Lower Huang He	temperate floodplain rivers and wetlands	temperate
Lower Lancang (Mekong)	tropical and subtropical floodplain rivers and wet	(sub)tropical
Lower Mackenzie	polar freshwaters	cold
Lower Mississippi	temperate floodplain rivers and wetlands	temperate
Lower Niger - Benue	tropical and subtropical floodplain rivers and wet	(sub)tropical
Lower Nile	xeric freshwaters and endorheic (closed) basins	xeric
Lower Parana	temperate floodplain rivers and wetlands	temperate
Lower Rio Grande - Bravo	temperate floodplain rivers and wetlands	temperate
Lower Tigris & Euphrates	temperate floodplain rivers and wetlands	temperate
Lower Uruguay	tropical and subtropical upland rivers	(sub)tropical
Lower Yangtze	temperate floodplain rivers and wetlands	temperate
Lower Zambezi	tropical and subtropical floodplain rivers and wet	(sub)tropical
Madagascar Eastern Highlands	montane freshwaters	cold
Madagascar Eastern Lowlands	tropical and subtropical coastal rivers	(sub)tropical
Madeira Brazilian Shield	tropical and subtropical upland rivers	(sub)tropical
Mae Khlong	tropical and subtropical floodplain rivers and wet	(sub)tropical
Magdalena - Sinu	tropical and subtropical upland rivers	(sub)tropical





Ecoregion as defined by Abell and colleagues (2008)	Original MTH name as defined by FEOW	Region
Mai Ndombe	tropical and subtropical floodplain rivers and wet	(sub)tropical
Malagarasi - Moyowosi	tropical and subtropical floodplain rivers and wet	(sub)tropical
Malay Peninsula Eastern Slope	tropical and subtropical floodplain rivers and wet	(sub)tropical
Malebo Pool	tropical and subtropical floodplain rivers and wet	(sub)tropical
Malukku	oceanic islands*	(sub)tropical
Mamore - Madre de Dios Piedmont	tropical and subtropical upland rivers	(sub)tropical
Mar Chiquita - Salinas Grandes	xeric freshwaters and endorheic (closed) basins	xeric
Maracaibo	large lakes*	(sub)tropical
Mascarenes	oceanic islands*	(sub)tropical
Mayran - Viesca	xeric freshwaters and endorheic (closed) basins	xeric
Mediterranean Northwest Africa	temperate coastal rivers	temperate
Mekong Delta	tropical and subtropical floodplain rivers and wet	(sub)tropical
Middle Amu Darya	temperate upland rivers	temperate
Middle Amur	temperate upland rivers	temperate
Middle Brahmaputra	tropical and subtropical upland rivers	(sub)tropical
Middle Missouri	temperate floodplain rivers and wetlands	temperate
Middle Saskatchewan	temperate upland rivers	temperate
Middle Yangtze	montane freshwaters	cold
Middle Zambezi - Luangwa	tropical and subtropical floodplain rivers and wet	(sub)tropical
Mindanao	tropical and subtropical coastal rivers	(sub)tropical
Mobile Bay	temperate floodplain rivers and wetlands	temperate
Mosquitia	tropical and subtropical coastal rivers	(sub)tropical
Mulanje	montane freshwaters	cold
Murray - Darling	temperate floodplain rivers and wetlands	temperate
Namak	xeric freshwaters and endorheic (closed) basins	xeric
Namib	xeric freshwaters and endorheic (closed) basins	xeric
Namuda - Tapi	tropical and subtropical floodplain rivers and wet	(sub)tropical
New Caledonia	tropical and subtropical coastal rivers	(sub)tropical
New Guinea Central Mountains	montane freshwaters	cold
New Guinea North Coast	tropical and subtropical coastal rivers	(sub)tropical





Ecoregion as defined by Abell		Destas
and colleagues (2008)	Original MTH name as defined by FEOW	Region
New Zealand	temperate coastal rivers	temperate
Niger Delta	large river deltas*	(sub)tropical
Nile Delta	large river deltas*	xeric
North Andean Pacific Slopes - Rio Atrato	tropical and subtropical coastal rivers	(sub)tropical
Northeast US & Southeast Canada Atlantic Drainages	temperate coastal rivers	temperate
Northeastern Borneo	tropical and subtropical coastal rivers	(sub)tropical
Northeastern Caatinga & Coastal Drainages	tropical and subtropical coastal rivers	(sub)tropical
Northeastern Mata Atlantica	tropical and subtropical coastal rivers	(sub)tropical
Northern Anatolia	temperate coastal rivers	temperate
Northern Annam	tropical and subtropical coastal rivers	(sub)tropical
Northern Baltic Drainages	polar freshwaters	cold
Northern British Isles	temperate coastal rivers	temperate
Northern Central Asian Highlands	temperate upland rivers	temperate
Northern Central Sumatra - Western Malaysia	tropical and subtropical coastal rivers	(sub)tropical
Northern Deccan Plateau	tropical and subtropical floodplain rivers and wet	(sub)tropical
Northern Eastern Rift	xeric freshwaters and endorheic (closed) basins	xeric
Northern Gulf of Guinea Drainages - Bioko	tropical and subtropical coastal rivers	(sub)tropical
Northern Hormuz Drainages	temperate coastal rivers	temperate
Northern Philippine Islands	tropical and subtropical coastal rivers	(sub)tropical
Northern Upper Guinea	tropical and subtropical coastal rivers	(sub)tropical
Northwestern Borneo	tropical and subtropical coastal rivers	(sub)tropical
Northwestern Madagascar	tropical and subtropical floodplain rivers and wet	(sub)tropical
Norwegian Sea Drainages	polar freshwaters	cold
Ob	polar freshwaters	cold
Ogooue - Nyanga - Kouilou - Niari	tropical and subtropical coastal rivers	(sub)tropical
Okavango	tropical and subtropical floodplain rivers and wet	(sub)tropical
Okhotsk Coast	temperate coastal rivers	temperate
Oman Mountains	xeric freshwaters and endorheic (closed) basins	xeric
Oregon & Northern California Coastal	temperate coastal rivers	temperate
Oregon Lakes	xeric freshwaters and endorheic (closed) basins	xeric





Ecoregion as defined by Abell and colleagues (2008)	Original MTH name as defined by FEOW	Region
Orinoco Delta & Coastal Drainages	large river deltas*	(sub)tropical
Orinoco Guiana Shield	tropical and subtropical upland rivers	(sub)tropical
Orinoco Llanos	tropical and subtropical floodplain rivers and wet	(sub)tropical
Orinoco Piedmont	montane freshwaters	cold
Orontes	temperate coastal rivers	temperate
Orumiyeh	xeric freshwaters and endorheic (closed) basins	xeric
Ouachita Highlands	temperate upland rivers	temperate
Ozark Highlands	temperate upland rivers	temperate
Palawan - Busuanga - Mindoro	tropical and subtropical coastal rivers	(sub)tropical
Paleo	xeric freshwaters and endorheic (closed) basins	xeric
Pangani	tropical and subtropical coastal rivers	(sub)tropical
Panuco	tropical and subtropical coastal rivers	(sub)tropical
Papaloapan	tropical and subtropical coastal rivers	(sub)tropical
Papuan Peninsula	tropical and subtropical coastal rivers	(sub)tropical
Paraguay	tropical and subtropical floodplain rivers and wet	(sub)tropical
Paraiba do Sul	tropical and subtropical coastal rivers	(sub)tropical
Parnaiba	tropical and subtropical coastal rivers	(sub)tropical
Patagonia	temperate coastal rivers	temperate
Pecos	xeric freshwaters and endorheic (closed) basins	xeric
Pilbara	xeric freshwaters and endorheic (closed) basins	xeric
Puerto Rico - Virgin Islands	tropical and subtropical coastal rivers	(sub)tropical
Qaidan	montane freshwaters	cold
Quintana Roo - Motagua	tropical and subtropical coastal rivers	(sub)tropical
Ribeira de Iguape	tropical and subtropical coastal rivers	(sub)tropical
Rio Balsas	tropical and subtropical coastal rivers	(sub)tropical
Rio Conchos	xeric freshwaters and endorheic (closed) basins	xeric
Rio Negro	tropical and subtropical floodplain rivers and wet	(sub)tropical
Rio Salado	xeric freshwaters and endorheic (closed) basins	xeric
Rio San Juan (Mexico)	xeric freshwaters and endorheic (closed) basins	xeric
Rio Santiago	tropical and subtropical coastal rivers	(sub)tropical
Rio Tuira	tropical and subtropical coastal rivers	(sub)tropical
S. Francisco	tropical and subtropical upland rivers	(sub)tropical
Sabine - Galveston	temperate coastal rivers	temperate





Ecoregion as defined by Abell and colleagues (2008)	Original MTH name as defined by FEOW	Region
Sacramento - San Joaquin	temperate coastal rivers	temperate
Sahara	xeric freshwaters and endorheic (closed) basins	xeric
Sakhalin, Hokkaido, & Sikhote - Alin Coast	temperate coastal rivers	temperate
San Juan (Nicaragua/Costa Rica)	tropical and subtropical coastal rivers	(sub)tropical
Sangha	tropical and subtropical floodplain rivers and wet	(sub)tropical
Santa Maria	tropical and subtropical coastal rivers	(sub)tropical
Scotia - Fundy	temperate coastal rivers	temperate
Senegal - Gambia	tropical and subtropical floodplain rivers and wet	(sub)tropical
Shebelle - Juba	xeric freshwaters and endorheic (closed) basins	xeric
Shilka (Amur)	temperate upland rivers	temperate
Sierra Madre del Sur	tropical and subtropical coastal rivers	(sub)tropical
Sinai	xeric freshwaters and endorheic (closed) basins	xeric
Sinaloa	tropical and subtropical coastal rivers	(sub)tropical
Sitang - Irawaddy	tropical and subtropical floodplain rivers and wet	(sub)tropical
Solomon Islands	tropical and subtropical coastal rivers	(sub)tropical
Song Hong	tropical and subtropical floodplain rivers and wet	(sub)tropical
Songhua Jiang	temperate floodplain rivers and wetlands	temperate
Sonora	xeric freshwaters and endorheic (closed) basins	xeric
South America Caribbean Drainages - Trinidad	tropical and subtropical coastal rivers	(sub)tropical
South Andean Pacific Slopes	temperate coastal rivers	temperate
Southeast Adriatic Drainages	temperate coastal rivers	temperate
Southeastern Borneo	tropical and subtropical floodplain rivers and wet	(sub)tropical
Southeastern Ghats	tropical and subtropical coastal rivers	(sub)tropical
Southeastern Korean Peninsula	temperate coastal rivers	temperate
Southeastern Mata Atlantica	tropical and subtropical coastal rivers	(sub)tropical
Southern Anatolia	temperate coastal rivers	temperate
Southern Annam	tropical and subtropical coastal rivers	(sub)tropical
Southern Baltic Lowlands	temperate floodplain rivers and wetlands	temperate
Southern California Coastal - Baja California	xeric freshwaters and endorheic (closed) basins	xeric
Southern Central Sumatra	tropical and subtropical floodplain rivers and wet	(sub)tropical





Ecoregion as defined by Abell and colleagues (2008)	Original MTH name as defined by FEOW	Region
Southern Deccan Plateau	tropical and subtropical floodplain rivers and wet	(sub)tropical
Southern Eastern Rift	xeric freshwaters and endorheic (closed) basins	xeric
Southern Gulf of Guinea Drainages	tropical and subtropical coastal rivers	(sub)tropical
Southern Hudson Bay	temperate coastal rivers	temperate
Southern Iberia	temperate coastal rivers	temperate
Southern Kalahari	xeric freshwaters and endorheic (closed) basins	xeric
Southern Madagascar	xeric freshwaters and endorheic (closed) basins	xeric
Southern Sumatra - Western Java	tropical and subtropical floodplain rivers and wet	(sub)tropical
Southern Tasmania	temperate coastal rivers	temperate
Southern Temperate Highveld	temperate upland rivers	temperate
Southern Upper Guinea	tropical and subtropical coastal rivers	(sub)tropical
Southwest New Guinea - Trans-Fly Lowland	tropical and subtropical coastal rivers	(sub)tropical
Southwestern Arabian Coast	xeric freshwaters and endorheic (closed) basins	xeric
Southwestern Australia	temperate coastal rivers	temperate
Sri Lanka Dry Zone	tropical and subtropical coastal rivers	(sub)tropical
Sri Lanka Wet Zone	tropical and subtropical coastal rivers	(sub)tropical
St.Lawrence	temperate coastal rivers	temperate
Sudanic Congo - Oubangi	tropical and subtropical floodplain rivers and wet	(sub)tropical
Sulawesi	tropical and subtropical coastal rivers	(sub)tropical
Taimyr	polar freshwaters	cold
Tana, Athi & Coastal Drainages	tropical and subtropical coastal rivers	(sub)tropical
Tapajos - Juruena	tropical and subtropical upland rivers	(sub)tropical
Tarim	xeric freshwaters and endorheic (closed) basins	xeric
Teays - Old Ohio	temperate upland rivers	temperate
Tennessee	temperate upland rivers	temperate
Thrace	temperate coastal rivers	temperate
Tibetan Plateau Endorheic Drainages	montane freshwaters	cold
Titicaca	xeric freshwaters and endorheic (closed) basins	xeric
Tocantins - Araguaia	tropical and subtropical upland rivers	(sub)tropical
Tumba	tropical and subtropical floodplain rivers and wet	(sub)tropical
Turan Plain	xeric freshwaters and endorheic (closed)	xeric





Ecoregion as defined by Abell and colleagues (2008)	Original MTH name as defined by FEOW	Region
	basins	
Ucayali - Urubamba Piedmont	montane freshwaters	cold
Uele	tropical and subtropical upland rivers	(sub)tropical
Upper Amu Darya	montane freshwaters	cold
Upper Brahmaputra	montane freshwaters	cold
Upper Congo	tropical and subtropical upland rivers	(sub)tropical
Upper Danube	temperate floodplain rivers and wetlands	temperate
Upper Huang He	montane freshwaters	cold
Upper Huang He Corridor	montane freshwaters	cold
Upper Indus	montane freshwaters	cold
Upper Irtysh	temperate upland rivers	temperate
Upper Lancang (Mekong)	tropical and subtropical upland rivers	(sub)tropical
Upper Lualaba	tropical and subtropical floodplain rivers and wet	(sub)tropical
Upper Mackenzie	temperate floodplain rivers and wetlands	temperate
Upper Mississippi	temperate floodplain rivers and wetlands	temperate
Upper Missouri	temperate upland rivers	temperate
Upper Niger	tropical and subtropical upland rivers	(sub)tropical
Upper Nile	tropical and subtropical floodplain rivers and wet	(sub) tropical
Upper Parana	tropical and subtropical upland rivers	(sub)tropical
Upper Rio Grande - Bravo	temperate upland rivers	temperate
Upper Salween	tropical and subtropical upland rivers	(sub)tropical
Upper Saskatchewan	temperate upland rivers	temperate
Upper Snake	temperate upland rivers	temperate
Upper Tigris & Euphrates	temperate floodplain rivers and wetlands	temperate
Upper Uruguay	tropical and subtropical upland rivers	(sub)tropical
Upper Usumacinta	tropical and subtropical upland rivers	(sub)tropical
Upper Yangtze	montane freshwaters	cold
Upper Yukon	polar freshwaters	cold
Upper Zambezi Floodplains	tropical and subtropical floodplain rivers and wet	(sub)tropical
US Southern Plains	temperate upland rivers	temperate
Valdivian Lakes	temperate coastal rivers	temperate
Vanuatu	oceanic islands*	(sub)tropical
Vardar	temperate coastal rivers	temperate
Vegas - Virgin	xeric freshwaters and endorheic (closed) basins	xeric
Vogelkop - Bomberai	tropical and subtropical coastal rivers	(sub)tropical
Volga - Ural	temperate floodplain rivers and wetlands	temperate
Volga Delta - Northern Caspian Drainages	large lakes*	temperate





Ecoregion as defined by Abell		
and colleagues (2008)	Original MTH name as defined by FEOW	Region
Volta	tropical and subtropical floodplain rivers and wet	(sub)tropical
West Florida Gulf	temperate coastal rivers	temperate
West Texas Gulf	tropical and subtropical coastal rivers	(sub)tropical
Western Amazon Piedmont	montane freshwaters	cold
Western Anatolia	temperate coastal rivers	temperate
Western Caspian Drainages	montane freshwaters	cold
Western Equatorial Crater Lakes	montane freshwaters	cold
Western Ghats	tropical and subtropical coastal rivers	(sub)tropical
Western Hudson Bay	polar freshwaters	cold
Western Iberia	temperate coastal rivers	temperate
Western Madagascar	xeric freshwaters and endorheic (closed) basins	xeric
Western Mongolia	xeric freshwaters and endorheic (closed) basins	xeric
Western Orange	xeric freshwaters and endorheic (closed) basins	xeric
Western Red Sea Drainages	xeric freshwaters and endorheic (closed) basins	xeric
Western Taiwan	tropical and subtropical coastal rivers	(sub)tropical
Western Transcaucasia	temperate coastal rivers	temperate
Xi Yiang	tropical and subtropical floodplain rivers and wet	(sub)tropical
Xingu	tropical and subtropical upland rivers	(sub)tropical
Yaghistan	montane freshwaters	cold
Yenisei	polar freshwaters	cold
Yucatan	tropical and subtropical coastal rivers	(sub)tropical
Zambezian Headwaters	tropical and subtropical upland rivers	(sub)tropical
Zambezian Highveld	tropical and subtropical upland rivers	(sub)tropical
Zambezian Lowveld	tropical and subtropical coastal rivers	(sub)tropical

\* Ecoregions that belong to the large lakes or large river deltas MHT classes were manually allocated to one of the four new habitats based on their geographical location. All ecoregions that belong to the Oceanic Islands MHT were allocated to the (sub)tropical habitat.



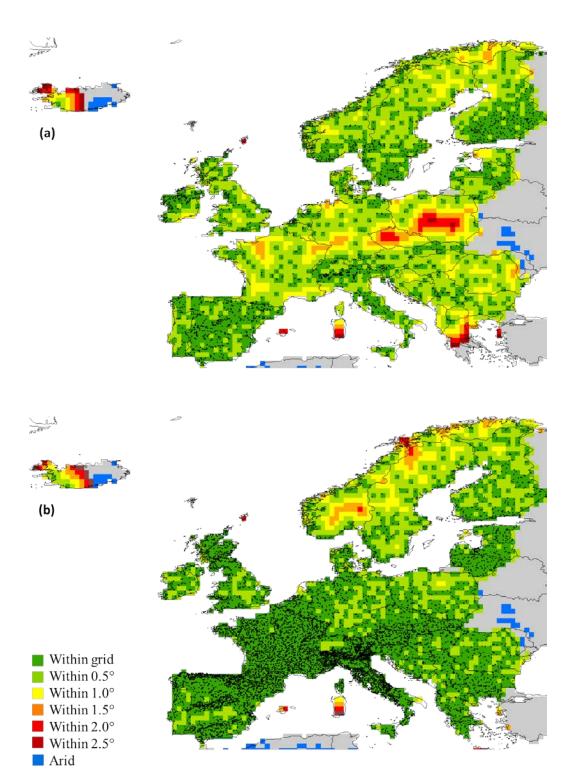


# Appendix 2-II: Environmental concentration data

Given the few mean annual TP data available outside Europe, we limited the analysis of the effect factors (EF) which required the concentration of P as an input parameter to the European continent. We included the latest mean annual TP record at each monitored station reported by the European Environment Agency (www.eea.europa.eu) up to January 2013. The locations of the monitoring stations reporting mean annual TP data are shown in Figure 2.4. In a second step, we determined the concentration of P in each 0.5° x 0.5° grid in Europe as TP as the mean average of the TP concentrations of the monitoring stations for lakes and streams separately. For grids where no monitoring station was present, we used the mean average of the TP concentrations in the monitoring stations within a 0.5° distance from the grid. For grids where no monitoring station was present within a 0.5° distance, we used the monitoring stations within a 1.0° distance, and so on, until all continental European grids were given a TP concentration estimate. Finally, we determined the concentration of TP in freshwater *w* in grid *j* ( $C_{w,j}$ ) as the mean of the individual annual mean TP concentrations in monitored lake or stream stations within *j*.







**Figure 2.4**: Distance from grids to their nearest (a) lake (n = 2375) and (b) stream (n = 9194) monitoring station (dots) in Europe. The percentage of grids comprising a lake monitoring station within the grid and within 0.5°, 1.0°, 1.5°, 2.0°, and 2.5°, respectively, is 32.14, 43.45, 12.43, 3.50, 1.55, and 0.64. The percentage of grids comprising a stream monitoring station within the grid and within 0.5°, 1.0°, 1.5°, 2.0°, and 2.5°, respectively, is 32.14, 43.45, 12.43, 3.50, 1.55, and 0.64. The percentage of grids comprising a stream monitoring station within the grid and within 0.5°, 1.0°, 1.5°, 2.0°, and 2.5°, respectively are 60.16, 26.56, 4.87, 2.01, 0.67, and 0.25.





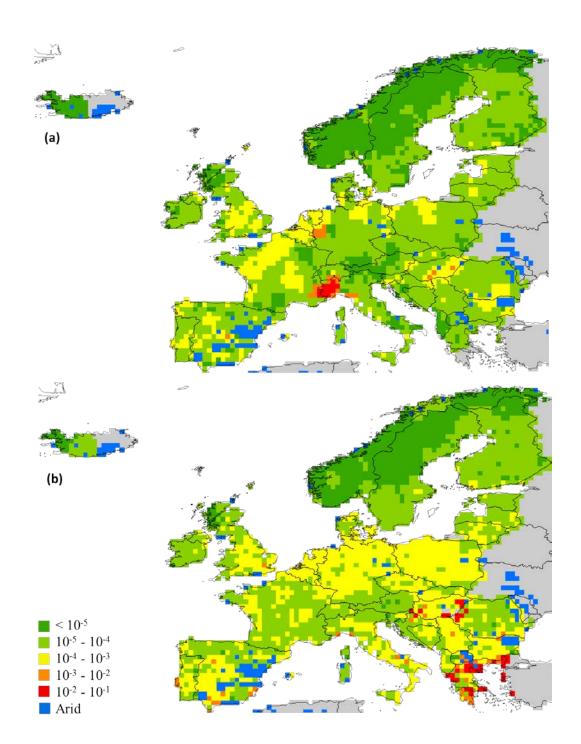


Figure 2.5: Concentrations of mean annual TP,  $C_{w,j}$  (kg P·m<sup>-3</sup>), for (a) lakes and (b) streams in Europe.





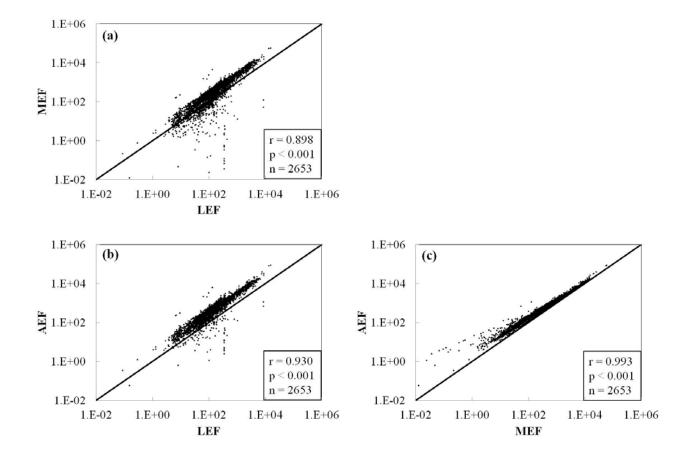
# Appendix 2-III: Comparison between characterisation factors types for lake heterotrophs and stream autotrophs and heterotrophs

42

The results of the pearson correlation between the CFs derived by the linear (*LEF*), marginal (*MEF*), and average (*AEF*) effect factors for lake autotrophs, lake heterotrophs and stream autotrophs are shown in Figure 2.6: Comparison between characterisation factors (CFs) based on the linear (LEF), marginal (MEF), and average (AEF) effect factors in each emitting grid for lake autotrophs. The pearson correlation coefficient (r), p value, and number of samples (n) is shown in the bottom right corner.Figure 2.6, Figure 2.7, and Figure 2.8, respectively. The ratio between the CFs results based on the three effect factor types are shown in Figure 2.9, Figure 2.10, and Figure 2.11, respectively. The pearson correlation results for stream heterotrophs can be found in Figure 2.3 of the main text and the cumulated difference for this organism and freshwater group is shown in Figure 2.12 of this appendix.



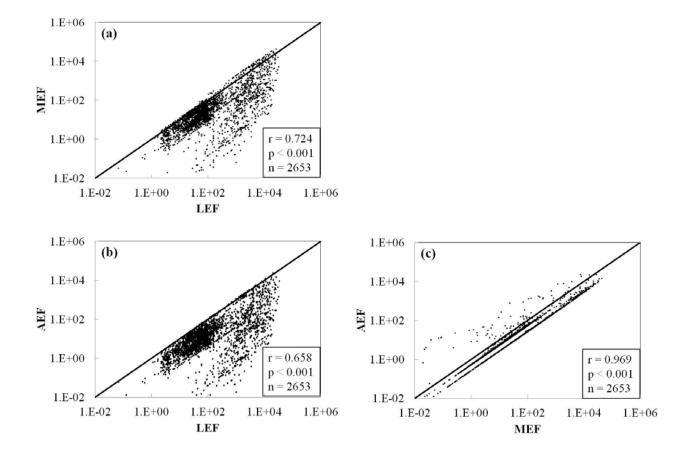




**Figure 2.6**: Comparison between characterisation factors (CFs) based on the linear (*LEF*), marginal (*MEF*), and average (*AEF*) effect factors in each emitting grid for lake autotrophs. The pearson correlation coefficient (r), p value, and number of samples (n) is shown in the bottom right corner.



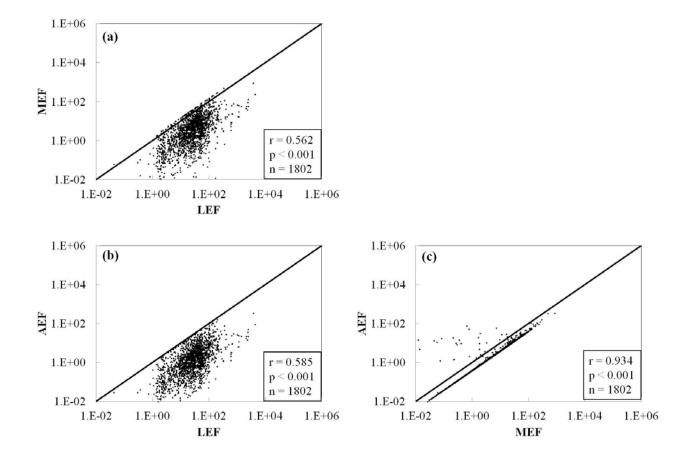




**Figure 2.7**: Comparison between characterisation factors (CFs) based on the linear (*LEF*), marginal (*MEF*), and average (*AEF*) effect factors in each emitting grid for lake heterotrophs. The pearson correlation coefficient (r), p value, and number of samples (n) is shown in the bottom right corner.



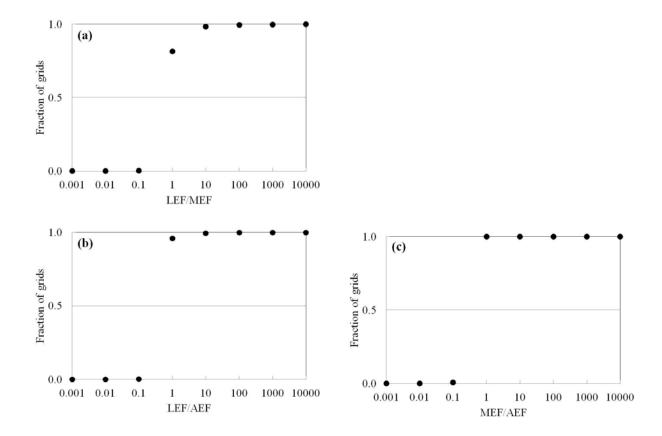




**Figure 2.8**: Comparison between characterisation factors (CFs) based on the linear (*LEF*), marginal (*MEF*), and average (*AEF*) effect factors in each emitting grid for stream autotrophs. The pearson correlation coefficient (r), p value, and number of samples (n) is shown in the bottom right corner.



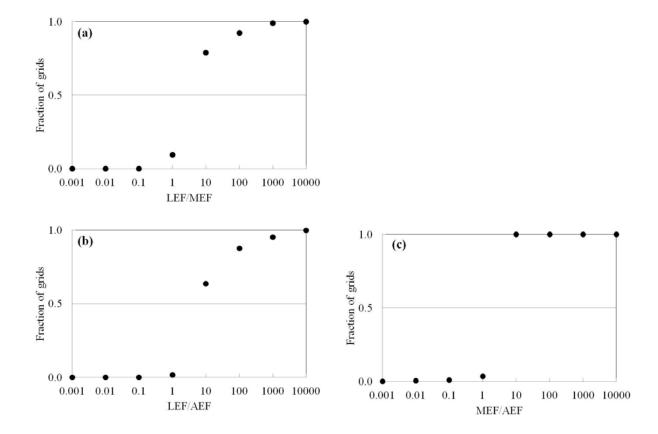




**Figure 2.9:** Cumulative frequency distribution of the ratio between characterisation factors (CFs) based on the linear (*LEF*), marginal (*MEF*), and average (*AEF*) for lake autotrophs.



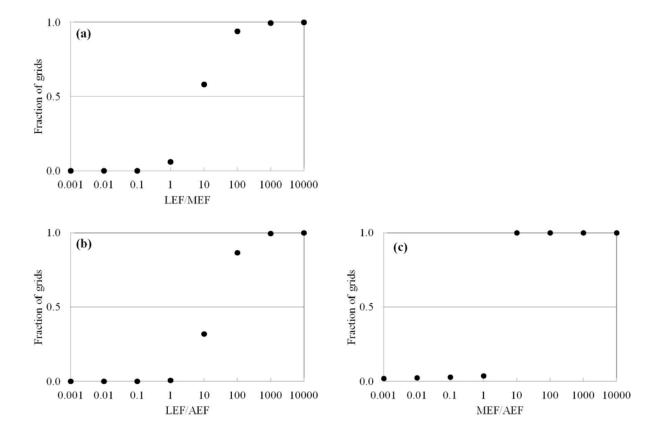




**Figure 2.10**: Cumulative frequency distribution of the ratio between characterisation factors (CFs) based on the linear (*LEF*), marginal (*MEF*), and average (*AEF*) for lake heterotrophs.



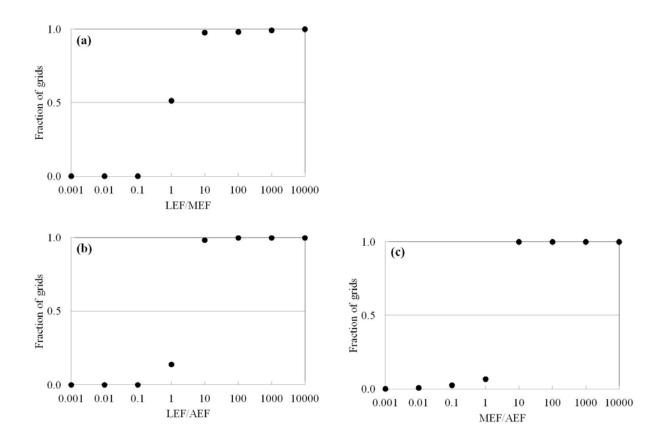




**Figure 2.11**: Cumulative frequency distribution of the ratio between characterisation factors (CFs) based on the linear (*LEF*), marginal (*MEF*), and average (*AEF*) for stream autotrophs.



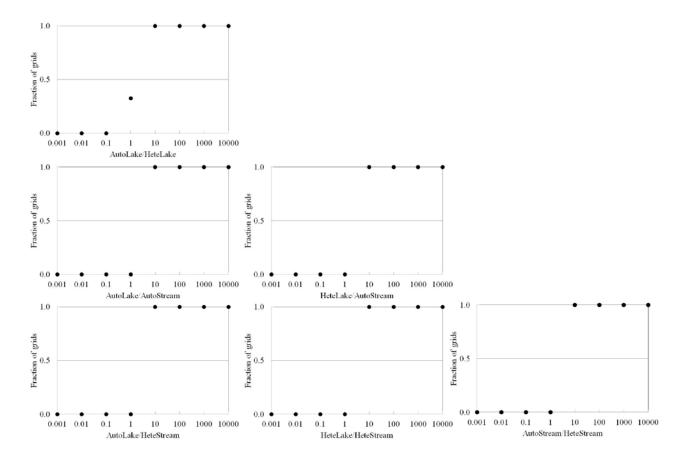




**Figure 2.12**: Cumulative frequency distribution of the ratio between characterisation factors (CFs) based on the linear (*LEF*), marginal (*MEF*), and average (*AEF*) for stream heterotrophs.



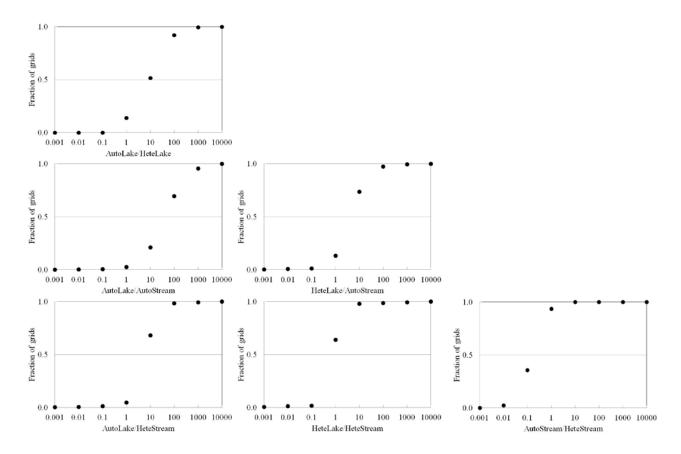




**Figure 2.13**: Cumulative frequency distribution of the ratio between characterisation factors of autotrophs in lakes (AutoLake), heterotrophs in lakes (HeteLake), autotrophs in streams (AutoStream), and heterotrophs in streams (HeteStream) based on linear effect factors.



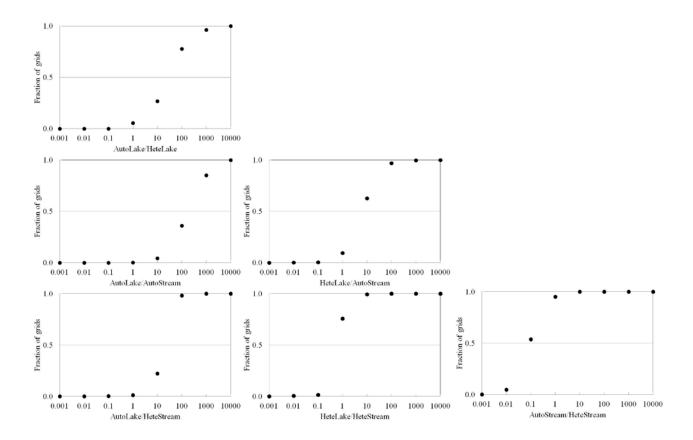




**Figure 2.14**: Cumulative frequency distribution of the ratio between characterisation factors of autotrophs in lakes (AutoLake), heterotrophs in lakes (HeteLake), autotrophs in streams (AutoStream), and heterotrophs in streams (HeteStream) based on marginal effect factors.







**Figure 2.15**: Cumulative frequency distribution of the ratio between characterisation factors of autotrophs in lakes (AutoLake), heterotrophs in lakes (HeteLake), autotrophs in streams (AutoStream), and heterotrophs in streams (HeteStream) based on average effect factors.





# Appendix 2-IV: Grid, country, continent, and world characterisation factors

53

Grid, country, continent, and world midpoint CF (day) and endpoint CFs (day·kg<sup>-1</sup>·m<sup>3</sup>) based on the linear (*LEF*), marginal (*MEF*), and average (*AEF*) effect factors are shown in excel file 'CF.xlsx' (see description of dataset in Table 2.3).

Table 2.3: Description of the worksheets in the CF excel table.

Worksheet name	Description
GridMidCF	Grid-specific midpoint CF
GridEndCF	Grid-specific endpoint CF
CountryMidCF	Country-specific midpoint CF
CountryEndCF	Country -specific endpoint CF
ContinentMidCF	Continent-specific midpoint CF
ContinentEndCF	Continent -specific endpoint CF
WorldMidCF	World midpoint CF
WorldEndCF	World endpoint CF
Readme	Details of the excel document





# Appendix 2-V: Grid, country, continent, and world emission estimates

Grid, country, continent, and world emission estimates point-sources  $S_{Sew}$  (kgP·person<sup>-1</sup>·yr<sup>-1</sup>) (from human sewage and laundry and dishwasher detergent) are shown in excel file 'Sewage.xlsx' (see description of dataset in Table 2.4). Grid, country, continent, and world emission estimates non-point-sources from manure fertilizer are shown in excel file 'ManureFertilizer.xlsx' (see description of dataset in Table 2.5). Grid, country, continent, and world emission estimates non-point-sources from synthetic fertilizer are shown in excel file 'SyntheticFertilizer.xlsx' (see description of dataset in Table 2.5). Grid, country, continent, and world emission estimates non-point-sources from synthetic fertilizer are shown in excel file 'SyntheticFertilizer.xlsx' (see description of dataset in Table 2.6).

 Table 2.4: Description of the worksheets in the 'Sewage.xlsx' file.

Worksheet name	Description
EmissionGrid	Grid-specific emissions
EmissionCountry	Country-specific emissions
EmissionContinent	Continent-specific emissions
EmissionWorld	World emissions

 Table 2.5: Description of the worksheets in the 'ManureFertilizer.xlsx' file.

Worksheet name	Description
EmissionGrid	Grid-specific emissions
EmissionCountry	Country-specific emissions
EmissionContinent	Continent-specific emissions
EmissionWorld	World emissions

**Table 2.6**: Description of the worksheets in the 'SyntheticFertilizer.xlsx' file.

Worksheet name	Description
EmissionGrid	Grid-specific emissions
EmissionCountry	Country-specific emissions
EmissionContinent	Continent-specific emissions
EmissionWorld	World emissions





# Appendix 2-VI: Grid, country, continent, and world normalization factors

Grid, country, continent, and world normalization factors NS estimates point-sources (from human sewage and laundry and dishwasher detergent) as shown in excel file 'NS.xlsx' (see description of dataset in Table 2.7).

Table 2.7: Description of the worksheets in the 'NS.xlsx' file.

Worksheet name	Description
GridMidNS	Grid-specific midpoint NS
GridEndNS	Grid-specific endpoint NS
CountryMidNS	Country-specific midpoint NS
CountryEndNS	Country -specific endpoint NS
ContinentMidNS	Continent-specific midpoint NS
ContinentEndNS	Continent -specific endpoint NS
WorldMidNS	World midpoint NS
WorldEndNS	World endpoint NS
Readme	Details of the excel document





# 2.8 References for freshwater eutrophication

Abell, R., Thieme, M.L., Revenga, C., Bryer, M., Kottelat, M., Bogutskaya, N., Coad, B., Mandrak, N., Balderas, S.C., Bussing, W., Stiassny, M.L.J., Skelton, P., Allen, G.R., Unmack, P., Naseka, A., Ng, R., Sindorf, N., Robertson, J., Armijo, E., Higgins, J.V., Heibel, T.J., Wikramanayake, E., Olson, D., Lopez, H.L., Reis, R.E., Lundberg, J.G., Perez, M.H.S., Petry, P., 2008. Freshwater ecoregions of the world: A new map of biogeographic units for freshwater biodiversity conservation. Bioscience 58, 403-414.

Amarasinghe, U.S., Welcomme, R.L., 2002. An analysis of fish species richness in natural lakes. Environmental Biology of Fishes 65, 327-339.

Azevedo, L.A., Van Zelm, R., Elshout, P.M.F., Hendriks, A.J., Leuven, R.S.E.W., Struijs, J., de Zwart, D., Huijbregts, M.A.J., In Press . Species richness – phosphorus relationships for lakes and streams worldwide. Global Ecology and Biogeography.

Björklund, G., Burke, J., Foster, S., Rast, W., Vallée, D., van der Hoek, W., 2009. 3<sup>rd</sup> UN World Water Development Report: Water in a Changing World (WWDR-3). Chapter 8: Impacts of water use on water systems and the environment, in: UNESCO (Ed.). UN World Water Assessment Programme, p. 432.

Bouwman, A.F., Beusen, A.H.W., Billen, G., 2009. Human alteration of the global nitrogen and phosphorus soil balances for the period 1970-2050. Global Biogeochemical Cycles 23, 16.

Carpenter, S.R., Cole, J.J., Hodgson, J.R., Kitchell, J.F., Pace, M.L., Bade, D., Cottingham, K.L., Essington, T.E., Houser, J.N., Schindler, D.E., 2001. Trophic cascades, nutrients, and lake productivity: whole-lake experiments. Ecological Monographs 71, 163-186.

CIESIN, CIAT, 2005. Center for International Earth Science Information Network (CIESIN)/Columbia University, and Centro Internacional de Agricultura Tropical (CIAT). Gridded Population of the World, Version 3 (GPWv3): Population Density Grid. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC).

http://sedac.ciesin.columbia.edu/data/set/gpw-v3-population-density. Accessed March 12th, 2013.

Curran, M., de Baan, L., De Schryver, A.M., van Zelm, R., Hellweg, S., Koellner, T., Sonnemann, G., Huijbregts, M.A.J., 2010. Toward Meaningful End Points of Biodiversity in Life Cycle Assessment. Environmental Science & Technology 45, 70-79.

Helmes, R.J.K., Huijbregts, M.A.J., Henderson, A.D., Jolliet, O., 2012. Spatially explicit fate factors of phosphorous emissions to freshwater at the global scale. International Journal of Life Cycle Assessment 17, 646-654.

Huijbregts, M.A.J., Hellweg, S., Hertwich, E., 2011. Do We Need a Paradigm Shift in Life Cycle Impact Assessment? Environmental Science & Technology 45, 3833-3834.

Lenat, D.R., Resh, V.H., 2001. Taxonomy and stream ecology - The benefits of genus- and species-level identifications. Journal of the North American Benthological Society 20, 287-298.

Liu, Y., Villalba, G., Ayres, R.U., Schroder, H., 2008. Global phosphorus flows and environmental impacts from a consumption perspective. Journal of Industrial Ecology 12, 229-247.

Nour, M.H., Smith, D.W., El-Din, M.G., Prepas, E.E., 2006. Neural networks modelling of streamflow, phosphorus, and suspended solids: application to the Canadian Boreal forest. Water Science and Technology 53, 91-99.

Payet, J., 2006. Report Describing a Method for the Quantification of Impacts on Aquatic Freshwater Ecosystems Resulting from Different Stressors (e.g., Toxic Substances, Eutrophication,

# OLC-IMPACT



Etc). Novel Methods for Integrated Risk Assessment of Cumulative Stressors in Europe (NOMIRACLE). École Polytechnique Fédérale de Lausanne.

http://nomiracle.jrc.ec.europa.eu/webapp/ViewPublicDeliverables.aspx.

Pennington, D.W., Payet, J., Hauschild, M., 2004. Aquatic ecotoxicological indicators in lifecycle assessment. Environmental Toxicology and Chemistry 23, 1796-1807.

Posch, M., Aherne, J., Forsius, M., Rask, M., 2012. Past, Present, and Future Exceedance of Critical Loads of Acidity for Surface Waters in Finland. Environmental Science & Technology 46, 4507-4514.

Potter, P., Ramankutty, N., Bennett, E.M., Donner, S.D., 2011. Global Fertilizer and Manure, Version 1: Phosphorus in Manure Production. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://sedac.ciesin.columbia.edu/data/set/ferman-v1-phosphorusin-manure-production. Accessed March 12th, 2013.

Rosenbaum, R.K., Bachmann, T.M., Gold, L.S., Huijbregts, M.A.J., Jolliet, O., Juraske, R., Koehler, A., Larsen, H.F., MacLeod, M., Margni, M., McKone, T.E., Payet, J., Schuhmacher, M., van de Meent, D., Hauschild, M.Z., 2008. USEtox-the UNEP-SETAC toxicity model: recommended characterisation factors for human toxicity and freshwater ecotoxicity in life cycle impact assessment. International Journal of Life Cycle Assessment 13, 532-546.

Sattari, S.Z., Bouwman, A.F., Giller, K.E., van Ittersum, M.K., 2012. Residual soil phosphorus as the missing piece in the global phosphorus crisis puzzle. Proceedings of the National Academy of Sciences of the United States of America 109, 6348-6353.

Schindler, D.W., 1977. Evolution of phosphorus limitation in lakes. Science 195, 260-262.

Seppälä, J., Knuuttila, S., Silvo, K., 2004. Eutrophication of aquatic ecosystems - A new method for calculating the potential contributions of nitrogen and phosphorus. International Journal of Life Cycle Assessment 9, 90-100.

Struijs, J., Beusen, A., de Zwart, D., Huijbregts, M., 2011a. Characterization factors for inland water eutrophication at the damage level in life cycle impact assessment. International Journal of Life Cycle Assessment 16, 59-64.

Struijs, J., De Zwart, D., Posthuma, L., Leuven, R.S.E.W., Huijbregts, M.A.J., 2011b. Field sensitivity distribution of macroinvertebrates for phosphorus in inland waters. Integrated Environmental Assessment and Management 7, 280-286.

Udo de Haes, H.A., Finnveden, G., Goedkoop, M., Hauschild, M., Hertwich, E., Hofstetter, P., Jolliet, O., Klöpffer, W., Krewitt, W., Lindeijer, E., Müller-Wenk, R., Olsen, S.I., Pennington, D.W., Potting, J., Steen, B., 2002. Life Cycle Impact Assessment: Striving towards best practice. SETAC Press, 2002, Pensacola, Florida.

Van de Meent, D., Huijbregts, M.A.J., 2005. Calculating life-cycle assessment effect factors from potentially affected fraction-based ecotoxicological response functions. Environmental Toxicology and Chemistry 24, 1573-1578.

Van Drecht, G., Bouwman, A.F., Harrison, J., Knoop, J.M., 2009. Global nitrogen and phosphate in urban wastewater for the period 1970 to 2050. Global Biogeochem. Cycles 23, GB0A03.

van Zelm, R., Huijbregts, M.A.J., Van Jaarsveld, H.A., Reinds, G.J., De Zwart, D., Struijs, J., Van de Meent, D., 2007. Time horizon dependent characterization factors for acidification in life-cycle assessment based on forest plant species occurrence in Europe. Environmental Science & Technology 41, 922-927.





# 3. SPATIALLY-EXPLICIT CHARACTERISATION FACTORS FOR MARINE EUTROPHICATION

Nuno Cosme\*, Henrik Fred Larsen, Michael Zwicky Hauschild

Division for Quantitative Sustainability Assessment (QSA), Department of Management Engineering (DTU-MAN), Technical University of Denmark (DTU), Building 426, 2800 Kgs. Lyngby, Denmark

\*Corresponding author: Nuno Cosme; Tel: +45 45 25 47 29; Fax: +45 45 93 34 35; e-mail: nmdc@dtu.dk

# Abstract

Marine eutrophication processes include the excessive growth of phytoplankton biomass in response to increased availability of nitrogen (N) in the photic zone of marine coastal waters. The eventual degradation of this biomass results in oxygen consumption in bottom waters by bacterial respiration. The excessive depletion of dissolved oxygen (DO) poses a potential impact to ecology, economy, and water quality. Land based human interventions are increasing the N loadings to marine coastal systems and overrunning their natural capacity to absorb N. Life Cycle Impact Assessment (LCIA) methodologies have been developed to assess and comparatively quantify the potential environmental impacts in different categories. Marine eutrophication is still lacking a sound methodology to link midpoint and endpoint indicators and an overall model to assess the potential impact of the over-enrichment of marine ecosystems by N. A model was built for the estimation of endpoint CF for marine eutrophication: Fate Factors (FF) were estimated for both airborne and waterborne N emissions based on modelling of river-N and marine-N losses to deliver the midpoint category indicator (i.e. increase of N in the marine compartment); Exposure Factors (XF) were estimated based on incorporation of N into biomass in the photic zone to DO consumption in the benthic habitat. Finally, Effect Factors (EF) were estimated by applying the statistical Distribution of the Species Sensitivity (SSD) to hypoxia delivering the endpoint category indicator (i.e. species diversity loss). The product of the three factors, FF·XF·EF delivers the CF with the desired damage dimension, i.e. (PAF·)[m<sup>3</sup>·d/kg], to be applied to the emitted amount of N [kg] from Life Cycle Inventory (LCI). The model provides CFs for the "N to air", "N to surface freshwater", "N to groundwater", and "N to marine water" LCI flows for 214 country-to-LME (Large Marine Ecosystems), 143 countries, 13 regions/continents, and a global default. The sensitivity and uncertainty analyses identified key issues for data quality improvement, namely Primary Production (PP) datasets, residence time, and N-export splitting rules for multiple receiving ecosystems. Further improvements point to the inclusion of spatial differentiation to the N-losses within the fate models.





# **3.1 Introduction**

#### 3.1.1 Background

Life Cycle Assessment (LCA) has been dealing with the environmental performance of products and services throughout their life cycle (Hauschild 2005; Curran et al. 2011). However, accounting for all the resulting environmental impacts has not been covered in full extent. Impact assessment methodology is still lacking for several of the impact categories, including eutrophication (Huijbregts 2011).

It is widely acknowledged that marine eutrophication involves natural processes leading to an excessive growth of algal biomass in response to nutrient enrichment of marine systems. Once the plant nutrients, mainly nitrogen (N) are available to assimilation and growth, the excessive biomass produced can decrease the water quality (along with the degradation of organic matter from other sources) and bring undesirable effects to biological communities both in the water column and at the bottom (OSPAR 2008). While being true this broad definition falls short in addressing the sources, processes, and effects involved.

Kitsiou & Karydis (2011) compiled a comprehensive historical evolution of the definition of marine eutrophication. In broad terms, this evolution started early in 1919 when Naumann focused on the increase of phosphorous and nitrogen in lake systems (cited in Hutchinson 1967), later extended to "any and all nutritive substances" (Hasler 1947, p. 383). As the marine eutrophication processes were being studied and knowledge expanded, the definition also evolved to include the algal growth in response to the increase of nutrients in the marine environment as well as introducing the idea of its immediate consequences (Steele 1974). The inclusion of the impacts in the definition was proposed by Vollenweider (1992, p. 3) by referring to algal blooms in response to "the process of enrichment of waters with plant nutrients, primarily nitrogen and phosphorus that stimulates aquatic primary production". At the same time, Gray (1992) pursued the photosynthesis concept and nutrients loadings as a source provided that the nutrients are not toxic compounds. Nixon (1995, p. 201) then defined marine eutrophication as a process, instead of a trophic state, and introduced the organic matter concept when proposing his short definition: "Eutrophication is an increase in the rate of supply of organic matter to an ecosystem". Sharing the same considerations, Heip (1995) included the impacts elsewhere, namely in the benthos, by expanding the nutrients loadings and productivity to include the indirect impacts of oxygen depletion and ecological changes (species composition and interaction).

The above definitions were developed in a scientific perspective. International official entities have further contributed with practical and assertive definitions:

- The European Environmental Agency (EEA) directed the concept to anthropogenic causes: *"Eutrophication means enhanced primary production due to excess supply of nutrients from human activities, independent of the natural productivity level for the area in question"* (EEA 2001, p. 8);
- The European Council focused on compounds of nitrogen and phosphorous as the cause for the "accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned" (EC 1991, p. 41). The novelty was the 'disturbance' perspective and the need for management of these nutrients in sewage treatment;





• The UNEP (2003), agreeing with the historical development of the concept, introduced the 'excess' term over 'increase' when referring to the nutrients availability and the system's natural thresholds by mentioning that the cause is "the load of nutrients (...) from human activities in quantity exceeding the carrying capacity of the receiving environment" (UNEP, 2003, 2) while recognizing Nixon's concept and generalizing it with: "caused by an excess rate of supply of organic matter, including excessive primary production" (EEA 1999, p. 16; UNEP 2003, p. 1).

## 3.1.2 Eutrophication as a function of nutrients or organic matter enrichment?

Despite the effort in finding a clear operational definition for eutrophication over the years, the concept is used in a blurry way by scientists and managers (Nixon & Fulweiler 2009).

As seen above, the concept of marine eutrophication has evolved into two major mindsets (although intertwined) – the one based on the nutrients loadings signalling primary productivity, and the other based on the degradation of organic matter. While both share the rationale of the biological processes and interesting topics for discussion, the nutrients approach seems to be restricting the sources of organic matter to the degradation of the newly produced biomass (autochthonous, i.e. locally produced biomass from non-anthropogenic available nutrients) resulting from the addition of nutrients to a nutrient-limited system. Indeed, marine eutrophication has its roots in the nutrients loadings and their limiting availability in dictating plant biomass growth and thus carbon fixation. However, the regeneration and recycling of nutrients and its accountability to the biomass production is not mentioned. This has been addressed and worked upon both in the scientific and regulatory frameworks resulting in contributions to understand, mitigate, and manage the processes and results.

On its turn, Nixon's proposed definition directs focus to organic matter in the ecosystem, in the sense that it is a result from a dynamic process, from sources (fate) to effects. It also reminds that nutrients enrichment is not the only cause of eutrophication (although the most common) and that organic matter can be autochthonous but also allochthonous (organic loads from outside the ecosystem, like sewage water and industrial wastes for instance), thus better reflecting the fate dynamics (Nixon 2009). Moreover, this approach skips the considerations about regeneration and recycling of nutrients by focusing on a single parameter on the net result of production, i.e. biomass. This simple definition eases the distinction from causes to consequences: the causes are diverse and may include increase in inorganic nutrients inputs or organic matter loadings, decrease in grazing pressure over phytoplankton, alterations on system's dynamics or water residence time, while the consequences may include changes in the ecosystems' populations structure, increased oxygen demand, mass mortalities, harmful algal blooms, and others (Hinga et al. 1995). Finally, Nixon argues that explaining eutrophication as responses to *"nutrients concentrations, chlorophyll levels or species composition confuses symptoms with the underlying phenomenon"* (Nixon 2009, p. 5).

## 3.1.3 Marine productivity and eutrophication

The basis for primary production is the photosynthetic process by phytoplankton. Productivity relates to the system's capacity to utilize available nutrients and generate organic matter by fixating carbon. The main sources of N can be nitrate (the oxidised form) or ammonia and urea

# OLC-IMPACT



(the reduced forms) that are natural metabolic waste products of respiration (degradation of e.g. amino acids/proteins) supplied internally in the surface mixed layer (Platt & Sathyendranath 2007). Nitrate is externally supplied from deeper waters where OM is remineralized, from terrestrial/freshwater runoff (where the anthropogenic contribution is significant), or in less extent by atmospheric N<sub>2</sub>-fixation.

According to the mentioned sources of N, productivity consists of *new production* ( $P_{new}$ ), which uses nutrients that are supplied externally (allochthonous sources), and *regenerated production* ( $P_r$ ), which uses nutrients that are recycled within the surface mixed layer. The sum of the two components equals *total productivity* ( $P_t$ ). The organic carbon that sinks to the aphotic zone is an *export production* ( $P_E$ ) (Wassmann 1990). This fraction is important because it constitutes a source of organic matter (particulate organic carbon, POC) for bacterial degradation in the bottom layers.

$$P_t = P_{new} + P_r$$

In a steady-state perspective,  $P_r$  is referred as the component of  $P_t$  that meets the metabolic demands of the community of pelagic primary producers. The remaining component ( $P_{new}$ ) is the production that can be used to increase phytoplankton's biomass (Platt & Sathyendranath 1988). This assumption is of key importance to understand the potential effect on phytoplankton populations of the anthropogenic input of N to the marine system and to the "biological pump" responsible for the sink effect for carbon from atmospheric carbon dioxide to deeper waters, thus helping to regulate greenhouse effect and global climate. Again, under the same steady-state assumption, the downward flux of sinking POC is equivalent to  $P_{new}$  (Wassmann 1990; Platt & Sathyendranath 2007).

Eutrophy characterizes the level of productivity of a system, meaning that systems holding high rates of carbon fixation by primary producers into biomass from nutrients and carbon dioxide are known as eutrophic (Nixon & Fulweiler 2009). Possibly the most adopted productivity scale for classification of marine ecosystems is the one proposed by Nixon (1995):

- Oligotrophic systems, with productivity rate <100 gC·m<sup>-2</sup>·y<sup>-1</sup>;
- Mesotrophic systems, with productivity rate ranging from 100-300 gC·m<sup>-2</sup>·y<sup>-1</sup>;
- Eutrophic systems, with productivity rate ranging from 301-500 gC·m<sup>-2</sup>·y<sup>-1</sup>;
- Hypertrophic, with productivity rate >500 gC·m<sup>-2</sup>·y<sup>-1</sup>.

Alone, these values are not indicative of ecological degradation or problems associated with eutrophication. Highly productive systems (i.e. eutrophic) associated with upwelling conditions to feed and renew their biogeochemical processes may be far from cultural eutrophication (i.e. with anthropogenic causes), as can be found in the Patagonian shelf (>500 gCm<sup>-2</sup>yr<sup>-1</sup>), the Benguela Current off Southwest Africa (>500 gCm<sup>-2</sup>yr<sup>-1</sup>), the Canary Current off Northwest Africa (>400 gCm<sup>-2</sup>yr<sup>-1</sup>), and the Humboldt Current off Peru and Chile (>300 gCm<sup>-2</sup>yr<sup>-1</sup>) mainly powered by upwelling resurface of nutrients (and recycling) allied to longitudinal currents that prevent stratification.

# 3.1.4 Organic loading

With the increasing human pressure caused by excessive population growth on coastal areas (de Jonge et al. 2002) and the installation of urban water infrastructures and sewage systems, especially in Europe and North America, together with industrial wastewater (e.g. food





processing, paper, textiles), a significant load of organic matter is delivered to coastal waters (Nixon & Fulweiler 2009).

Historically, the first concern was directed to human health and aesthetics, and a reduction of its pathogenicity was achieved. The same did not happen to the organic matter input to coastal ecosystems, where bottom waters gradually became hypoxic and the ecological impacts soon turned visible (Nixon & Fulweiler 2009).

While starting up to tackle the problem in the 1960s and 1970s with secondary treatment aiming at reducing BOD of discharged wastewaters, several regions of the world (mainly developing countries) are still facing a similar impact (Nixon & Fulweiler 2009).

Moreover, when modelling the organic carbon loadings for places with significant sources of allochthonous carbon, like estuaries or highly populated coastal areas, the carbon input to bottom processes may be relevant, but the uncertainty associated with determining the labile fraction is very high (Nixon 1995).

## 3.1.5 Nutrients enrichment

Nutrients enrichment of coastal ecosystems originated from freshwater runoff after the largescale introduction of inorganic fertilizers and detergents worldwide (de Jonge et al. 2002) has been identified as the main cause for marine eutrophication (Nixon 1995; Smith et al. 1999). Apart from less significant causes the human mobilization of N and P to coastal waters has grown into a serious environmental concern because of its ability to stimulate primary production and disrupt the production/metabolism balance of organic matter in coastal areas (Cloern 2001).

The anthropogenic nutrient enrichment is recognized as highly widespread and more damaging than organic loading (Nixon & Fulweiler 2009), especially due to the nutrients recycling/regeneration in the recipient ecosystem. While organic matter is degraded once by heterotrophic bacteria (Levin et al. 2009) nutrients can be incorporated into biomass several times, increasing its retention time before eventually being flushed away from the regeneration cycle (or abstracted, e.g. biomass capture by fishing, or deep buried in sediments). Nutrients are turned available as organic matter is degraded (and oxygen is consumed) and by excretion products from heterotrophic grazers (Clark et al. 2008), and can be recycled into 'regenerated production' (Wassmann 1990; Domine et al. 2010).

## 3.1.6 Nitrogen cycle

Studies have shown that N availability acts as a limiting and controlling factor of primary production in estuarine and marine waters (Vitousek et al. 2002; Howarth & Marino 2006). In principle, the concept of 'limiting nutrient' states that one nutrient is limiting the growth (size and number) of a resident population and that all other nutrients are available in excess. If an additional amount of the limiting nutrient is introduced into the system, this will promote an increase in growth. On the other hand, an introduction of any of the other nutrients will have no reflection on growth as they are already in excess (Finnveden & Potting 1999). Freshwater systems are often limited by phosphorous, marine systems by nitrogen, and estuarine systems by either or both. For modelling purposes the 'limiting nutrient' concept is a simplification, as exceptions can be found, other nutrients can be limiting in specific conditions, variations along the annual seasons, and different species can show different requirements (Finnveden & Potting 1999).





While this N limitation in ecosystems is a natural process, human interventions have greatly interfered with the N cycling in the various environmental compartments, from a local to a global scale (Howarth & Marino 2006). Anthropogenic sources of N to natural systems have increased greatly in the recent decades to accommodate the demand for food of a fast growing human population by means of production of reactive N for fertilizer use, and inadvertently, from combustion of fossil fuels (Galloway et al. 2004).

Food production activities have increased fixation of atmospheric  $N_2$  (by legumes and rice cultivation) and intensive agricultural activities that lead to the industrial production of reactive N. Energy production emits  $NO_x$  during combustion of fossil fuels, either by an oxidation process of atmospheric  $N_2$  or fuel's organic N (mainly in coal and biomass burning) (Socolow 1999; Galloway et al. 2002). While intensive use of fertilizers in food production introduces new N into the environment, fossil fuels combustion simply mobilizes once sequestered N.

Vitousek et al. (1997) and Scavia et al. (2002) have recognized the anthropogenic introduction of N in the environment as "one of the greatest consequences of human-accelerated global change on the coastal oceans of the world" (Howarth & Marino 2006, p. 364)

Facing a patently growing (and unavoidable) demand for food and energy production to such an alarming magnitude, the sustainability of natural and man-made productive ecosystems raises critical concerns about the current and future fate and impacts of further introductions of N in the environment. The complexity of an accurate assessment of emissions, transport, transformation, and deposition processes of the various N forms makes monitoring, modelling, and damage estimation a challenging exercise. Life cycle thinking and methodologies can be applied here in the attempt to contribute to understand and estimate the importance of potential impacts of such emissions. Still, the broad reach of the N cycle in the geochemical fluxes of C and P, and on a variety of biological cycles, significantly impacts the human economy, society, and environment in regional to global changes, like carbon balance, acidification, terrestrial and marine eutrophication, that are currently being addressed by scientist, managers, and regulators.

#### 3.1.7 Effects of nitrogen in marine waters

The biological response to nutrients loadings to the marine system is phytoplankton growth, shown either by increased individual biomass or population numbers. Ecologically, this means that photosynthesis in the photic zone by primary producers is enhanced by newly-available nutrients. In oligotrophic waters the enhanced growth of this primary production is mainly consumed by the secondary production (Powers et al. 2005) rendering little negative impacts off the nutrients enrichment. However, in eutrophic waters (already bearing high productivity) nutrients loadings may result in excessive phytoplankton biomass and significant ecological impacts.

High productivity in the photic zone may (*i*) change communities' composition and species interaction, enhancing the growth of toxic and harmful algal species, triggering harmful algal blooms (HAB) events, (*ii*) decrease water quality, by high turbidity, colour, and smell, hindering water uses, fish production, and aesthetic value, and (*iii*) deplete dissolved oxygen in bottom waters with resulting impact on the benthic species survival (Kelly 2008).

The effects addressed in this report refer to those related to the photosynthesis in the photic zone and those that potentially occur in bottom waters affecting benthic, demersal, or benthopelagic species, in coastal marine systems that are sufficiently eutrophic to be negatively affected by further anthropogenic nutrients enrichment. This excludes the impacts (either positive





or negative) in oligotrophic systems seasonally affected by natural upwelling-fed nutrients inputs for instance.

In this section, the focus is put on the fate of the excessive phytoplankton biomass as it is degraded in bottom waters resulting in dissolved oxygen depletion and hypoxia.

#### Нурохіа

Hypoxia of marine coastal waters is a shortage of dissolved oxygen (DO) that can be caused by natural processes or by human interventions that promote an excessive consumption of oxygen, or by the interaction of both (Levin et al. 2009). The processes are basically the same and involve a biological demand of oxygen (i.e. BOD) greater than its supply, thus the depletion. In the case of marine eutrophication, the oxygen near the sediments is consumed as aerobic bacteria decompose the organic matter (the senescent biomass from above) (Levin et al. 2009; Middleburg & Levin 2009) potentially developing into hypoxic conditions.

As suggested by EC (2009) following OSPAR's (2008) proposal, hypoxia occurs as DO drops below 6 mg/L in bottom waters. Alternative classifications have been produced (*cf.* Riedel et al. 2008), with normoxia for DO>2 ml/L) but not adopted here.

In highly stratified waters the DO depletion under the pycnocline can bring the water masses to severe hypoxia and even anoxia closer to the bottom. Severe anoxia is conventionally defined as the threshold below which the impacts on biota are significant (Thibodeau et al. 2006) and DO drops below 2 mg/L (or 1.42 ml/L, 62.5  $\mu$ M, approximately 30% oxygen saturation), i.e. fisheries collapse (Diaz & Rosenberg 1995; Rabalais et al. 2001; Vaquer-Sunyer & Duarte 2008; Levin et al. 2009). Reviews of experimental data (Gray et al. 2002; Vaquer-Sunyer & Duarte 2008) point for an inadequacy of such threshold for the description of hypoxia stress triggering, as many species show significant responses and mortality at higher DO concentrations. Data show that responses significantly vary across taxa and that the conventional 2 mg/L of DO to define hypoxic waters falls "below the empirical sublethal and lethal O<sub>2</sub> thresholds for half of the species tested" (Vaquer-Sunyer & Duarte 2008, p. 15452).

Coastal hypoxia is a major threat to shallow coastal ecosystems and shown to be responsible for mortality events resulting in wide depletion of metazoans in some ecosystems ('dead zones') (Rabalais et al. 2002; Diaz & Rosenberg 2008). Moreover, the proliferation of hypoxic zones along populated coastal areas and estuaries has been associated with nutrients loading from anthropogenic sources and coastal eutrophication (Turner & Rabalais 1994; Diaz & Rosenberg 1995; Cloern 2001; Gray et al. 2002; Thibodeau et al. 2006).

#### Impacts of hypoxia on biota

The impacts of hypoxia on biota depend much on the severity (intensity), frequency and duration of the exposure to reduced DO in marine ecosystems (Powers et al. 2005; Haselmair et al. 2010). Both acute and chronic effects can be mentioned, including behaviour and physiological adaptations (Diaz & Rosenberg 1995; Burnett & Stickle 2001; Gray et al. 2002; Wu 2002).

In general, crustaceans show the highest sensitivity to lower oxygen saturation rates (with high  $LC_{50}$  results and low  $LT_{50}$ ) followed by fishes (with high  $SLC_{50}$  results). Larval stages are also referred as more sensitive than adults (Miller et al. 2002). On their turn, molluscs (with the lowest  $LC_{50}$ ), cnidarians (with the lowest  $SLC_{50}$ ) and priapulids (with the highest  $LT_{50}$ ) show more tolerance to oxygen depletion.





Mortality is observed for the majority of benthic organisms at DO<3 mg/L, which corresponds to the  $83^{rd}$  percentile of the distribution of their LC<sub>50</sub> values (Vaquer-Sunyer & Duarte 2008). Exposure to extreme or prolonged hypoxia leads to mass mortalities, however hypoxia induces many different sub-lethal responses on organisms at the:

- Behavioural level triggering behavioural changes (Riedel et al. 2008) and avoidance strategies (Vaquer-Sunyer & Duarte 2008);
- Physiological level reduced tolerance to other stressors, limiting energy budget, growth rate, activity and respiration rate (Burnett & Stickle 2001);
- Ecological level altering structure, function, and services of benthic communities (Levin et al. 2009; Sala & Knowlton 2006).

On the ecological level, Levin et al. (2009) present a comprehensive review of the effects of both natural and human-induced hypoxia on coastal benthos species over several regional studies. In general, the ecological impact on benthic communities related to hypoxia leads to the loss of the buffer species that contribute to resilience. Moreover, benthic communities normally increase oxygen penetration into the soft bottom sediments through bioirrigation and bioturbation (Steckbauer et al. 2011) and their loss may lead to changes in the sediment chemistry, mainly shifting to anaerobic metabolic pathways (mostly sulphate reduction) intensifying the biological impacts (Vaquer-Sunyer & Duarte 2010), imposing a positive feedback on oxygen depletion (trapping oxygen) (Steckbauer et al. 2011), releasing stocked nutrients (Conley et al. 2009), and impacting elemental cycling (Middleburg & Levin 2009).

# 3.1.8 Data search

Specific information about species sensitivity, distribution, ecology, and LME was mainly found by searching the following data sources:

- Vaquer-Sunyer & Duarte (2008) Review of species sensitivity data to hypoxia, including laboratory SLC<sub>50</sub> values for 65 species;
- The World Register of Marine Species (WoRMS) (marinespecies.org) A taxonomic database for marine species with ecological and distribution information (Appeltans et al. 2012);
- The Species 2000 & ITIS Catalogue of Life (www.catalogueoflife.org) A comprehensive catalogue of known species and compilation from 66 other source databases with useful taxonomic and distribution information (Bisby et al. 2009);
- Fishbase (www.fishbase.org) Database on fish species with taxonomic, distribution and ecology information (Froese & Pauly 2012);
- Large Marine Ecosystems of the World (http://www.lme.noaa.gov/) The compiled information and reports on the LMEs and the LME biogeographical classification system;
- Sea Around Us Project (http://www.seaaroundus.org/lme/) Database for Fisheries, Ecosystems and Biodiversity of the LME biogeographical classification system.

All the remaining information and data used in the present study was found in the sources cited in the text and later listed under the Section *References*.





#### 3.1.9 Research goals

The eutrophication impacts of anthropogenic N inputs to marine ecosystems depend on the fate processes and the sensitivity of receiving environments. Spatial differentiation is also important to discriminate the distribution of impact estimation results, to improve the fate model accuracy and the overall model applicability. A suitable impact assessment methodology for global marine eutrophication at endpoint is still lacking in LCIA. While the fate modelling has been the subject of advances and contributions, it has not yet been feasible to fully relate nitrogen concentrations in marine coastal waters to the effects on resident species of these ecosystems, meaning that the estimation of an ecological damage factor for nitrogen enrichment of marine coastal waters in terms of loss of biodiversity would be scientifically relevant.

Facing these needs and the available information, the present study aims at (*i*) understanding the fate processes affecting nitrogen loading to coastal waters, (*ii*) defining and estimating factors for the impact characterisation (CFs), (*iii*) introducing spatial differentiation at a suitable scale, in order to (*iv*) build a marine eutrophication damage model for application as a LCIA methodology.

# 3.2 Methodology

#### 3.2.1 Framework

The system boundaries defined for the present study were set to solely include the processes regarding marine eutrophication. The inputs to this system are derived from the global processes involving atmospheric nitrogen and freshwater/terrestrial fate of N from inorganic fertilizers used in agriculture, manure used in agriculture, N-fixation in agriculture, air emissions as NH<sub>3</sub>, air emissions as NO<sub>x</sub>, and sewage discharges.

The relevant processes in the cause-effect chain for marine eutrophication are presented in Figure 3.1, which also identifies the processes that are included in the modelling of fate, exposure, and effect factors.

The estimation of potential impacts for marine eutrophication is built on the application of Characterisation Factors (CF, unit:  $(PAF)[m^{3}\cdot d/kgN]$ ), defined by:

$$CF_{ij} = FF_{ij} \times XF_j \times EF_j$$

Where FF is the Fate Factor (unit: [d]) for emission route *i* to receiving ecosystem *j*, XF is the Exposure Factor (unit: [kgO<sub>2</sub>/kgN]) in receiving ecosystem *j*, and EF is the Effect Factor (unit: (PAF·)[m<sup>3</sup>/kgO<sub>2</sub>]) in receiving ecosystem *j*.

Emission routes include "N to air", "N to surface freshwater", "N to groundwater" and "N to coastal marine waters". The receiving ecosystems considered in the present study are the Large Marine Ecosystems (LME) spatial units (see 3.2.2).

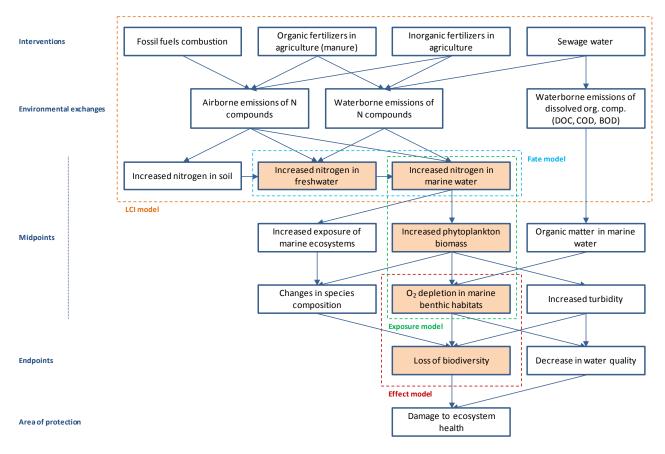
The FF estimates the N fraction exported to marine waters and the N losses in the marine compartment, thus expressing how N loadings into this compartment vary. The FF depends on the N fate in soil, the atmospheric fate, the fate in freshwater systems, and on the losses once in the marine compartment (denitrification, advection and sedimentation).

The XF expresses the conversion from nitrogen to organic matter (phytoplankton biomass) in the photic zone and to dissolved oxygen consumption in bottom waters.

# OLC-IMPACT

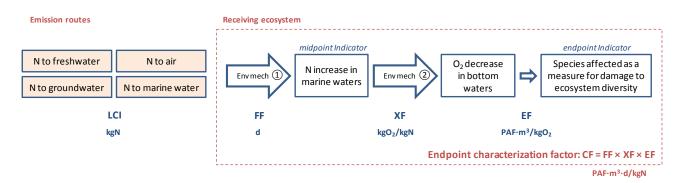


The EF represents the change in the potentially affected fraction of species (PAF) in the receiving marine ecosystem due to the change in dissolved oxygen.



**Figure 3.1:** Cause-effect chain for marine eutrophication from sources of N emissions, midpoint, and endpoint processes, also showing those included in the fate, exposure and effect models (orange-shaded boxes).

The marine eutrophication model (Figure 3.2) may be seen as a combination of an environmental mechanism governing the fate of nitrogen and another environmental mechanism governing the oxygen depletion that results in impact on biota.



**Figure 3.2:** Harmonized midpoint-endpoint model for marine eutrophication linking human interventions to ecosystem damage.





The diagram above is the basis for the LCIA calculations and estimation of CF and ultimately builds up on the cause-effect chain (Figure 3.1).

As seen above, the proposed model deals with the fate and effect components of nitrogen involved in the marine eutrophication processes at both midpoint and endpoint levels. Additions of N to the marine system results in enhanced phytoplankton biomass that eventually sink and decay by the action of bacterial degradation consuming dissolved oxygen; the benthic habitat is affected by the low dissolved oxygen levels and biota is affected at different scales depending on their specific sensitivity to hypoxia.

These fate and effect processes try to explain the marine eutrophication phenomenon and are the basis to the present damage model. Further details are described later in this chapter.

#### 3.2.2 Unit areas for spatial differentiation

#### The biogeographical classification system

The delimitation of the applicable study areas, with special relevance for the spatially differentiated modelling, is drawn from a biogeographical classification system proposed by the U.S. National Oceanic and Atmospheric Administration (NOAA) identifying 64 Large Marine Ecosystems (LME), set for areas of the oceans defined for conservation purposes (Sherman 1991).

Spalding et al. (2007) and UNESCO (2009) reviewed some of these biogeographic classification systems.

Overall, the availability and dispersion of data sources, geographic coverage and representativeness, ecological relevance, and adaptation to the needs of the present study, were the criteria for selecting the most suitable option. The LME classification system was adopted here as better suiting the study purpose as they refer to the marine area from the coastal areas (neritic zone) plus river basins and estuaries to the seaward boundaries of the continental shelf with a particular influence of mixing processes that promote a good oxygenation and stable temperature and salinity. Additionally, the presence of light (fundamental in the continental shelf) and nutrients (from freshwater and terrestrial run-off) promotes the occurrence of phytoplanktonic species. Overall, LMEs are characterized by its "distinct bathymetry, hydrography, productivity and trophically dependent populations" (Sherman & Duda 1999, p. 15). LMEs are mainly aiming at providing a basis for practical application of transboundary management issues in 5 modules (productivity and oceanography, fish and fisheries, pollution and ecosystem health, socioeconomics, and governance (Spalding et al. 2007). The 64 LMEs were developed and presented as ecologically rational units of ocean space in which ecosystem-based management can be applied (Mahon et al. 2010), and it is this integrated approach that builds the criteria for choosing LMEs as suitable study areas for marine eutrophication.

The identification of the 64 LMEs and their geographical location can be found in Figure 3.6 (Appendix 3-I).

Spalding et al. (2007) point to some criticisms to the LME classification system, including the fact that it is an "*expert-derived system without a rigorous, replicable core definition*" and that it is focused on "*productivity and oceanographic processes, and in its present form omits substantial areas of islands in the Pacific and the Indian oceans*" (Spalding et al. 2007, p. 574). However, considering the suitability of the LME classification system to represent the receiving compartment of terrestrial/freshwater N, the amount of data available for productivity, and ease

# OLC-IMPACT



of adaptation to a climate zonation, overcomes the referred weaknesses. No classification system is perfect, but using the LME system seems like an opportunity rather than a challenge.

A necessary assumption here is that the sea bottom area is set to correspond to the sea surface area, disregarding slope profile and roughness of the bottom, thus underestimating the bottom area. Nevertheless, it seems a good proxy considering the purposes of the study, the effort needed to calculate the bottom area, and the resulting associated uncertainty.

## Grouping spatial units into climate zones

Spatial units (LMEs) were grouped in climate zones (Tropical, Subtropical, Temperate, Subpolar, and Polar) to provide regional assessment of impacts on biota. The basis for the grouping was mainly geographic coverage and water temperature, as explained next:

- Latitudinal distribution: Tropical from Equator to ≈20°N, Subtropical from ≈20°-30°N, Temperate from ≈30°-50°N, Subpolar from ≈50°-70°N, and Polar from ≈70°-90°N (and the same for the Sourthern Hemisphere);
- Mean annual sea surface temperature (maSST): based on the information included in the LME briefs (data collection of specific distinctive characteristics) provided by NOAA (2012) where maSST is presented as a dataset extending from 1975-2005 and a regression curve fitted to assess variation trends in each LME. Individual regression equations were used to estimate maSST for 2012 for each LME, which were the used to complement the grouping of LMEs into the 5 climate zones (Table 3.5 in Appendix 3-II);
- To help on the classification of certain LMEs, complementary information was found on the Marine Ecoregions of the World (MEOW) classification system (Spalding et al. 2007) and on the Köppen-Geiger climate classification system (Peel et al. 2007).

# 3.2.3 Fate Factors (FF) and the fate model

The FF<sub>i,j</sub> (unit: [d]) is obtained by:

$$FF_{i,j} = \frac{f_{\exp i}}{\lambda_j}$$

Where:

 $f_{\exp i}$  (fraction, [-]) is the fraction of N exported to coastal marine waters calculated for each emission route *i*, and

 $\lambda_i$  (unit: [d<sup>-1</sup>]) is the N loss rate coefficient in receiving ecosystem j

The receiving ecosystems considered in this study are the Large Marine Ecosystems (LME) defined by NOAA (Sherman 1991).

The FFs were estimated at a country-to-LME level per emission route, i.e. factors for an emitting country to a receiving LME, e.g. "*Canada to LME#2. Gulf of Alaska*" and "*Canada to LME#63. Hudson Bay*" (x4 emission routes: "N to air", "N to surface freshwater", "N to groundwater" and "N to marine coastal water").

The fate model is composed of a land based component and a marine based component. The first deals with the loss/transformations processes affecting N forms from air emissions and its deposition, agricultural and natural land, groundwater, and surface freshwater systems. The

# OLC-IMPACT



marine component deals with N losses due to denitrification, advection, and sedimentation in marine costal waters.

# Estimation of N export to coastal marine waters (f<sub>exp</sub>)

Atmospheric emissions of either NOx or  $NH_3$  will deposit differently in natural soil, agricultural soil, surface freshwater, and sea (oceanic and coastal) waters. Roy (2012) has provided a model dataset that delivers the amounts of these N forms being deposited in various countries from any emitting country (data available for 236 countries).

The model estimates the N amount deposited in marine waters and land. The fraction deposited on marine waters can be further differentiated in 0.9 to coastal marine waters (mw) and 0.1 to oceanic waters (Roy et al. 2012). The fraction deposited inland is then further divided into 0.604 to natural soil (ns) and 0.362 to agricultural soil (as) (Bouwman et al 2011a), and 0.034 to surface freshwater (sfw) (Larsen et al 2009).

Leaching to sfw is estimated at 0.142 (from ns) and 0.081 (from as) after accounting for harvesting/grazing, topsoil denitrification, and infiltration to groundwater (gw), which also applies to the N forms amount emitted from agricultural systems.

Denitrification losses in gw is estimated at 0.646 (Bouwman 2011b) and at 0.527 (Wollheim et al. 2008) in sfw.

The estimation of the exported amount of N to marine coastal waters for each of the emission routes, which are identified as "N to air", N to sfw", "N to gw", and "N to mw", is obtained by applying the mentioned fractions (see also Table 3.1 below).

Fraction	Value	Source	
Deposition (1.000)	Deposition (1.000)		
f <sub>dep</sub> to sea	× country f	Roy (2012)	
f <sub>dep</sub> to mw	× 0.900	Roy et al. (2012)	
$f_{dep}$ to inland	× (1-country f)	Roy (2012)	
Deposition inland			
$f_{dep}$ to ns	× 0.604	Bouwman et al. (2011a)	
$f_{dep}$ to as	× 0.362	Bouwman et al. (2011a)	
$f_{dep}$ to sfw	× 0.034	Larsen et al. (2009)	
Leaching to sfw			
$f_{leach}$ from ns	× 0.142	Bouwman et al. (2011b)	
$f_{leach}$ from as	× 0.081	Bouwman et al. (2011b)	
Denitrification			
Denitr in gw	× 0.354	Bouwman et al. (2011b)	
Denitr in <b>s</b> fw	× 0.473	Wollheim et al. (2008)	

Table 3.1: N fractions applicable in the calculation of N export to coastal marine waters.

The calculations lead to an exported fraction of N to mw originated from the N emission to air obtained by:

(LCI  $N_{to air}$ ) \*  $f_{dep}$  to sea \*  $f_{dep}$  to mw + (LCI  $N_{to air}$ ) \* f to inland \*  $f_{dep}$  to ns \*  $f_{leach}$  from ns \* Denitr in sfw + (LCI  $N_{to air}$ ) \* f to inland \*  $f_{dep}$  to as \*  $f_{leach}$  from as \* Denitr in sfw + (LCI  $N_{to air}$ ) \* f to inland \*  $f_{dep}$  to sfs \* Denitr in sfw





- The exported fraction of N to mw originated from the N emission to sfw is obtained by: (LCI  $N_{to sfw}$ ) \* Denitr in sfw
- The exported fraction of N to mw originated from the N emission to gw is obtained by: (LCI  $N_{to gw}$ ) \* Denitr in gw \* Denitr in sfw
- The exported fraction of N to mw originated from direct N emission to mw is obtained by: (LCI  $N_{to\,mw})$  \* 1

Overall, the exported amount of N involves the application of a loss fraction, or exported fraction ( $f_{exp}$ ), to the N amount emitted and identified with the help of an LCI model.

A suitable LCI model should be applied to estimate relevant outputs from human interventions, such as fertilizer application in agriculture, air emissions, treated sewage discharges. Examples of such LCI models can be found in Van Drecht et al. (2003) and Bouwman et al. (2009) – agriculture exports, Van Drecht et al. (2009) – sewage emissions, Roy et al. (2012) – atmospheric emissions and deposition, Wollheim et al. (2006, 2008) – N losses in freshwater systems.

## Data sources for N-emissions and N-export calculations

Nitrogen emissions per country were provided by Bouwman and co-workers (Bouwman 2011a).

Export rates of N from non-point sources to rivers (leaching and denitrification rates) were provided by Bouwman and co-workers (Bouwman 2011b) as the result of the modelling work described by Van Drecht et al. (2003) and Bouwman et al. (2009).

Atmospheric nitrogen emissions and deposition rates at country level were provided by Roy and co-workers (Roy 2012) following the model by Roy et al. (2012).

Nitrogen losses in river systems were obtained from the removal model implemented with FrAMES-N by Wollheim et al. (2006, 2008).

## Estimation of the nitrogen loss rate coefficient ( $\lambda$ ) in the marine compartment

Nitrogen losses in marine coastal waters can be caused by:

- Denitrification, which is the reduction of oxidized forms of nitrogen (NO<sub>3</sub><sup>-</sup>, NO<sub>2</sub><sup>-</sup> and NO) into N<sub>2</sub> in a microbial-mediated process in the bottom sediments;
- Advection, which represents the transport of nitrogen forms from the considered spatial unit by the effect of local hydrodynamics (equivalent to flushing);
- Sedimentation, which represents a loss to mineralization of nitrogen forms into bottom sediments.

The nitrogen losses estimation applies the same denitrification rates as for rivers (30%) calculated by Van Drecht et al. (2003) and sedimentation rates (5%) in literature (Nixon et al. 1996). The hydraulic residence times for some of the receiving LME were found in literature (listed in Table 3.6 in Appendix 3-III), while four archetypes were applied to the LME for which no data was found or to settle high variability data, based on coastal exposure to currents and regional ocean circulation, depth, and coastal profile, as follows:





- High dynamics and exposure to regional currents: residence time estimated of 3 months (archetype 1);
- Medium dynamics and exposure to local currents: estimated residence time of 2 years (archetype 2);
- Low dynamics: estimated residence time of 25 years (archetype 3);
- Very low dynamics or embayment: estimated residence time of 90 years (archetype 4).

The N-loss routes 'denitrification' ( $\lambda_{denitr}$ ) and 'sedimentation' ( $\lambda_{sed}$ ) are obtained from the equation for the expected first-order kinetics with a constant removal rate ( $\lambda$ ):

$$N_t = N_0 \cdot e^{-\lambda_r t}$$

Where N<sub>0</sub> is initial nitrogen amount [kgN], N<sub>t</sub> is the nitrogen amount [kgN] after time t [yr], and  $\lambda_r$  is the removal rate [yr<sup>-1</sup>] per loss route r (*denitr*, *sed*).

The loss route 'advection' ( $\lambda_{adv}$ ) can be estimated using the LME residence time ( $\lambda_{adv j} = 1/\tau_{LME j}$ ).

The overall N loss rate for receiving ecosystem (j) is then calculated by:

$$\lambda_{LME \ j} = \lambda_{denitr \ j} + \frac{1}{\tau_{LME \ j}} + \lambda_{sed \ j}$$

The calculations, data, and results of the N loss rate coefficients estimations for the various LMEs can be found in Table 3.7 in Appendix 3-III.

#### 3.2.4 Exposure Factors (XF)

The XF<sub>j</sub> [unit: kgO<sub>2</sub>/kgN] for any receiving ecosystem *j* is obtained by:

$$XF_{j} = \frac{kgOM}{kgN} \times \frac{kgO_{2} \times (1 - BGE)}{kgOM} \times NIE_{j} \times VCC$$

The nitrogen in the photic zone is incorporated into phytoplankton biomass (OM:N ratio) which induces a consumption of dissolved oxygen in the benthic habitat ( $O_2$ :OM ratio) with its degradation. This N:O<sub>2</sub> conversion is affected by a bacterial growth efficiency (BGE) coefficient.

The XF expresses the potential exposure of the target species to the available N (resulting from the fate estimations), relating nitrogen in the photic zone to dissolved oxygen (DO) consumption in bottom waters (benthic habitat). It further applies a site-dependent Nitrogen Incorporation Efficiency (NIE) concept, which depends on the response of individual receiving LME *j*, i.e the differentiated productivity rates in response to the combined effect of the different local environmental factors. A volume conversion coefficient (VCC) was included to account for the different volumes of the photic zone and the benthic habitat at the bottom

#### The OM:N ratio

The correlation between N incorporation and DO consumption in bottom waters is obtained from the stoichiometry of both photosynthesis and organic matter (OM) degradation (bacterial respiration) governing reactions. It is assumed that OM degradation is the only DO-loss process in the bottom layer.





The estimation of the production of phytoplankton biomass is obtained from photosynthesis, where inorganic nutrients, carbon dioxide, and water are converted into organic matter and oxygen.

The elemental composition of marine phytoplankton biomass was found similar to the major dissolved inorganic nutrients in the deep ocean by Alfred Redfield (Redfield 1934) supporting the concept of reciprocity between organisms and environment (Redfield 1958). The initially proposed molar ratio for nitrate:phosphate (N:P) of 16:1 was supported by remineralization of phytoplankton with release of N and P to the environment at this specific ratio. Later, this ratio was extended to include carbon (C) on a C:N:P ratio of 106:16:1 (Arrigo 2005) as shown in the OM term. The Redfield ratio is still adopted in modelling studies and it is often assumed that the average phytoplankton stoichiometry is consistent with it, despite the oversimplification involved and the many studies challenging the ratio in different locations, species, or life stages (Arrigo 2005).

The OM:N ratio assumes the Redfield ratio to define the average stoichiometry of the production of biomass of marine primary producers (Sand-Jensen 2000) from a certain amount of input of N.

 $\begin{array}{l} 106\ CO_2 + 16\ HNO_3 + H_3PO_4 + 122\ H_2O \Rightarrow C_{106}H_{263}O_{110}N_{16}P + 138\ O_2\\ \text{Using molar masses }(M):\\ \textbf{Biomass:}\ \ C_{106}H_{236}O_{110}N_{16}P = 12.\ 0107_{106} + 1.\ 00794_{263} + 15.\ 9994_{110} + 14.\ 0067_{16}\\ & + 30.\ 973762 = 3553.\ 2\\ N_{input}:\ \ 16N = 16*14.\ 00674 = 224.\ 1\\ \textbf{Conversion rate} = \frac{M(Biomass)}{M(N_{input})} \approx \frac{3553}{224} \approx 15.\ 86\ gOM/gN\\ \underline{Application}\\ \textbf{The hypothetical input of 1 kg of N:}\\ \textbf{Biomass} = mass\ N_{input} \times conv\ rate = 10^3gN \times 15.\ 86\ gOM/gN = 1.\ 59\cdot 10^4gOM\\ \textbf{results in an hypothetical production of 15.9\ kg of phytoplankton biomass.} \end{array}$ 

#### The O<sub>2</sub>:OM ratio

The phytoplankton biomass produced in the photic zone goes through a senescence phase. This decay results in the sinking of degradable organic matter to bottom waters where degradation by heterotrophic bacteria (respiration) takes place. In this process, oxygen is consumed, and carbon dioxide, nitrate, and phosphate are released to the water mass, explaining both the depletion of DO in bottom waters and the potential 'recycling' of nutrients after remineralization. Some of the nutrients end in a refractory fraction that becomes part of the sediment (Gulliver et al. 2010).

Based on the stoichiometry of the OM degradation equation and on the specific molar mass (*M*) of the reaction's components the ratio between the amount of degradable OM and the oxygen required for its degradation is  $\approx 1:1.24$  (OM:O<sub>2</sub>) (*cf.* calculations shown next).





Degradation of organic matter (heterotrophic bacteria respiration):  $(CH_2O)_{106}(NH_3)_{16}H_3PO_4 + 138 O_2 \Rightarrow 106 CO_2 + 122 H_2O + 16 HNO_3 + H_3PO_4$ Organic matter shown as:  $(CH_2O)_{106}(NH_3)_{16}H_3PO_4$  i.e.  $M = 3553.2 \ gOM \cdot mol^{-1}$ Oxygen consumed:  $138 O_2$  i.e.  $M = 4415.8 \ gO \cdot mol^{-1}$ 

O<sub>2</sub>:OM ratio:  $\frac{O_2}{OM} \approx \frac{4416}{3553} \approx 1.24 \ gO_2/gOM$ 

<u>Application</u>

Following the hypothetical input of N from before, using 15.9 kg of OM:

total 
$$O_2$$
 consumed = mass of  $OM \times O_2$ :  $OM$  ratio

$$= 1.59 \cdot 10^4 gOM \times 1.24 \ gO_2/gOM = 1.97 \cdot 10^4 gO_2$$

results in the consumption of 19.7  $kgO_2$  assuming 100% of OM respired

# Bacterial Growth Efficiency (BGE)

An additional coefficient (1-BGE) is added here to express the fraction of organic matter that is not respired. Some of the OM (26%) is incorporated into bacterial biomass and later mineralized into bottom sediments thus not contributing to DO consumption (del Giorgio & Cole 1998).

Following the hypothetical input of N from before, using 15.9 kg of OM:  $total O_2 consumed = mass of OM \times O_2$ : OM ratio  $\times (1 - BGE)$   $= 1.59 \cdot 10^4 gOM \times 1.24 \ gO_2/gOM \times 0.74 = 1.46 \cdot 10^4 gO_2$ then actually resulting in the consumption of 14.6 kgO<sub>2</sub>

# Estimating the Nitrogen Incorporation Efficiency (NIE) per LME

As the modelling of the input/output balance is recognized as highly complex, a proxy for the net N-balance was here defined and found useful. This approach deals with the concept of Nitrogen Incorporation Efficiency (NIE) as a response of individual receiving water masses (LMEs in the present case) to the N loadings and N availability to primary production.

The productivity (primary production) rate is determined by the combined influence of many environmental factors, including light availability to power photosynthesis, water temperature, currents and advection regulating horizontal and vertical mixing of gases, nutrients, salinity, etc. The interaction of these factors is the subject of some dedicated models (like DHI's MIKE model and others) in the attempt to explain and describe the global outcome of the biogeochemical processes involved. Ultimately, these models can estimate biological parameters, such as productivity rates, with the necessary data input requirements, generally highly demanding. The NIE concept shows up as a possible tool to understand and roughly compare the responses of different LME exposed to different environmental conditions (light, temperature, mixing, nutrients, etc.) to the available nitrogen. The NIE involves the use of site-specific productivity rates that lead to the calculation of an expected amount of nitrogen incorporated obtained from an empirical PP-N relationship by Nixon *et al.* (1996), compared to the theoretical (stoichiometry-based) nitrogen needed in the system to generate the measured biomass and works as a proxy for the potential regeneration of N (i.e. reuse in further incorporation-mineralization cycles). In other

74





words, the ratio between how much N is actually incorporated in each considered ecosystem (or spatial unit) and how much N had to be available.

With NIE's application, LMEs showing environmental conditions favouring primary production will present higher nitrogen utilization possibly due to higher onwelling N supply. Less favourable conditions will lead to lower nitrogen use efficiency meaning that the environmental conditions are either limiting the biological processes, leading to more nitrogen losses (transformation or export), or the LME gets less onwelling N supply.

As the objective is not to determine exact figures for the N inputs and outputs but rather to compare different study areas by estimating NIE values of the various LME, the concept provides comparative information about the fate of N in marine waters. Additionally, it expresses the ecosystems' relative response and does not bring further complexity and uncertainty that modelling individual environmental factors (or combination of factors) would have. NIE calculations are explained below:

Starting from the PP rate available from the LME briefs by NOAA and using Nixon's equation (Nixon, 1996) relating PP and  $N_{input}$  ( $logPP = 0.442 \times logDIN + 2.332$ ) and Seitzinger's estimation (Seitzinger, 2010) of 40% of DIN in Total-N ( $DIN = 0.4 \times N_{tot}$ ), the Empirical  $N_{input}$  calculates as:

 $EmpN_{input} = \frac{DIN}{DIN \text{ content in } N_{tot}} \times M_N \times A_{LME}$ 

Where  $DIN = 10^{(logPP - 2.332)/0.442}$  in [molN.m<sup>-2</sup>·yr<sup>-1</sup>], PP is the productivity rate of the study area [gC·m<sup>-2</sup>·yr<sup>-1</sup>], M<sub>N</sub> the molar mass of nitrogen [gN/mol] and A<sub>LME</sub> the area of the study area (or Large Marine Ecosystem) [m<sup>2</sup>]. EmpN<sub>input</sub> [gN·yr<sup>-1</sup>] expresses the N loading to marine coastal waters based on Nixon's empirical equation to support the given PP rate.

The theoretical  $N_{input}$  is estimated from the maximum conversion of N into biomass based on the stoichiometry of the photosynthesis equation and the Redfield ratio.

$$Theor N_{input} = PP \times \frac{M_N}{M_C} \times A_{LME}$$

Where PP is the productivity rate of the study area [gC· m<sup>-2</sup>·yr<sup>-1</sup>],  $M_N$  and  $M_C$  are molar masses of N and C respectively [gC·mol<sup>-1</sup>/gN·mol<sup>-1</sup>], and  $A_{LME}$  the area of the study area (or Large Marine Ecosystem) [m<sup>2</sup>]. TheorN<sub>input</sub> [gN·yr<sup>-1</sup>] expresses the stoichiometric incorporation of N into biomass.

By comparing the empirical and the theoretical  $N_{input}$  it is possible to assess the net balance of losses and input rates within the specific ecosystem boundaries (study area or LME) as:

$$NIE = \frac{EmpN_{input}}{TheorN_{input}}$$

The NIE concept reads as: A certain incorporation rate of carbon through photosynthetic primary production into phytoplankton biomass (productivity rate) is the result of an addition of an average amount of nitrogen (EmpN<sub>input</sub>) estimated by an empirical relationship from various marine ecosystems. Although every study area uses nitrogen with different conversion efficiencies, a theoretical amount of nitrogen (TheorN<sub>input</sub>) is expected to feed that productivity rate, based on the stoichiometry of the photosynthetic governing equation.

Primary production rates per LME were obtained from NOAA and the 'Sea Around Us Project'. The NIE results per LME are shown in Table 3.8 in Appendix 3-IV.





#### The volume correction coefficient (VCC)

The photic zone is defined as the top layer of the water column exposed to sufficient solar radiation to support photosynthesis, downward to a depth where only 1% of the light intensity penetrates. The photic zone may extend down to ca. 200 m (open ocean) (NOAA, 2011) but varies with the light penetration (function of turbidity). As the spatial units considered in the present study are coastal zones, generally the neritic zone over the continental platform, the photic depth is highly reduced (assumed to half). As 100 m is deeper than the average photic zone depth of various of the considered LME and assuming that more than half of the LME area is on shallow waters (due to depth profile of the littoral zonation of the platform) an average photic zone of 30 m deep (for any LME) is assumed.

The thickness of the bottom layer is defined as 0.3 m assumed as providing a suitable benthic habitat layer to accommodate living species, either submerged aquatic vegetation (SAV), sessile animal species, bottom dependent animal species and free-swimming species that feed, reproduce, hide, or somehow spend there a part of their life cycle or habits.

The volume correction coefficient is then defined by:  $VCC = \frac{V_{bentic habitat}}{V_{photic zone}}$ 

#### 3.2.5 Effect Factors (EF)

The correlation between the dissolved oxygen depletion in the benthic habitat and the potential effect on biota is based on an extrapolation model of the sensitivity of single species to dissolved oxygen concentrations in the water, in accordance to what is defined by Posthuma et al. (2002).

The Species Sensitivity Distribution (SSD) methodology is a probabilistic model that estimates the variability of the sensitivity of biological species to a specific environmental stressor by means of a statistical or empirical distribution function of responses of a sampled group (Posthuma et al. 2002). Moreover, the distribution function is solely based on single species sensitivity (usually obtained by laboratorial experiments) and does not reflect ecosystem-level responses or ecological interactions (Blanck 1984).

In the present report, it is assumed that the dissolved oxygen depletion in the water mass triggers the stress effect and the sensitivity of biological species to it is used to estimate an effect on general populations. The practical results of such an analysis are either the estimation of a target concentration of dissolved oxygen in a perspective of protection of the occurring species, or the assessment of the risk associated with low dissolved oxygen concentrations.

The SDD concept usually assumes a parametric distribution (such as log-logistic) of the individual species sensitivity to hypoxia, from where the SSD parameters are estimated and ultimately the stressor concentration that is expected to result in a certain amount of effect. The same rationale is shared by Ecological Risk Assessment (ERA) predicting an effect from a known intensity of the stressor (like the estimation of PAF), or in establishing Environmental Quality Criteria (EQC) where a 'safe' concentration is defined bearing a known expected (and acceptable) effect (Posthuma et al. 2002).

The SSD-based methodology is commonly applied in ecotoxicology and species sensitivity to contaminants. In the present case, the effect posed by hypoxia (resulting from dissolved oxygen depletion in the water mass composing the marine benthic habitat) is understood as a stress agent similar to the physical and chemical effects of a 'traditional' contaminant. The basis for SSD is the



assumption that different species show different sensitivities to hypoxia and its application requires log-normality of the distribution of the sample's sensitivity data in order to assure representativeness of the natural target community (Posthuma et al. 2002). Statistical goodness-of-fit tests should be applied to the data before using and discussing SSD results. The goodness-of-fit test for log-normality of data distribution is included in Appendix 3-V.

The 'Species Sensitivity Distribution Generator' developed by The Causal Analysis/Diagnosis Decision Information System (CADDIS) of the U.S. Environmental Protection Agency (cf. USEPA 2004) was used for the calculation of SSD curves. The methodology and calculations follow those proposed by Posthuma et al. (2002). Details on the method can be found in Appendix 3-VI.

The SSD calculations are used to plot sensitivity data on a cause-effect perspective, i.e. stressor intensity (decreasing dissolved oxygen concentrations in the present case) is plotted as species'  $EC_{50}$  to a Potentially Affected Fraction (PAF) of species. From the resulting plots and curves fitting, the HC50<sub>EC50</sub> and the Effect Factor (EF) are obtained.

The species sensitivity dataset was obtained from a comprehensive review by Vaquer-Sunyer & Duarte (2008) including sublethal concentrations (SLC<sub>50</sub>) of low dissolved oxygen concentrations (i.e. response to hypoxia) for 65 different species of the following taxa:

- Fish species (15): 12 Osteichthyes (bony fishes, *Superclass*) and 3 Chondrichthyes (cartilaginous fishes, *Class*);
- Echinoderms (7): 4 Ophiuroidea (brittle stars, *Class*), 1 Asteroidea (starfishes, *Class*), 1 Echinoidea (sea urchins, *Class*) and 1 Holothuroidea (sea cucumbers, *Class*);
- Crustaceans (13): 10 Decapoda (crabs, lobsters, prawns, shrimps, *Order*), 1 Isopoda (pillbugs, woodlice, *Order*), 1 Amphipoda (amphipods, *Order*), and 1 Stomatopoda (mantis shrimps, *Order*);
- Molluscs (7): 5 Bivalvia (bivalves, *Class*), 1 Gastropoda (sea snails and sea slugs, *Class*), and 1 Cephalopoda (octopuses, squids, cuttlefish, nautilus, *Class*);
- Annelida (7): 7 Polychaeta (polychaete worms, *Class*);
- Cnidarians (15): 9 Hydrozoa (hydroids, *Class*), 3 Scyphozoa (jellyfish, *Class*), and 3 Anthozoa (sea anemones, corals, *Class*);
- Plant (1): Zostera marina (eelgrass, Species).

 $SLC_{50}$  are considered equivalent to  $EC_{50}$  to feed the SSD calculations. In short, the effects identified by Vaquer-Sunyer & Duarte (2008) include:

- Avoidance of hypoxic waters or anoxic sediments, depressed activity, shift to anaerobic metabolism, increased ventilatory water flow, reduced growth, reduced predation rates, lethargy (on fish and crustaceans);
- Reduction of burial depth, climbing on structures (e.g. echinoderms, polychaetes, annelids, crustaceans, gastropods, bivalves, priapulids, and anemones);
- Depression of activity (e.g. echinoderms);
- Reduced feeding activity (e.g. some crustaceans, molluscs, and polychaetes);
- Reduced metabolic rates (e.g. cnidarians) and heartbeat rate (some crustaceans);
- Temporary shifts to anaerobic metabolism (e.g. bivalves, polychaetes, oligochaetes, echinoderms, and some crustaceans).

The representativeness of the reported taxa might be questionable facing all the existing benthic, demersal, and bentho-pelagic species in marine coastal waters worldwide, but the results compiled in Vaquer-Sunyer & Duarte (2008) represent the most comprehensive dataset available to date.





The geographical distribution of all the 65 species was found on several biology/ecology databases and attributed to their respective large marine ecosystem(s) (LME) and later grouped in climate zones (Tropical, Subtropical, Temperate, Subpolar, and Polar). SSD curves were calculated for the 5 climate zones and for a global zone (results in) based on:

- Polar climate zone: 20 species in 11 LMEs;
- Subpolar climate zone: 33 species in 7 LMEs;
- Temperate climate zone: 55 species in 16 LMEs;
- Subtropical climate zone: 41 species in 13 LMEs;
- Tropical climate zone: 19 species in 17 LMEs;
- Global zone: 65 species in 64 LMEs.

The criteria for the grouping of LMEs into climate zones was primarily its geographic coverage and water temperature:

- Latitudinal distribution: Tropical from Equator to ≈20°N, Subtropical from ≈20°-30°N, Temperate from ≈30°-50°N, Subpolar from ≈50°-70°N, and Polar from ≈70°-90°N (and the same for the Southern Hemisphere);
- Mean annual sea surface temperature (maSST): based on the information included in the LME briefs (data collection of specific distinctive characteristics) provided by NOAA (2012), where maSST is presented as a dataset extending from 1975-2005 with regression curves fitted to assess variation trends per LME. The individual regression equations were then used to calculate maSST for 2005 for each LME and used to complement the grouping of LMEs into the 5 climate zones (Figure 3.6 in Appendix 3-II);
- To help on the classification of some LMEs, complementary information was found on the MEOW classification system (Spalding et al. 2007) and on the Köppen-Geiger climate classification system (Peel et al. 2007).

Adapting the definitions from Trass et al. (2002) and Larsen & Hauschild (2007) to the present study, the PAF is the fraction of species in a generic ecosystem/community that is expected to be potentially affected above its no-effect level (NOEC) or a predefined effect level for a given intensity of the environmental stressor. The PAF approach assumes that the distribution of the species' sensitivity values (EC<sub>50</sub>) in the SSD methodology can be described by a Probability Distribution Function (PDF), which can be integrated into a Cumulative Distribution Function (CDF) (Larsen & Hauschild 2007).

The Effect Factor (EF, unit:  $PAF \cdot m^3/kgO_2$ ) represents the variation of effect ( $\Delta PAF$ ) due to a variation of the stressor intensity ( $\Delta[O_2]$ ) and is calculated as:

$$EF = \frac{\Delta PAF}{\Delta[O_2]} = \frac{0.5}{HC_{50}}$$

Where HC<sub>50</sub> is obtained by calculating  $HC_{50} = 10^{\log(EC_{50})}$  or by calculating the geometric mean of the EC<sub>50</sub> data, in accordance to the average gradient method as described by (Pennington et al. 2004).

Traditionally, the aim in ecotoxicology is to estimate the effect of a contaminant. Roughly, the increase in its concentration results in more effect or more organisms/species affected – therefore PAF is used to express that resulting effect. In the present case, where the effects result from hypoxia (i.e. DO depletion), as the DO concentration increases (within a reasonable range) less

78



effect is expected and more species are 'safe'. This fraction should be seen as the proportion of non-affected fraction of species (or PNAF) where: PNAF = 1 - PAF

The SSD curves and the global results obtained from their analysis can be found in Figure 3.7 through to Figure 3.12 and Table 3.10 in Appendix 3-VII.

#### 3.2.6 Normalisation

All environmental emissions from human intervention resulting in nitrogen export to marine coastal waters constitute the relevant inputs to the normalisation phase. As seen before, the identified routes of N emissions to receiving compartments that ultimately build into increased N loadings to the marine system are "N to air", "N to surface freshwater (sfw)", "N to groundwater (gw)", and "N to coastal marine waters (mw)".

Data of N emissions in those routes were obtained from the sources and years indicated in Table 3.2 and multiplied by the respective CFs and then aggregated to find the overall impact score for the selected spatial scale (country, region/continent, or global). This overall impact score is then divided by the population reference (for the respective scale) to find an average impact per inhabitant of the spatial scale used, which constitutes the Normalisation Reference (NR). Emissions should be divided by NR or multiplied by the Normalisation Factor (NF, for NF=1/NR).

Practitioners should apply NRs after aggregation of the impact scores from the different identified emission routes in the inventory, calculated by applying the respective CFs to the LCI emissions. The resulting normalised impact scores can be compared more effectively with other categories, as pointed out by Sleeswijk et al. (2008).

Population data for year 2005 retrieved from UN statistics (UN 2013).

Emission routes	Method	Notes on data source
Agriculture N application per country	Bouwman et al. (2009) Van Drecht et al. (2003)	Year 2000. Supplementary material provided in data files by Bouwman (2011a, 2011b)
N exports to fresh- and groundwater	Bouwman et al. (2009) Van Drecht et al. (2003)	Year 2000. Supplementary material provided in data files by Bouwman (2011a, 2011b)
Air emissions as NH3	Roy et al. (2012)	Year 2005. Supplementary material provided in data files by Roy (2012)
Air emissions as NOx	Roy et al. (2012)	Year 2005. Supplementary material provided in data files by Roy (2012)

 Table 3.2: Data sources for the nitrogen emissions per emission route.

Nitrogen emissions from sewage water directly to marine waters is not available, so no normalisation references were calculated.

# 3.2.7 Sensitivity analysis

A sensitivity analysis was performed to identify the parameters of the model with the highest influence on the resulting CFs. The analysis was achieved by changing the selected model parameters and comparing the outcomes ( $CF_{end}$ ) with the otherwise modelled results ( $CF_{start}$ ). The sensitivity of these parameters was assessed separately.

The chosen parameters consisted of the N export fraction ( $f_{exp}$ , a relevant component of the FF term, expressing the N exported to marine waters compared to the total emitted from land and





freshwater systems), the sedimentation rate, the denitrification rate, and the residence time of each of the receiving LMEs (these last three parameters refer to the marine ecosystem and compose the marine-N losses due to sedimentation, denitrification, and advection, completing the FF term together with  $f_{exp}$ ), the Primary Production rate (PP, applied in the NIE term calculations, part of the XF), the Bacterial Growth Efficiency (BGE, applied in the OM:O<sub>2</sub> conversion, also part of the XF), the Volume Correction Coefficient (VCC, also part of the XF), and the HC<sub>50</sub> value (the damage dimension of the EF).

All the parameters were independently increased by 10% and the Sensitivity Ratios (SR) calculated by:

$$SR_X = \frac{(CF_{end} - CF_{start})/CF_{start}}{(X_{end} - X_{start})/X_{start}}$$

Where  $CF_{start}$  is the original CF calculated (also referred as modelled CF),  $CF_{end}$  is the CF obtained after increasing parameter *X*,  $X_{start}$  is the original value for the studied parameter, and  $X_{end}$  is the final value of the changed parameter (Strandesen et al. 2007).

#### 3.2.8 Uncertainty analysis

The nitrogen export from a country to multiple receiving LMEs may range from null to total export. The present model uses an even split rule in the estimation of the FF by dividing  $f_{exp}$  by the number of receiving LMEs. The range of variation of the N-export for multiple LMEs, as a source of uncertainty, was calculated for the extreme values (minimum and maximum  $f_{exp}$ ) to each of the receiving LMEs. Only the countries exporting to multiple LMEs were tested.

The N-losses terms for sedimentation, denitrification, and advection, together constitute the nitrogen degradation rate (see Section 3.2.3) in the marine compartment, hence it is a critical term for the estimation of CFs. From their correct estimation much depends the confidence on the CFs and the overall model.

To test the possible propagation of the uncertainty associated with the marine-N loss rate, the sedimentation rate, denitrification rate, and residence time were varied to the lower and upper limits of their possible variation range based on the criteria shown next:

- The global average sedimentation rate was varied from 5% (average for coastal areas and estuaries compiled by Nixon et al. 1996) to 8% (as for the North Atlantic also reported by Nixon et al. 1996);
- The global average denitrification rate was varied from 30% (reported by Van Drecht et al. 2003) to 52.7% (reported by Wollheim et al. 2008);
- The residence time was varied for every receiving marine ecosystem (LME) either based on the variation of reported estimations/calculations in literature, using residence times of the lower and upper archetypes, or when that was not possible or reasonably probable (based on the depth, width, and currents exposure characteristics of each LME) on -50% of the used residence time (for the lower limit) or +50% (for the upper limit), or a mix of these options. All the used criteria are shown in Table 3.11 in Appendix 3-VIII.

BGE was varied from 0.01 to 0.69 following the variation range published by del Giorgio & Cole (1998).





Primary Production (PP) is an important parameter to calculate the NIE term and the XF. The uncertainty of this parameter is inherently associated with its estimation method (depth integrated PP rate based on chlorophyll pigment concentration as derived from SeaWiFS satellite remote sensing data and photosynthethically active radiation, as described by Sherman & Hempel (2009) or 'Sea Around Us' Project @ http://www.seaaroundus.org/lme/). The uncertainty of the various models applied to deliver the PP rates is not clearly reported and the effort to assess the resulting combined uncertainty is fairly large. Additionally, after comparing PP rates produced by the two sources mentioned above, significant variations of PP for the same ocean areas (LMEs) were found. These discrepancies were also found highly inconsistent from an expert judgment perspective when analysing the data. In this sense, the PP rates values used in the present model are classified as highly uncertain. The PP rates reported in the 'Sea Around Us' Project's database were used in the present model as they were the least inconsistent.

The Volume Correction Coefficient (VCC) is a model decision-based parameter. The choice of defining 30 meters for the photic zone depth and 0.3 m for the benthic habitat height is described in Section 3.2.4. The uncertainty associated with using average thicknesses for these two layers is classified as low. The effort required to reduce the uncertainty on this parameter would involve the assessment of light penetration depths and continental platform's depth profile for all the LME (or categories of LME) for the photic zone, and continental platform's depth profile, bottom profile, type of substrat, typical resident benthic species, and more, for the benthic habitat height. It is recognised that the required effort exceeds the potential benefits, and therefore the use of the mentioned average figures are adopted and the uncertainty set to low.

# 3.3 Results

# 3.3.1 Fate Factors (FF)

The results of the Fate Factors (FF) estimations are included in Table 3.12 in Appendix 3-IX.

#### 3.3.2 Exposure Factors (XF)

The results of the Exposure Factors (XF) estimations are shown in Table 3.13 in Appendix 3-X.

#### 3.3.3 Effect Factors (EF)

The results of the Effect Factors (EF) estimations are included in Table 3.14 in Appendix 3-XI.

# 3.3.4 Characterisation Factors (CF)

The results of the Characterisation Factors (CF) estimations per emission rate and at Countryto-LME and Country scales can be found in Table 3.15 in Appendix 3-XII, and per emission route with reference N emissions at the various scales in Table 3.16 through to Table 3.23 in Appendix 3-XII. Aggregated results for the region/continent and global scales are included in Table 3.24 through to Table 3.27 in Appendix 3-XIII.





#### 3.3.5 Normalization References (NR)

Normalisation References were calculated and included in Table 3.28 for the country-to-LME scale, in Table 3.29 for the country scale, and Table 3.30 for the region/continent and global scales (Appendix 3-XIV).

For practical reasons practitioners may find useful to normalise results at the country-to-LME scale, especially when the emission location is well defined within this scale. For this purpose, the relevant NRs are included in Table 3.28 assuming a simple country population even split by the number of possible receiving LMEs. Improvements can be added here by estimation a more accurate number of inhabitants on the relevant emitting region to that LME.

#### 3.3.6 Sensitivity test

The sensitivity ratio (SR) results (Figure 3.3) are equal for any considered N emissions route ("N to air", "N to sfw", "N to gw", and "N to mw"), so the results are generically shown per varying parameter.



**Figure 3.3**: Sensitivity analysis results: Sensitivity Ratios (SR) for the tested parameters: Primary Production (PP), N-export fraction ( $f_{exp}$ ), Volume Correction Coefficient (VCC), residence time (RT), sedimentation rate (Sed), Bacterial Growth Efficiency (BGE), denitrification rate (Denitr), and effect component of the EF (HC50). SR<sub>max</sub> and SR<sub>min</sub> represent the upper and lower limit of the variation of the results obtained.

A negative SR value indicates that input and output are inversely related, i.e. increasing the input value will decrease the output value (Strandesen et al. 2007) and the absolute values show the impact contribution of the parameter to the model outputs.

The SR(PP) of 1.28 means that output (CF) is highly sensitive to the input parameter and therefore the uncertainty associated with the input parameter is amplified at the CF level contributing to a larger uncertainty there, and lower confidence on the results. This amplification





is given by the exponential effect introduced in the NIE calculation (where PP is applied) affecting the resulting CF (see NIE equations in Section 3.2.4)

The SR( $f_{exp}$ ) and SR(VCC) (both equal to 1.00) show that the output vary in the same proportion as the variation applied to the input data, revealing that the CFs are insensitive to these parameters. This fact is expected as both parameters are applied linearly as simple multiplication terms in the calculations of the CFs.

The SR results for the three parameters composing the marine-N loss rate coefficient (sedimentation, denitrification, and residence time) show very low contribution of the sedimentation rate, and low contribution of denitrification and residence time (below the neutral contribution of 1.00). This fact is explainable by the low values used for the sedimentation and denitrification rates (5% and 30%, respectively). Even though, the RT term is the one originating the variability of the FF and, the high variation of SR(RT) and SR(denitr) is mostly depending on the productivity of the receiving LME (differentiation given by the PP and NIE values).

The SR(BGE) and SR(HC50) results show that these parameters do not contribute significantly to the CF, as it falls below the neutral contribution of SR=1.00, and that its uncertainty is propagated equally to the results of any of the receiving ecosystems.

#### 3.3.7 Uncertainty estimation

The variation range of the possible N-export scenarios (from null export  $f_{exp}=0$ , through to total export  $f_{exp}=$ country N export, to each of the multiple receiving LMEs) expresses the uncertainty associated with this model choice. The model estimation uses an even-split rule from one country to multiple LMEs. The uncertainty of the term, which is used to calculate the FF, is quantified by calculating the extreme values of the possible outcome of the CFs (when the even-split rule is not adopted) per emission route and only for the countries exporting to multiple receiving LMEs. The results are included in Table 3.32 (Appendix 3-XV) and note that the variation range (i.e. uncertainty) is logically in direct proportion to the number of possible receiving LMEs.

The extreme values of uncertainty of the marine-N loss rate were also calculated by applying the combined upper (lower) limits of the sedimentation and denitrification rates and the lower (upper) limit of the residence time simultaneously to estimate the impact of applying a maximised (minimised) N-loss rate to obtain the lowest (highest) set possible of CFs, i.e. the lower (upper) limit of the uncertainty range for the resulting CFs for each combination of Country-to-LME. The results are shown in Table 3.33 (Appendix 3-XV) and the (CF variation weighted) average of variation due to RT is ca. 0.82 (82%). The uncertainty range thus calculated expresses the best-case and worst-case scenarios of the potential impacts to marine eutrophication from anthropogenic N-emissions, based on the present modelling framework for even-splitting of countries N emissions to multiple receiving coastal ecosystems.

The uncertainty associated with the BGE parameter was tested with the estimation of the variation range of the extreme values of BGE contributing to the XF term. The published BGE data values (del Giorgio & Cole 1998) represent a possible range of scenarios for receiving ecosystems and were adopted here as obtaining/finding individual LME BGE values is not feasible. The results are shown in Table 3.34 (Appendix 3-XV) and the (CF variation weighted) average of variation due to BGE is ca. 0.92 (92%).



# 3.4 Discussion

The present damage model is built on the use of explainable natural ecological processes (biogeochemical) supporting a LCIA methodology to make them useful for practical applications. Correlating nitrogen inputs and primary production in marine ecosystems at a midpoint level, and degradation of organic matter and oxygen depletion to statistically significant effects on marine organisms at an endpoint level, is intended to draw the basis for an endpoint characterisation method and a way to address management options as a decision-support tool.

#### 3.4.1 Estimations and modelling

The link between FF and XF assumes an incorporation of nitrogen into phytoplankton biomass. As nitrogen loadings are used to estimate the nitrogen present in the water mass it is also assumed that the nitrogen availability to primary producers is fairly constant in the input forms, i.e. the fraction of bioavailable forms in the Total-N input should be constant for all the receiving ecosystems (LME). The significance of this assumption involves potential different loss rates or flushing times for different forms, with resulting overestimations of primary production (and subsequent nitrogen incorporation, biomass produced, oxygen consumed, and effect on biota).

In the estimation of nitrogen losses, it seems that net sedimentation (or burial) is generally a small fraction (Hinga et al. 1995) while denitrification appears to be a critical term. Studies have shown that denitrification can exceed the sum of land fluxes and atmospheric deposition (Nixon et al. 1996) and that the negative net balance of anthropogenic nitrogen is compensated by deeper ocean waters (upwelling). This extra input brings into the study systems an amount (or loading) of nitrogen whose source (natural or anthropogenic) cannot be defined (although primarily natural might seem right). Therefore the primary production and organic matter posteriorly degraded has a potential non-anthropogenic source, which should not be covered by the LCIA model.

Furthermore, the systems' dynamics governing the residence time may also have a unquantified influence on the nitrogen losses by denitrification. In principle, highly dynamic ecosystems show a shorter residence time and thus less time for denitrification processes to take place, as less nitrogen sinks to bottom sediments. On its turn, oxygenation by vertical mixing of the bottom benthic layer (right above the sediment) also contributes to lower denitrification rates. Inversely, low dynamic ecosystems potentially show higher denitrification. In the present model, nitrogen losses are individually modelled as denitrification-, net sedimentation-, and advection-driven, thus only the latter is dynamics-dependent, and no other influence is included, especially to the denitrification rates to the model would contribute to improve the spatial differentiated denitrification rates to the model would contribute to improve the spatial

No temporal differentiation is included in the damage model. The occurrence of hypoxia conditions after the spring and autumn algal blooms, allied to temperature and nitrogen availability, and the seasonality of phytoplankton growth due to light and temperature patterns, especially at higher latitudes, suggest differentiated damage patterns over an annual cycle. Although very relevant for management purposes, also due to the seasonal patterns of the nitrogen loadings (e.g. application of fertilizers in agriculture, or atmospheric deposition profiles),



the aim of the present model is to focus on the average annual fluxes and impact scenarios. This means that loadings are treated as evenly spread over time, and severe hypoxia (and possibly anoxia) due to extreme point consumption of DO are avoided by dispersion of oxygen consumption figures over time.

In the same line, specific local conditions favouring extreme DO depletion in bottom waters are avoided by assuming an evenly distribution of oxygen consumption within the benthic layer volume. This simplification may bring significant underestimations on localized damage to biota, and may pose relevant management consideration in terms of water quality.

# 3.4.2 The biogeographical classification system

The LME biogeographical classification system was chosen based on the advantages discussed in Section 3.4.2. Even though other classification systems can be used in the present damage model, the data availability, the modelling feasibility, and the size (and number) of other spatial units may bring unnecessary work or uncertainty to the modelling and spatial differentiation.

# 3.4.3 Issues concerning biological data

The Fate Factors are built on SSD curves based on a limited number of  $SLC_{50}$  results. This dataset is composed of only 65 species distributed unevenly by the 5 considered climate zones. In fact, this constraint is the reason for the necessity of adopting the climate zones grouping, as some of the LME show no occurring species.

The limited dataset may also contribute to low representativeness of the sampled species and reduce validity of the EF estimations. The sensitivity to hypoxia results compiled in the dataset and the SSD methodology may also raise questions regarding the equal weight given to abundant and rare species, the dominance of some groups over others (e.g. 15 fish species vs. 1 plant species) the dominance of diversity of some climate zones (e.g. 55 species in 16 temperate climate LMEs vs. 19 species in 17 tropical climate LMEs), the dominance of species that can be reared or survive in laboratory conditions, the dominance of more abundant species, or the skewed distribution of species due to the location and resources of laboratory facilities or research groups.

# 3.4.4 Comparison with existing and recommended methods

From the analysis of the existing characterisation methods, the present proposed method shows up as the only including both airborne and waterborne emissions fate models with spatial differentiation at individual country level and global applicability.

The proposed model uses the N increase in marine waters as midpoint indicator, like ReCiPe for marine eutrophication or EDIP2003 for aquatic eutrophication, but it is not limited to European emissions (like ReCiPe is) and it is dedicated to marine eutrophication (while EDIP2003 is generic for aquatic eutrophication).

The proposed endpoint characterisation includes species diversity loss as the endpoint indicator and (presently) provides CFs for 143 countries and 6 nitrogen emissions routes, and CFs for 214 individual Country-to-LME spatial combinations rendering an extensive coverage and spatial representativeness, as well as different ecosystem types and local/regional environmental



conditions. The number of CFs can grow to include more countries and further Country-to-LME providing that national emission rates are found/turned available and data processed.

A further application of the model results could be the aggregation of impacts per receiving LME, where estimations of the damage to each LME would integrate contributions from different countries (multiple countries to each receiving LME instead of each country to multiple receiving LMEs). The information thus obtained would be mostly aimed at ecosystem protection.

# 3.4.5 Analysis of the spatial differentiation of the Characterisation Factors (CF)

After the estimation of CFs aggregated at a country level, an analysis was conducted to assess the countries with the highest and the lowest CF per emission route. The top 10 countries for each of the nitrogen emission routes are shown below (Table 3.3), and the bottom 10 countries are shown next (Table 3.4). In these sets of tables is also included a short note on the analysis of the parameters dominating the high or low CF results.

**Table 3.3:** Countries showing the highest 10 Characterisation Factors (CF) and analysis of the parameterspossibly governing such high rankings, per nitrogen emission route.

Emission route:	N to Air		Emission route:	N to sfw	
Spatial scale:	Country		Spatial scale:	Country	
Top10 CFs	PAF.m3.d/kgN	Receiving ecosystem's features	Top10 CFs	PAF.m3.d/kgN	Receiving ecosystem's features
Finland	38,643.28	high $f_{exp}$ ; RT=25yr; NIE=4.1 (highest)	Russian Federation	99,924.93	Comb high RT+NIE for LME 50, 52, 62
Estonia	38,535.67	RT=25yr; NIE=4.1 (highest)	Denmark	93,854.51	avg RT=9.1yr; avg NIE=2.3
Latvia	35,828.36	RT=25yr; NIE=4.1 (highest)	Germany	92,574.02	avg RT=13.5yr; high avg NIE=3.1
Poland	35,107.62	RT=25yr; NIE=4.1 (highest)	Sweden	92,574.02	avg RT=13.5yr; high avg NIE=3.1
Lithuania	33,510.99	RT=25yr; NIE=4.1 (highest)	Switzerland	73,923.07	high avg RT=60.1yr; avg NIE=1.5
Belarus	29,863.38	RT=25yr; NIE=4.1 (highest)	Belarus	71,378.35	RT=25yr; NIE=4.1 (highest)
Sri Lanka	25,932.46	high $f_{exp}$ ; avgRT=12yr; avg NIE=1.2	Estonia	71,378.35	RT=25yr; NIE=4.1 (highest)
Oman	21,274.65	avg RT=6.5yr; high avg NIE=1.98	Finland	71,378.35	high f <sub>exp</sub> ; RT=25yr; NIE=4.1 (highest)
Sweden	21,154.72	avg RT=13.5yr; high avg NIE=3.1	Latvia	71,378.35	RT=25yr; NIE=4.1 (highest)
United Arab Emirates	20,715.44	avg RT=6.5yr; high avg NIE=1.98	Lithuania	71,378.35	RT=25yr; NIE=4.1 (highest)

Emission route:	N to gw		Emission route:	N to mw	
Spatial scale:	Country		Spatial scale:	Country	
Top10 CFs	PAF.m3.d/kgN	Receiving ecosystem's features	Top10 CFs	PAF.m3.d/kgN	Receiving ecosystem's features
Russian Federation	35,377.15	Comb high RT+NIE for LME 50, 52, 62	Russian Federation	211,257.79	Comb high RT+NIE for LME 50, 52, 62
Denmark	33,227.99	avg RT=9.1yr; avg NIE=2.3	Denmark	198,423.91	avg RT=9.1yr; avg NIE=2.3
Germany	32,774.65	avg RT=13.5yr; high avg NIE=3.1	Germany	195,716.75	avg RT=13.5yr; high avg NIE=3.1
Sweden	32,774.65	avg RT=13.5yr; high avg NIE=3.1	Sweden	195,716.75	avg RT=13.5yr; high avg NIE=3.1
Switzerland	26,171.52	high avg RT=60.1yr; avg NIE=1.5	Switzerland	156,285.57	high avg RT=60.1yr; avg NIE=1.5
Belarus	25,270.60	RT=25yr; NIE=4.1 (highest)	Belarus	150,905.61	RT=25yr; NIE=4.1 (highest)
Estonia	25,270.60	RT=25yr; NIE=4.1 (highest)	Estonia	150,905.61	RT=25yr; NIE=4.1 (highest)
Finland	25,270.60	high $f_{\rm exp}$ ; RT=25yr; NIE=4.1 (highest)	Finland	150,905.61	highƒ <sub>exp</sub> ; RT=25yr; NIE=4.1 (highest)
Latvia	25,270.60	RT=25yr; NIE=4.1 (highest)	Latvia	150,905.61	RT=25yr; NIE=4.1 (highest)
Lithuania	25,270.60	RT=25yr; NIE=4.1 (highest)	Lithuania	150,905.61	RT=25yr; NIE=4.1 (highest)

The high ranking of CF results of the countries showed above is justified by the dominance of the effect of high residence times in the estimation of the marine N-loss rate, and high productivity (seen from the very high NIE value), meaning that nitrogen is kept within the ecosystem long enough to promote biomass production either by long availability or by several





893.27 low RT (0.03 - lowest)

reuse cycles (suspension, incorporation, mineralization, and resuspension). As the CFs are resulting from the varying effect of N-export fraction and HC50 (apart from the residence time and NIE already mentioned) smaller variations of the CFs (and rankings) may also be explained by the combination (with cumulative effect) of the various parameters without necessarily showing one that dominates the estimation.

Overall, countries exporting N to the Baltic Sea and the Black Sea show the highest CFs and tend to occupy the top ranks for all the emission routes. For the atmospheric deposition route ("N to air") there is a further influence of the export fractions (more deposition) in some of the top ranks ( $f_{\text{air Finland}}$ =0.750 and  $f_{\text{air Sri Lanka}}$ =0.579, above the average  $f_{\text{air avg}}$  of 0.313).

The practical meaning of analysing the CFs results is to identify patterns in the geographical location (see figure ) and possible explanations for a potential high prevalence in specific regions that ultimately quantifies the impact of a potential increment in the nitrogen emissions from those countries.

Emission route:	N to Air		Emission route:	N to sfw	
Spatial scale:	Country		Spatial scale:	Country	
Bottom10 CFs	PAF.m3.d/kgN	Receiving ecosystem's features	Bottom10 CFs	PAF.m3.d/kgN	Receiving ecosystem's features
Belize	1,097.00	RT=0.21yr; NIE=0.7	Dominican Republic	1,163.28	RT=0.21yr; NIE=0.7
Nicaragua	1,070.72	avg RT=0.23yr; avg NIE=0.9	Haiti	1,163.28	RT=0.21yr; NIE=0.7
Guatemala	1,007.93	avg RT=0.23yr; avg NIE=0.9	Honduras	1,163.28	RT=0.21yr; NIE=0.7
Brazil	974.66	avg RT=0.25yr	Jamaica	1,163.28	RT=0.21yr; NIE=0.7
Venezuela	874.99	RT=0.21yr; NIE=0.7	Puerto Rico	1,163.28	RT=0.21yr; NIE=0.7
Colombia	809.98	avg RT=0.23yr; avg NIE=0.9	Venezuela	1,163.28	RT=0.21yr; NIE=0.7
Australia	550.68	avg RT=0.25yr; avg NIE=0.8	New Caledonia	966.37	RT=0.25yr; NIE=0.5
Chile	369.57	low RT (0.03 - lowest)	Bolivia	422.52	low RT (0.03 - lowest)
Peru	301.05	low RT (0.03 - lowest)	Chile	422.52	low RT (0.03 - lowest)
Bolivia	214.72	low RT (0.03 - lowest)	Peru	422.52	low RT (0.03 - lowest)
Emission route:	N to gw		Emission route:	N to mw	
Spatial scale:	Country		Spatial scale:	Country	
Bottom10 CFs	PAF.m3.d/kgN	Receiving ecosystem's features	Bottom10 CFs	PAF.m3.d/kgN	Receiving ecosystem's features
Dominican Republic	411.84	RT=0.21yr; NIE=0.7	Dominican Republic	2,459.37	RT=0.21yr; NIE=0.7
Haiti	411.84	RT=0.21yr; NIE=0.7	Haiti	2 450 27	
Honduras		- //	narti	2,459.37	RT=0.21yr; NIE=0.7
	411.84	RT=0.21yr; NIE=0.7	Honduras	· ·	RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7
Jamaica				2,459.37	
Jamaica Puerto Rico	411.84	RT=0.21yr; NIE=0.7	Honduras	2,459.37 2,459.37	RT=0.21yr; NIE=0.7
	411.84 411.84	RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7	Honduras Jamaica	2,459.37 2,459.37 2,459.37	RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7
Puerto Rico	411.84 411.84 411.84	RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7	Honduras Jamaica Puerto Rico	2,459.37 2,459.37 2,459.37 2,459.37	RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7
Puerto Rico Venezuela	411.84 411.84 411.84 342.13	RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7	Honduras Jamaica Puerto Rico Venezuela	2,459.37 2,459.37 2,459.37 2,459.37 2,043.07	RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7 RT=0.21yr; NIE=0.7

**Table 3.4:** Countries showing the lowest 10 Characterisation Factors (CF) and analysis of the parameterspossibly governing such low rankings, per nitrogen emission route.

From the analysis of the CF results and the different parameters contributing to the lowest 10 rank positions, Peru, Chile, and Bolivia consistently show the lowest CFs. All the lowest CF rank positions are taken by countries exporting nitrogen to very dynamic ecosystems, with low capacity of retaining nitrogen long enough to promote high biomass production or total use of the supplied N forms. This fact reveals the influence of the residence time and the productivity of the receiving ecosystems in the model results and the critical relevance of the nitrogen losses/use in the marine

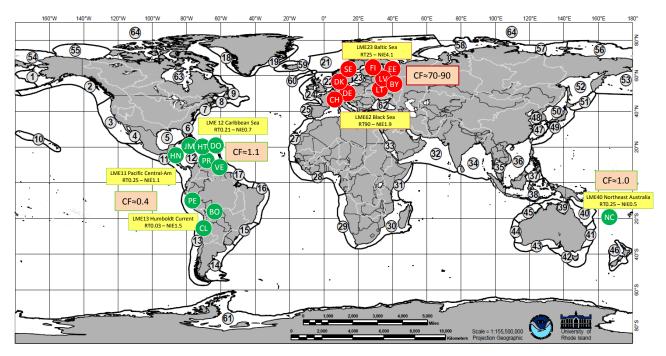
149.59 low RT (0.03 - lowest)

Peru



compartment. This assessment, together with the sensitivity analysis and the uncertainty quantification (discussed ahead) contributes to find key issues.

Again, by analysing patterns in the distribution of low CF countries and understanding the most probable reasons for such results may help mapping critical regions and categorize coastal ecosystems regarding their potential capacity to withstand the effect of eutrophying nitrogen loadings, as they show little impact from incremental N emissions.



**Figure 3.4**: Spatial differentiation of the model results – example of the geographical distribution of the countries showing the Top10 (red) and Bottom10 (green) Characterisation Factors (CFs) for source emissions to surface freshwater (cf. Table 3.3 and Table 3.4). Distribution pattern is similar to emissions to groundwater and marine water, but CF values vary. **CF unit = ×10<sup>3</sup> PAF·m<sup>3</sup>·d/kgN**.

The geographical distribution showed in Figure 3.4 points to a concentration of high potential impacts from countries exporting nitrogen to receiving ecosystems with longer residence time and higher productivity, and lower potential impacts from countries exporting to highly dynamic (low residence time), low productivity, or a combination of both.

# 3.4.6 Normalisation References (NR)

Normalisation is an optional step in LCIA (ISO 14044:2006) and provides a way to meaningfully compare impact scores of different impact categories.

The calculated normalisation references (NR) are available at the country-to-LME (214), country (143), region/continent (13), and world (1) scale, and depending on the scale practitioners are working with the characterised scores, the NRs can be applied to obtain normalised impacts for marine eutrophication.





#### 3.4.7 Environmental relevance, completeness, and consistency

The present model integrates a river-N fate model, a marine-N fate model, a NIE environmental model (included in the exposure model) and an Effect component built on experimental SLC<sub>50</sub> and statistical SSD curves. The integration of these various components forms a comprehensive damage model that covers all the recognisable involved biogeochemical processes. It is fed by sufficient data, although some provided by external models for emission or deposition, with no significant assumptions that hinder interpretation.

The N loss processes and the NIE modelling components bring environmental relevance to the results. Additionally, the model provides CFs for 4 different emission routes widening its relevance and applicability. Although some minor data gaps are identifiable these do not hamper the CFs estimation, e.g. national N emissions missing resulting in some countries not being accounted in the CF calculations, or denitrification and leaching rates to river missing for 52 countries (hence not included), or the use of an average river denitrification rate instead of spatially differentiated rates.

In what regards to data consistency, the N emissions, leaching, and export to sfw are based on the IMAGE 2.4 model for the year 2000, and the atmospheric N-fate deposition of  $NH_3$  and NOx used a dataset simulated for year 2005, normalisation references were calculated from 2005 population data, and some other assorted data, e.g. maSST data (2005) for the climate zone grouping, and PP data from SeaWiFS remote sensing (monthly averages from 1997-2004) were also used.

The most relevant inconsistency is found in the 5-years discrepancy between the agriculture model governing the exports to sfw and gw (by Bouwman 2011a, 2011b), and the atmospheric depositions model governing export data soil, sfw and mw (by Roy 2011; Roy et al. 2012). Nevertheless, this discrepancy is expected to have a minor impact in the results.

#### 3.4.8 Sensitivity and uncertainty

The assumption of an even split of the N-export ( $f_{exp}$ ) when dealing with countries with N exports to multiple LMEs is a simplification of a complex estimation. It can be seen as a model choice and different scenarios may arise from choosing other export splitting rules. The uncertainty raised from the range of possible CF outcomes when testing the minimum and maximum CF scenarios variation (Table 3.32 in Appendix 3-XV) was found as of medium uncertainty, as the range can be estimated, but the true splitting rule is unknown. However, it is possible to improve the estimation of this term by considering several factors. Possible approaches may include the estimation of the area, volume, and discharge points of all the national watersheds, in order to determine the potential N loadings received from agricultural and natural land being leached (by surface and groundwater) to rivers, the potential atmospheric deposition on that land area and directly into surface freshwater, the use of country-specific individual or averaged denitrification rates on topsoil and freshwater systems, to ultimately know the amount of nitrogen being exported from a particular country to a specific receiving LME. Additionally, improved estimations of N emissions may also be assigned to different regions in the country based on the local concentration of industrial or agricultural activities. The complexity and feasibility of these estimations may vary from country to country depending on the availability of



data and national statistics, but overall it is definitely highly time- and resources-consuming (effort), hence the need for the above mentioned simplification.

The impact of using split N  $f_{exp}$  is particularly significant when the receiving LMEs show different marine-N loss rates combined with highly distinct NIE (due to different productivity rates). Countries exporting nitrogen to LMEs exposed to similar conditions, e.g. to contiguous LMEs in fairly similar coastal conditions may show minor variations in the resulting CFs (then the N-loss rates are dictated the residence time and the environmental conditions governing the NIE term). In some cases, however, high variation of the CFs may show if significantly different residence times and NIE occur. Once again, the impact of the N exported (or the certainty of the N-export splitting rule) is very important here.

An example of the uncertainty of exporting to significantly different LMEs can be built for Denmark, with discharges to both the North Sea (to the West) and the Baltic Sea (to the East). Both LMEs share the same sedimentation and denitrification rates (because average rates are used) but show significantly different residence times (2 yr for the North Sea vs. 25 yr for the Baltic Sea) and therefore different N-loss rates (and FFs) are expected. In addition, the NIE term is also significantly different (2.075 vs. 4.095 respectively, due to higher productivity in the Baltic Sea resulting in different XFs). While the EFs show similar figures, after applying the FF and XF the resulting CFs are significantly different (3.4 times higher for exports to the Baltic Sea).

Furthermore, the inclusion of the Faroe Plateau (LME#60) on the Danish statistics induces an overestimation of the CFs there (and underestimations to the North and Baltic Seas CFs). While the model estimation is delivering equal FFs for all the three receiving LMEs (North Sea, Baltic Sea, and Faroe Plateau) an improved N-export splitting rule would reflect the different loadings and LME conditions in the FF instead (with much fewer emissions to be assigned to the Faroe Plateau). This example points to possible refinements of the model and in particular to the FF estimation. Using the even split exports' method LME#60 is receiving one third of the Danish N-exports, which is not only incorrect but also unrepresentative for the potential impacts to marine eutrophication from the actual local activities.

Similarly to the example given for Denmark, finding the correct splitting of N exports for e.g. Japan, Morocco, or Saudi Arabia would also improve the results, as these countries N-export to LMEs with highly distinct N-loss rates due to local residence time (Japan, varying from 0.25-25 yr, Morocco, varying from 0.25-90 yr, and Saudi Arabia varying from 6.5-40 yr). More countries can be found with such variations and all the 34 countries exporting to multiple LMEs should be reviwed and the individual  $f_{exp}$  improved.

In opposition, countries like Norway or Australia split the N export to multiple LMEs with equal residence time (2 yr and 0.25 yr, respectively) and where only the NIE term varies (0.737-2.075 and 0.495-1.584, respectively) due to local productivity rates, and  $HC_{50}$  (1.357-1.611 mgO<sub>2</sub>/L for both countries) reflecting the climate zones grouping. In these cases the N-export splitting rules are not affecting the FF but only the XF and EF terms.

These examples and their discussion, extendable to several other point issues, show the importance of improving the estimations of national N exports to multiple receiving LMEs (especially relevant when these bear significantly different characteristics).

As mentioned, uncertainty quantification in the estimation of CFs indicates the confidence on the model results. The combination of uncertainty assessment and the sensitivity analysis should provide an overview of the key issues of the model and the critical aspects for improvement, by





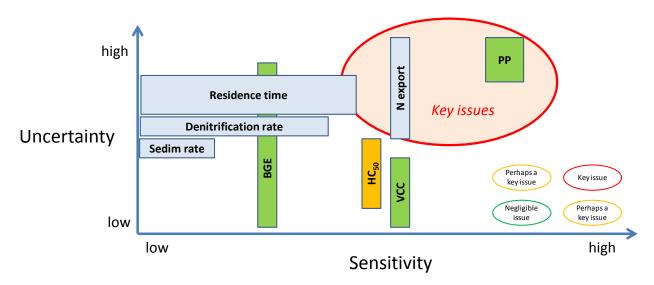
identifying the most relevant parameters for possible refinements on an effort investment-return basis, to ultimately improve transparency and robustness of the overall model.

The model refinements may involve:

- Improving data quality, either at data collection phase (quality and efficiency) or changing/improving the way to estimate non-existing data;
- The choices made within the model, such as compartment boundaries (e.g. depth of photic zone or benthic habitat) and biogeographical zonation systems (e.g. LME, MEOW, others), or sources and type of data to use (e.g. measured or estimated);
- Improving certainty of the model components (or sub-models), such as modelling river-N fate, N-losses in the marine compartment, exposure, or effects.

#### Key issues

The combination of the sensitivity and the uncertainty analyses results in the identification of the key issues of the present model framework (Figure 3.5), which can point to the best options for improvement.



**Figure 3.5**: Combined analysis of sensitivity and uncertainty for the model input parameters. Components of the FF (light blue), XF (green), and EF (yellow) depicted.

The PP meta-data is of major importance on the CFs estimation both due to possible high sensitivity (SR) and high variability of the reported values.

The parameters governing the marine-N loss rate are considered "perhaps a key issue" due to the uncertainty found when searching for averaged rates of sedimentation and denitrification, to the variation of published residence times for several of the LMEs, and the uncertainty that comes from using archetypes for some others, despite the low sensitivity assigned. However, the residence time is important for the CF results, as seen in Section 3.4.5.

The estimation of  $HC_{50}$  (and the EF) may be improved if the  $EC_{50}$  dataset is expanded. Using only 65 species to support such a damage model may underestimate some taxa and overestimate others. Worth of note is the fact that climate zones were included due to the low number of





species representativeness on several of the LMEs. Assigning EFs per climate zone comes with a non-quantified uncertainty that might conceal a significant effect on the CFs.

The significance of the issues identified should be addressed and data quality improved for the most relevant ones. Considering the effort required to achieve an overall improvement of data quality and uncertainty reduction:

- Finding the correct PP dataset would require a low investment by consulting the appropriate experts and assessing the methods to its calculation;
- Improving data quality for the estimation of specific VCC (photic zone and benthic layer boundaries) for each of the LMEs and to estimate LMEs average residence times would be time-consuming to search for available and confident datasets, but returning a good accuracy improvement of the results;
- Improving the sedimentation and denitrification rates estimation would require a large effort, as these rates vary with local conditions and specificities of the involved systems as diverse as temperature, organic content, type and geochemistry of the sediments, influence from estuaries, currents, and others. Additionally, the return of such high investment would be affected by a low sensitivity of the parameters to the model output;
- Expanding the EC<sub>50</sub> dataset to improve the EF estimation would require a major investment in time- and resources-consuming extensive experimental laboratorial work.

Overall, PP should be prioritized in the data quality improvement due to high contribution to the CF (sensitivity) and associated uncertainty. Residence time has been found as a possible issue but its high uncertainty and the relevance in governing marine-N losses, which is critical to the FF, makes it a target for improvement. An important note should be addressed to the N-export splitting rules, considering high relevant to the model. The overall model is supported by the output of terrestrial, freshwater, and atmospheric fate models for which no uncertainty was quantified. To several of the parameters of these 'third-party' models, average rates (related to e.g. leaching, denitrification, volatilisation) are applied when individual and more adequate rates should be developed to better reflect the spatial differentiation. The BGE term may also be improved by adding spatial differentiation, as only an average value was used in the model.

The importance of understanding and improving the spatial differentiation within these models is recognised here and the investment in this direction should also be prioritised.

#### Transparency and reproducibility

The data treatment and necessary calculations are easily understandable and can be used to include further data, further countries, or further receiving ecosystems.

In the case new data is available and rate coefficients updated (improved) or any different dataset tested in the present format, the model is easily adaptable, providing that the spreadsheets are corrected accordingly.

#### Applicability

The method principles are defined and described in the present report. While the results can be easily obtained the applicability of the model is still constrained by data sources quality and its availability, namely emissions and leaching/export to sfw from agriculture activities – Bouwman's





model (Bouwman 2011a, 2011b), and the atmospheric deposition rates by Roy's model (Roy 2011; Roy et al. 2012).

Improvements or refinements of the underlying exports to river and loss rates can definitely improve applicability and quality of the resulting CFs.

At the present version, the model renders a wide applicability providing CFs for 143 countries and 4 emissions routes, enhanced by 214 Country-to-LME spatial combinations, and aggregation into 13 regions or continents, and a global default. CF aggregation can be performed for any desired geographical grouping.

NRs/NFs are provided at a country (143), region/continent (13) and world (1) scale.

# 3.5 Final considerations

An ecosystem-based approach can bridge between a decision-support tool, such as LCA, and a management/regulatory framework. LCA can, in fact, produce usable results and support decision-making processes further down the science-management bumpy road.

The present methodology aims at modelling the increment of nitrogen loadings in receiving compartments, such as the LMEs. The immediate value of the present approach is to allow the inclusion of marine eutrophication impact in the calculation of environmental impacts from products or servies in a more qualified way than what is currently used.

Coastal systems managers, on a local, regional, or global reach, can also benefit from scientifically sound (cause-effect) predictions of the impacts of their management and operational decisions.

# 3.6 References for the Marine Eutrophication chapter

Appeltans W, Bouchet P, Boxshall GA, De Broyer C, De Voogd NJ, Gordon DP, Hoeksema BW, Horton T, Kennedy M, Mees J, Poore GCB, Read, G, Stöhr S, Walter, TC, Costello MJ (eds.). 2012. World Register of Marine Species. Retrieved from http://www.marinespecies.org [February 23rd, 2012].

Arrigo KR. 2005. Marine microorganisms and global nutrient cycles. Nature 437: 349-355.

Bisby FA, Roskov YR, Orrell TM, Nicolson D, Paglinawan LE, Bailly N, Kirk PM, Bourgoin T, Baillargeon G (eds.). 2009. Species 2000 & ITIS Catalogue of Life: 2009 Annual Checklist. Reading, UK: Species 2000. Retrieved from www.catalogueoflife.org/annual-checklist/2009/ [February 23rd, 2012].

Blaas M, Kerkhoven D, de Swart HE. 2001. Large-scale circulation and flushing characteristics of the North Sea under various climate forcings. Climate Research 18: 47–54.

Blanck H. 1984. Species dependent variation among aquatic organisms in their sensitivity to chemicals. Ecological Bulletin 36: 107-119.

Bouwman AF, Beusen AHW, Billen G. 2009. Human alteration of the global nitrogen and phosphorus soil balances for the period 1970–2050. Global Biogeochemical Cycles, 23, GB0A04, doi:10.1029/2009GB003576.

Bouwman AF, Kram T, Klein Goldewijk K (Eds.). 2006. Integrated modelling of global environmental change. An overview of IMAGE 2.4. Publication 500110002/2006, Netherlands Environmental Assessment Agency, Bilthoven.





Bouwman AF, Van Drecht G, Knoop JM, Beusen AHW, Meinardi CR. 2005. Exploring changes in river nitrogen export to the world's oceans. Global Biogeochemical Cycles, 19, GB1002, doi:10.1029/2004GB002314.

Bouwman AF. 2011a. Personal communication with AF Bouwmann. Excel file: "nutdata2000\_out", version 1.2.3, 7 May 2007.

Bouwman AF. 2011b. Personal communication with AF Bouwmann. DAT-files with leaching factors, denitrification factors and more in 0.5° by 0.5° spatial resolution. Calculated for the 1995 situation by IMAGE 2.2 as described in Bouwman et al. 2006.

Burnett LE, Stickle WB. 2001. Physiological responses to hypoxia. In NN Rabalais & RE Turner (eds.), Coastal Hypoxia: Consequences for Living Resources and Ecosystems. Washington DC: American Geophysical Union. Coastal and Estuarine Studies 58: 101-114.

Clark DR, Rees AP, Joint I. 2008. Ammonium regeneration and nitrification rates in the oligotrophic Atlantic Ocean: Implications for new production estimates. Limnology and Oceanography 53(1): 52-62.

Cloern JE 2001. Our evolving conceptual model of the coastal eutrophication problem. Marine ecology Progress Series 210: 223-53.

Conley DJ, Carstensen J, Vaquer-Sunyer R, Duarte CM. 2009. Ecosystem thresholds with hypoxia. Hydrobiologia 629: 21-29.

Curran M, de Baan L, de Schryver AM, van Zelm R, Hellweg S, Koellner T, Sonnemann G, Huijbregts MAJ. 2011. Toward meaningful end points of biodiversity in life cycle assessment. Environmental Science and Technology 45: 70-79.

de Jonge VN, Elliott M, Orive E. 2002. Causes, historical development, effects and future challenges of a common environmental problem: eutrophication. Hydrobiologia 475/476: 1-19.

del Giorgio PA, Cole JJ. 1998. Bacterial growth efficiency in natural aquatic ecosystems. Annu. Rev. Ecol. Syst. 29: 503-541.

Diaz RJ, Rosenberg R. 1995. Marine benthic hypoxia: a review of its ecological effects and the behavioural responses of benthic macrofauna. Oceanography and Marine Biology: Annual Review 33: 245-303.

Domine, LM, Vanni MJ, Renwick WH. 2010. New and regenerated primary production in a productive reservoir ecosystem. Canadian Journal of Fisheries and Aquatic Sciences 67: 278-287.

EC. 2009. Common implementation strategy for the Water Framework Directive (2000/60/EC). Guidance Document on eutrophication assessment in the context of European Water policies. European Communities. Guidance Document No. 23, 136 pp.

EEA. 2001. Eutrophication in Europe's coastal waters. Copenhagen: European Environmental Agency. Topic Report No. 7, 86 pp.

Finnveden G, Potting J. 1999. Eutrophication as an Impact Category – State of the Art and Research Needs. The International Journal of Life Cycle Assessment 4(6): 311-314.

Froese R, Pauly D (eds.). 2012. FishBase. World Wide Web electronic publication version (04/2012). Retrieved from www.fishbase.org [April 24<sup>th</sup>, 2012].

Galloway JN, Cowling EB, Seitzinger SP, Socolow RH. 2002. Reactive Nitrogen: Too Much of a Good Thing? Ambio 31(2): 60-63.

Galloway JN, Dentener FJ, Capone DG, Boyer EW, Howarth RW, Seitzinger SP, Asner GP, Cleveland CC, Green PA, Holland EA, Karl DM, Michaels AF, Porter JH, Townsend AR, Vörösmarty CJ. 2004. Nitrogen cycles: past, present, and future. Biogeochemistry 70: 153-226.





Gray JS, Wu RS, Or YY. 2002. Effects of hypoxia and organic enrichment on the coastal marine environment. Marine Ecology Progress Series 238: 249-279.

Gray SJ. 1992. Eutrophication in the sea. In G. Colombo & Viviani R. (eds.), Marine Eutrophication and Pollution Dynamics. Fredensborg: Olsen & Olsen, pp. 3-16.

Gulliver JS, Wilson BN, Mohseni O, Erickson AJ, Hozalski RM. 2010. Biological Processes. In JS Gulliver, AJ Erickson, PT Weiss (eds.), Stormwater Treatment: Assessment and Maintenance. Minneapolis MN: University of Minnesota, St. Anthony Falls Laboratory. Retrieved from http://stormwaterbook.safl.umn.edu/ [April 15th, 2012].

Haselmair A, Stachowitsch M, Zuschin M, Riedel B. 2010. Behaviour and mortality of benthic crustaceans in response to experimentally induced hypoxia and anoxia in situ. Marine Ecology Progress Series 414: 195-208.

Hasler AD. 1947. Eutrophication of lakes by domestic drainage. Ecology 28(4): 383-95. Hauschild MZ (2005). Assessing environmental impacts in a life-cycle perspective. Environmental Science & Technology 39: 81A-88A.

Haye S, Slaveykova VI, Payet J. 2007. Terrestrial ecotoxicity and effect factors of metals in life cycle assessment (LCA). Chemosphere 68: 1489-1496.

Heip C. 1995. Eutrophication and Zoobenthos dynamics. Ophelia 41: 113-36.

Hinga KR, Heon J, Lewis NF. 1995. Marine Eutrophication Review - Part 1: Quantifying the Effects of Nitrogen Enrichment on Phytoplankton in Coastal Ecosystems. NOAA Coastal Ocean Program Decision Analysis Series No. 4. NOAA Coastal Ocean Office: Silver Spring MD, 36 pp.

Howarth RW, Marino R. 2006. Nitrogen as the Limiting Nutrient for Eutrophication in Coastal Marine Ecosystems: Evolving Views over Three Decades. Limnology and Oceanography 51(1, Pt.2 Eutrophication of Freshwater and Marine Ecosystems): 364-376.

Huijbregts MAJ. 2011. Editorial: Working on the global applicability of Life Cycle Impact Assessment. In LC-IMPACT Newsletter June 2011. Retrieved from http://www.lc-

impact.eu/en/newspage/newsletter-june-2011 [29th January, 2012].

Hutchinson GE. 1967. A treatise on limnology. Introduction to lake biology and the limnoplankton, Volume II. NewYork: John Wiley & Sons Inc., 1115 pp.

ISO 14044:2006. Environmental management — Life cycle assessment — Requirements and guidelines. Geneva, Switzerland: International Organisation for Standardisation.

Jansson B-O. 1980. Natural Systems of the Baltic Sea. Ambio 9: 128.

Kelly JR. 2008. "Nitrogen in the Environment: Chapter 10. Nitrogen Effects on Coastal Marine Ecosystems". U.S. Environmental Protection Agency Papers. Paper 50. Retrieved from http://digitalcommons.unl.edu/usepapapers/50 [May 10th, 2012].

Kitsiou D, Karydis M. 2011. Coastal marine eutrophication assessment: A review on data analysis. Environmental International 37: 778-801.

Larsen HF, Hauschild M. 2007. Evaluation of Ecotoxicity Effect Indicators for Use in LCIA. International Journal of Life Cycle Assessment 12(1): 24-33.

Larsen HF, Olsen SI, Hauschild MZ, Laurent A. 2009. Deliverable 4.2 – Methodology for including specific biological effects and pathogen aspects into LCA. Work Package 4 – Assessment of environmental sustainability and best practice. EC Project "NEPTUNE", contract No.: 036845. www.eu-neptune.org.

Levin LA, Ekau W, Gooday AJ, Jorissen F, Middelburg JJ, Naqvi SWA, Neira C, Rabalais NN, Zhang J. 2009. Effects of natural and human-induced hypoxia on coastal benthos. Biogeosciences 6: 2063-2098.





Mahon R, Fanning L, McConney P, Pollnac R. 2010. Governance characteristics of large marine ecosystems. Marine Policy 34: 919-927.

Middleburg J, Levin LA. 2009. Coastal hypoxia and sediment bio-geochemistry. Biogeosciences 6: 1273–1293.

Miller DC, Poucher SL, Coiro L. 2002. Determination of lethal dissolved oxygen levels for selected marine and estuarine fishes, crustaceans, and a bivalve. Marine Biology 140: 287-296.

Nixon SW, Ammerman JW, Atkinson LP, Berounsky VM, Billen G, Boicourt WC, Boynton WR, Church TM, Ditoro DM, Elmgren R, Garber JH, Giblin AE, Jahnke RA, Owens NJP, Pilson MEQ & Seitzinger SP. 1996. The fate of nitrogen and phosphorous at the land-sea margin of the North Atlantic Ocean. Biogeochemistry 35: 141-180.

Nixon SW, Fulweiler RW. 2009. Nutrient pollution, eutrophication, and the degradation of coastal marine ecosystems. In C.M. Duarte (ed.), Global Loss of Coastal Habitats: Rates, Causes and Consequences. Bilbao, Spain: Fundación BBVA, pp. 23-58.

Nixon SW. 1995. Coastal marine eutrophication: A definition, social causes, and future concerns. Ophelia 41: 199-219.

Nixon SW. 2009. Eutrophication and the macroscope. Hydrobiologia 629(1): 5-19. NOAA. 2011. Ocean facts. Retrieved from

http://oceanservice.noaa.gov/facts/light\_travel.html [August 30th, 2012].

NOAA. 2012. LME Briefs. Large Marine Ecosystems of the World. Retrieved from http://www.lme.noaa.gov/ [April 24th, 2012].

OSPAR. 2008. Second Integrated Report on the Eutrophication Status of the OSPAR Maritime Area. OSPAR Commission. Eutrophication Series 372/2008, 107 pp.

Payet J. 2005. Assessing Toxic Impacts on Aquatic Ecosystems in LCA. International Journal of Life Cycle Assessment 10(5): 373.

Peel MC, Finlayson BL, McMahon TA. 2007. Updated world map of the Köppen-Geiger climate classification. Hydrology and Earth System Sciences 11: 1633-1644.

Pennington DW, Payet J, Hauschild M. 1994. Aquatic ecotoxicological indicators in life-cycle assessment. Environmental Toxicology and Chemistry 23(7): 1796-1807.

Pinet PR. 2008. Invitation to Oceanography. Jones & Barlett Learning, 220 pp.

Platt T & Sathyendranath S. 1988. Oceanic Primary Production: Estimation by Remote Sensing at Local and Regional Scales. Science 241(4873): 1613-1620.

Platt T, Sathyendranath S. 2007. Calculation of Primary Production from Remotely-sensed Data on Ocean Colour. In Modelling Primary Production Series, vol. XXIV, pp. 205-215. Retrieved from http://www.geosafari.org/kochi/Forms/PPMOMNI.pdf [May 1st , 2012].

Posthuma L, Suter II GW, Traas TP (eds.). 2002. Species Sensitivity Distributions in Ecotoxicology. Boca Raton FL: Lewis Publishers.

Powers SP, Peterson CH, Christian RR, Sullivan E, Powers MJ, Bishop MJ &, Buzzelli CP. 2005. Effects of eutrophication on bottom habitat and prey resources of demersal fishes. Marine Ecology Progress Series 302: 233-243.

Rabalais NN, Turner RE, Wiseman WJ. 2002. Gulf of Mexico hypoxia, aka "The dead zone". Annual Review of Ecology and Systematics 33: 235-263.

Redfield AC. 1934. On the proportions of organic derivations in sea water and their relation to the composition of plankton. In RJ Daniel (ed.), James Johnson Memorial Volume. Liverpool: University Press of Liverpool, pp. 177-192.





Redfield AC. 1958. The biological control of chemical factors in the environment. American Scientist 46: 205-221.

Riedel B, Zuschin M, Haselmair A, Stachowitsch M. 2008. Oxygen depletion under glass: behavioural responses of benthic macrofauna to induced anoxia in the Northern Adriatic. Journal of Experimental Marine Biology and Ecology 367: 17-27.

Roy P-O, Huijbregts MAJ, Deschênes L, Margni M. 2012. Spatially-differentiated atmospheric source-receptor relationships for nitrogen oxides, sulfur oxides, and ammonia emissions at the global scale for life cycle impact assessment. Atmospheric Environment 62: 74-81

Roy P-O. 2012. Personal communication with P-O Roy. Excel file: "country\_resolution\_SRMs (jan\_2012)", 27 April 2012.

Sala E, Knowlton N. 2006. Global marine biodiversity trends. Annual Review of Environment and Resources 31:93-122.

Sand-Jensen K. 2000. Økologi og biodiversitet - overordnede mønstre for individer, bestande og økosystemer. Copenhagen: Gad Publishers, 509 pp (in Danish).

Scavia D, Field JC, Boesch DF, Buddemeier RW, Burkett V, Cayan DR, Fogarty M, Harwell MA, Howarth RW, Mason C, Reed DJ, Royer TC, Sallenger AH, Titus JG. 2002. Climate Change Impacts on U. S. Coastal and Marine Ecosystems. Estuaries 25(2): 149-164.

Sherman K & Hempel G (eds.). 2009. The UNEP Large Marine Ecosystem Report: A Perspective on Changing Conditions in LMEs of the World's Regional Seas. UNEP Regional Seas Report and Studies No. 182. Nairobi, Kenya: UNEP, 872 p.

Sherman K, Duda AM. 1999. Large Marine Ecosystems: An Emerging Paradigm for Fishery Sustainability. Fisheries 24(12): 15-26.

Sherman K. 1991. The Large Marine Ecosystem Concept: Research and Management Strategy for Living Marine Resources. Ecological Applications 1(4): 350-360.

Sleeswijk AW, van Oers LFCM, Guinée JB, Struijs J, Huijbregts MAJ. 2008. Normalisation in Product Life Cycle Assessment: An LCA of the Global and European Economic Systems in the Year 2000. Science of The Total Environment 390: 227-240.

Smith VH, Tilman GD, Nekola JC. 1999. Eutrophication: impacts of excess nutrient inputs on frewshwater, marine, and terrestrial ecosystems. Environmental Pollution 100: 179-196.

Socolow RH. 1999. Nitrogen management and the future of food: Lessons from the management of energy and carbon. Proceedings of the National Academy of Sciences USA 96: 6001-6008.

Spalding MD, Fox, HE, Allen GR, Davidson N, Ferdaña ZA, Finlayson M, Halpern BS, Jorge MA, Lombana A, Lourie SA, Martin KD, McManus E, Molnar J, Recchia CA, Robertson J. 2007. Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. BioScience 57(7): 573-583.

Steckbauer A, Duarte CM, Carstensen J, Vaquer-Sunyer R, Conley DJ. 2011. Ecosystem impacts of hypoxia: thresholds of hypoxia and pathways to recovery. Environmental Research Letters 6: 025003.

Steele JH. 1974. The structure of marine ecosystems. Cambridge: Harvard University Press, 128 pp.

Strandesen M, Birkved M, Holm PE, Hauschild MZ. 2007. Fate and distribution of metals in life cycle impact assessment. Ecological Modelling 203: 327-338.





Thibodeau B, de Vernal A, Mucci A. 2006. Recent eutrophication and consequent hypoxia in the bottom waters of the Lower St. Lawrence Estuary: Micropaleontological and geochemical evidence. Marine Geology 231: 37-50.

Turner RE, Rabalais NN. 1994. Coastal eutrophication near Mississippi River Delta. Nature 368: 216-619.

UN 2013. National Accounts Main Aggregates Database. Retrieved from http://unstats.un.org/unsd/snaama/selbasicFast.asp [August 30th, 2012].

UNEP. 2003. Eutrophication monitoring and strategy of MED POL. Athens: UNEP(DEC)/MED WG.231/14.

UNESCO. 2009. Global Open Oceans and Deep Seabed (GOODS) Biogeographical Classification. Marjo Vierros, Ian Cresswell, Elva Escobar Briones, Jake Rice & Jeff Ardron (eds). Intergovernmental Oceanographic Commission, IOC Technical Series No. 84, 96 pp.

USEPA. 2004. Species Sensitivity Distribution Generator (SSD\_Generator\_V1.xlt). CADDIS Volume 4: data Analysis. U.S. Environmental Protection Agency. Retrieved from http://www.epa.gov/caddis/da\_software\_ssdmacro.html [March 23rd, 2012].

Van Drecht G, Bouwman AF, Harrison J, Knoop JM. 2009. Global nitrogen and phosphate in urban wastewater for the period 1970 to 2050. Global Biogeochemical Cycles, 23, GB0A03, doi:10.1029/2009GB003458.

Van Drecht G, Bouwman AF, Knoop JM, Beusen AHW, Meinardi CR. 2003. Global modeling of the fate of nitrogen from point and nonpoint sources in soils, groundwater, and surface water. Global Biogeochemical Cycles, 17(4), 1115, doi:10.1029/2003GB002060.

Vaquer-Sunyer R, Duarte CM. 2010. Sulphide exposure accelerates hypoxia-driven mortality. Limnology and Oceanography 55: 1075-1082.

Vaquer-Sunyer R, Duarte CM. 2008. Thresholds of hypoxia for marine biodiversity. Proceedings of the National Academy of Sciences USA 105: 15452–15457.

Vitousek PM, Hättenschwiler S, Olander L, Allison S. 2002. Nitrogen and Nature. Ambio 31(2): 97-101.

Vollenweider RA (1992). Coastal marine eutrophication: principles and control. In RA Vollenweider, R Marchetti & R Viviani (eds.), Marine coastal eutrophication. London: Elsevier, pp. 1-20.

Wassmann P. 1990. Calculating the Load of Organic Carbon to the Aphotic Zone in Eutrophicated Coastal Waters. Marine Pollution Bulletin 21(4): 183-187.

Wilke CR, Chang P. 1955. Correlation of diffusion coefficients in dilute solutions. American Institute of Chemical Engineers Journal 1: 264-270.

Wollheim WM, Vörösmarty CJ, Bouwman AF, Green P, Harrison J, Linder E, Peterson BJ, Seitzinger SP, Syvitski JPM. 2008. Global N removal by freshwater aquatic systems using a spatially distributed, within-basin approach, Global Biogeochemical Cycles, 22, GB2026, doi:10.1029/2007GB002963.

Wollheim WM, Vörösmarty CJ, Peterson BJ, Seitzinger SP, Hopkinson CS. 2006. Relationship between river size and nutrient removal, Geophysical Research Letters, 33, L06410, doi:10.1029/2006GL025845.

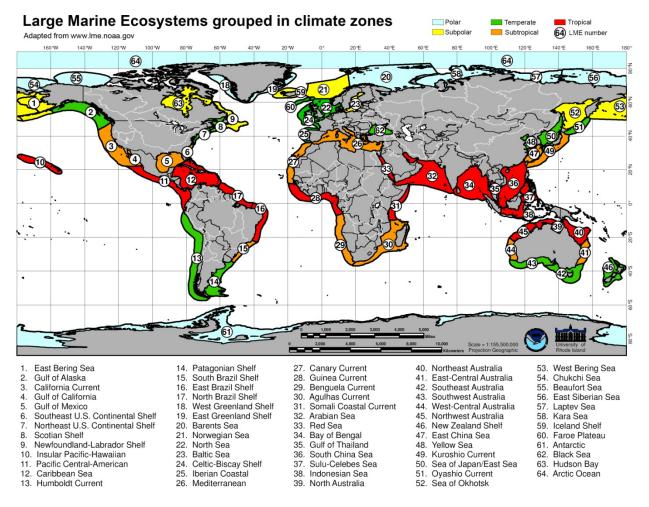
Wu RSS. 2002. Hypoxia: from molecular responses to ecosystem responses. Marine Pollution Bulletin 45: 35-45.





# 3.7 Appendices

#### Appendix 3-I. Large Marine Ecosystems (LMEs)



99

**Figure 3.6:** Geographical location of the 64 Large Marine Ecosystems (LMEs) grouped in the proposed 5 climate zones as per criteria shown in Table 3.5 (Appendix 3-II) (*adapted from www.lme.noaa.gov*).





100

#### **Appendix 3-II: Climate Zones**

**Table 3.5:** Classification and grouping of Large Marine Ecosystems (LME) into Climate Zones. Calculations refer to the estimation of the mean annual sea surface temperature (maSST) for 2005, based on the regression parameters of maSST data from 1957-2005 (data source: LME briefs, from NOAA, 2012).

64. Article Ocean       i.ee covered all year       -1.2       Polar         55. Beard/ord Seo       0.0034       -8.1379       -1.2       Polar         56. East Siberian Sea       0.0075       -16.1455       -1.1       Polar         56. East Siberian Sea       0.0061       -12.8746       -0.5       Polar         56. Attactic       0.0011       -2.8746       -0.5       Polar         56. Attactic Sea       0.0012       -2.1076       -0.6       Polar         57. Sea of Okhotsk       0.0004       -15.4208       4.6       Subpolar         52. Sea of Okhotsk       0.0007       -12.4254       5.6       Subpolar         50.0004       -13.6712       5.6       Subpolar       5.0       5.0         51. Oyashio Current       0.0027       -12.4524       7.0       Temperate         60.5       -0.0028       1.28745       6.6       Subpolar         71. Norwegian Sea       0.013       3.5225       6.6	ID LME name	Regression co b	efficients a	Calculation: maSST <sub>2012</sub> =b ×2005+a Estimation mean annual SST 2005	Classification Climate zone
Sp. Backford San         0.0024         8.1379         -1.2         Polar           Sc. Bart Sherian San         0.0037         -15.1415         -1.1         Polar           Sc. Bart Sherian San         0.0057         -15.1415         -1.1         Polar           St. Kara San         0.0061         -12.8746         -0.5         Polar           St. Kara San         0.0061         -12.8746         -0.5         Polar           St. Kara San         0.0120         -23.1076         1.0         Polar           St. Kara San         0.0120         -23.1076         1.0         Polar           JS. Ext Greenland Shelf         0.006         -16.298         -1.0         Polar           JS. Ext Greenland Shelf         0.007         -15.4208         6         Supplar           JS. Bard Grüchndishelf         0.007         -15.4208         6         Supplar           JS. Bard Grüchndishelf         0.007         -12.452         -5         Supplar           JS. Newt Bering Sea         0.0077         -12.452         -6         Supplar           JS. Newt Bering Sea         0.0077         -12.452         -6         Supplar           JS. Newt Bering Sea         0.0078         -12.4524         -7			-		
61. Antartic         0.003         -5.793         -1.2         Polar           52. Last Sherina Saa         0.0075         -151.413         -1.2         Polar           57. Lapter Saa         0.0075         -151.413         -0.8         Polar           57. Lapter Saa         0.0065         -13.693         -0.8         Polar           54. Chukchi Saa         0.0118         -23.6389         -0.1         Polar           58. Hora San         0.0118         -23.6389         -0.0         Polar           58. Hora San         0.010         -16.298         1.0         Polar           50. Barents Sea         0.0007         -13.670         5.2         Subpolar           52. Sea O'Lhindak         0.0100         -15.208         -6.6         Subpolar           51. Okashi Current         0.0027         -13.670         -5.2         Subpolar           51. Okashi Current         0.0036         1.2815         -6.6         Subpolar           52. Okashi Current         0.0037         -12.654         -7.0         Temperate           23. Norkegian Saa         0.0037         -12.817         -6.6         Subpolar           53. Okashi Current         0.0038         -5.6087         -6.6					
S6       161       11       Polar         S7       Lapter X8a       0.0075       11.415       -1.1       Polar         S8       Kara Sen       0.0051       12.8746       -0.5       Polar         S4       Chukchi Sea       0.018       -23.6389       -0.1       Polar         S4       Chukchi Sea       0.018       -23.6389       -0.1       Polar         S6       Kett Greenland Shelf       0.006       -16.2988       1.0       Polar         D1       Batt Greenland Shelf       0.0004       4.8395       3.3       Polar         D2       Seard Othorsk       0.0007       1.5.4208       6.0       Suppdar         S2       Seard Othorsk       0.0007       1.2.834       6.0       Suppdar         S. West Bering Sea       0.0007       1.2.834       6.0       Suppdar         S. Soland Shelf       0.0015       1.2.834       7.0       Temperate         S. Orgaho Current       0.0027       1.2.4524       7.0       Temperate         S. Orgaho Current       0.0077       -2.5.3742       6.6       Temperate         S. Orgaho Current       0.0077       -2.5.3734       6.6       Temperate					
Sk Kin Sen         0.0061         1.2374         -0.5         Polar           63. Hudkon Bay         0.013         -23.6389         -0.1         Polar           18. West Greenland Shelf         0.0130         -23.107         1.0         Polar           19. Bact Greenland Shelf         0.010         -16.2938         1.9         Polar           20. Barenti Sea         0.0004         -18.5958         1.9         Polar           20. Barenti Sea         0.0004         -18.5958         3.3         Polar           20. Seard Okhotsk         0.0004         -13.6712         5.6         Subpolar           20. Seard Okhotsk         0.0007         -22.495         8.8         Subpolar           20. Seard Okhotsk         0.0007         -22.495         8.8         Subpolar           20. Seard Okhotsk         0.0007         -22.495         8.8         Subpolar           21. Novegian Sea         0.0077         -22.454         7.0         Temperate           2. Oglard Okaska         0.0078         -22.495         8.8         Temperate           2. Oglard Okaska         0.0079         -22.454         7.0         Temperate           2. Oglard Okaska         0.0078         -25.523         1.3.	56. East Siberian Sea				
S4. Chukchi Sae         0.0118         23.3639         -0.1         Polar           18. West Greenland Shelf         0.026         -15.2938         1.0         Polar           19. East Greenland Shelf         0.0086         -15.2938         1.9         Polar           22. Sae of Okhots k         -0.000         4.8359         3.3         Welar           19. East Greenland Shelf         0.0004         4.8359         3.3         Welar           23. West Breing Sea         0.0007         14.3607         5.2         Subpolar           53. West Breing Sea         0.0097         14.3607         5.2         Subpolar           23. Bartent Sea         0.015         -22.3495         6.0         Subpolar           23. Norveglam Sea         0.015         -22.3495         6.0         Subpolar           23. Norveglam Sea         0.015         -22.3495         6.0         Subpolar           24. Norveglam Sea         0.0179         -22.3495         6.0         Temperate           24. Norveglam Sea         0.0179         -22.3495         6.0         Temperate           25. Os fan Jany Chartal Shelf         0.023         12.815         10.8         Temperate           24. Oktick Sea         0.0179	57. Laptev Sea			-0.8	Polar
63. Hudson Bay         0.012.0         23.1076         1.0         Polar           18. West Greenland Shelf         0.008         1.5293         1.0         Polar           20. Barent Sea         0.0008         4.8399         3.3         Polar           20. Barent Sea         0.0008         4.8399         3.3         Polar           20. Barent Sea         0.0007         15.4208         4.6         Subpolar           3. West Bering Sea         0.0094         13.6712         5.6         Subpolar           3. West Bering Sea         0.0097         1.2455         8.6         Subpolar           3. Reduct Shelf         0.0022         0.23775         6.0         Subpolar           2. Norwegian Sea         0.0035         1.2455         8.6         Subpolar           3. Could Alaska         0.007         1.2455         8.6         Temperate           2. Sourt Shelf         0.0037         5.0085         9.6         Temperate           2. Sourt Shelf         0.021         31.7325         1.1         Temperate           2. Aucht Sea         0.017         25.323         1.0         Temperate           2. Aucht Sea         0.017         12.9324         1.4         Temperate <td>58. Kara Sea</td> <td>0.0061</td> <td>-12.8746</td> <td>-0.5</td> <td>Polar</td>	58. Kara Sea	0.0061	-12.8746	-0.5	Polar
13. West Greenhand Sheff         0.0086         1:5243         1.0         Polar           13. East Greenhand Sheff         0.008         4:8359         3.3         Polar           20. Barents Sea         0.000         1:54208         4:6         Subpolar           25. Sea of Dkhotsk         0.000         1:54208         4:6         Subpolar           33. West Bering Sea         0.0097         1:4:3607         5:2         Subpolar           34. West Bering Sea         0.0097         1:4:3607         5:2         Subpolar           35. Newsding Aberit         0.0036         1:2815         8:3         Subpolar           25. Logand Sheff         0.0037         1:2815         8:3         Subpolar           25. Logand Sheff         0.0036         1:2815         8:6         Subpolar           25. Logand Maska         0.0079         7:2:323         10:5         Temperate           20. Mort Saa         0.0079         3:3225         13:1         Temperate           24. Celtic-Sicay Sheff         0.0031         5:5008         12:6         Temperate           24. Southeast Australia         0.0033         3:3225         13:1         Temperate           24. Southeast Australia         0.0069	54. Chukchi Sea	0.0118	-23.6389	-0.1	Polar
19       Est Greenland Shelf       0.0104       1.8983       1.9       Polar         20. Barents Sea       0.0008       4.8359       3.3       Polar         20. Sarent Sea       0.0004       1.5 4208       3.3       Polar         20. Sarent Sea       0.0094       1.5 6712       5.1       Subpolar         5. West Bering Sea       0.0097       1.4 36712       5.6       Subpolar         5. Icalad Shelf       0.0153       -22.3495       8.8       Subpolar         2. Bartic Sea       0.0153       -22.3495       8.3       Subpolar         2. Socia for Marka       0.0037       1.2.452       7.0       Temperate         0.025       38.742       8.4       Temperate       6.0031       4.5785       1.08       Temperate         2. Guf of Alaska       0.017       -25.213       1.05       Temperate       2.452       1.3       Temperate         2. Autor Sa       0.017       -25.213       1.05       Temperate       2.452       1.3       Temperate         2. Coll of Alaska       0.017       -25.213       1.05       Temperate       2.4016       1.4       7.4       5.4       Temperate       2.4       2.4       6.6       1.4	63. Hudson Bay				
20. Brents Sea       -0.0008       4.8359       3.3       Polar         52. Sea of Dkhots k       0.0010       15.4208       4.6       Subpolar         53. West Bering Sea       0.0097       14.3607       5.2       Subpolar         53. West Bering Sea       0.0097       14.3607       5.2       Subpolar         54. Newtoundhord Labrador Shelf       0.0153       22.3495       8.3       Subpolar         23. Baltic Sea       0.0097       12.4524       7.0       Temperate         82. Octan Shelf       0.0035       1.2815       8.6       Subpolar         23. Baltic Sea       0.0097       12.4524       7.0       Temperate         82. Soctan Shelf       0.0097       12.4524       7.0       Temperate         2. Gulf of Alaska       0.0078       6.0887       9.6       Temperate         2. Cult Scale       0.0133       4.5755       1.0.8       Temperate         2. Cult Scale       0.017       25.321       1.0.8       Temperate         2. Cult Scale       0.017       12.3266       1.4.9       Temperate         2. Southers Scale       0.017       12.3266       1.4.9       Temperate         2. Southers Scale       0.017 <td< td=""><td>18. West Greenland Shelf</td><td></td><td></td><td></td><td></td></td<>	18. West Greenland Shelf				
52. Sea of Okhotsk         0.0100         -15.4208         4.6         Subpolar           1. East Bering Sea         0.0094         -13.6712         5.1         Subpolar           9. Newfoundland-Labrador Shelf         0.0157         -25.9772         5.6         Subpolar           23. Baltic Sea         0.0157         -25.9772         5.6         Subpolar           23. Baltic Sea         0.0153         -22.3495         8.3         Subpolar           23. Baltic Sea         0.0153         -22.3495         8.3         Subpolar           23. Option Shelf         0.0036         1.2815         8.6         Subpolar           60. Farce Plateau         -0.0030         15.5008         9.6         Temperate           22. North Sea         0.0177         -25.3213         10.6         Temperate           22. North Sea         0.0167         -19.9861         13.4         Temperate           24. Celtic-Bisca Shelf         0.0023         13.8325         13.1         Temperate           24. Southeast Australia         0.0066         -13.844         Temperate           24. Southeast Australia         0.0065         -13.844         Temperate           24. Southeast Australia         0.0066         -15.848					
1. East Bering Sea       0.0094       13. 6712       5.1       Subpolar         53. West Bering Sea       0.0097       14.3607       5.2       Subpolar         53. West Bering Sea       0.0157       -25.3972       5.6       Subpolar         54. Lead Shelf       0.0037       -12.8075       6.0       Subpolar         53. Logand Shelf       0.0036       1.2815       8.6       Subpolar         51. Oyashio Current       0.0037       -12.4524       7.0       Temperate         60. Force Plateau       -0.0030       15.5008       9.6       Temperate         22. North Sea       0.0179       -25.3213       10.6       Temperate         22. North Sea       0.0179       -25.3213       10.8       Temperate         24. Celtic Alska       0.0031       4.6785       10.8       Temperate         24. Celtic Alska       0.0017       19.3961       13.4       Temperate         24. Celtic Alska       0.0017       18.2366       14.9       Temperate         24. Subtest Australia       0.0107       18.2366       14.9       Temperate         24. Subtest Australia       0.0117       17.350       12.4       Temperate         24. Subtest Australia <t< td=""><td>20. Barents Sea</td><td>-0.0008</td><td>4.8359</td><td>3.3</td><td>Polar</td></t<>	20. Barents Sea	-0.0008	4.8359	3.3	Polar
33. West Bering Sea         0.0097         -14.3607         5.2         Subpolar           9. Newfoundland-Labrador Sheff         0.00153         -22.3495         5.6         Subpolar           23. Baltic Sea         0.00153         -22.3495         8.8         Subpolar           23. Baltic Sea         0.0021         10.3775         6.0         Subpolar           23. Baltic Sea         0.0035         1.2815         8.6         Subpolar           21. Norvegian Sea         0.00097         -12.4524         7.0         Temperate           6. Farce Plateau         -0.0031         45.0568         9.6         Temperate           2. Guif of Alaska         0.0077         -25.321         10.5         Temperate           2. Guif of Alaska         0.0077         -25.321         10.6         Temperate           2. Guif of Alaska         0.0017         12.326         13.1         Temperate           2. Cutto fiscay Shelf         0.0023         10.8093         15.4         Temperate           2. Subtost Australia         0.0068         -0.4118         16.5         Temperate           2. Subtost Australia         0.0068         -0.4148         17.4         Temperate           3. Subtost Australia	52. Sea of Okhotsk			4.6	
9. Newfounding/Labrador Shelf         0.0157         -25.9772         5.6         Subpolar           59. Iceland Shelf         -0.0022         10.3775         6.6         Subpolar           23. Baltic Sea         0.0035         -1.2815         8.6         Subpolar           21. Norwegian Sea         0.0036         1.2815         8.6         Subpolar           51. Oyashio Current         0.0097         -12.4524         7.0         Temperate           60. Face Plateau         -0.003         15.5008         9.6         Temperate           22. Ourl of Alaska         0.0078         -6.087         9.6         Temperate           22. North Sea         0.0179         25.3213         10.05         Temperate           23. Colin of Alaska         0.0021         -31.7350         12.6         Temperate           24. Celtic Siscay Shelf         0.0038         -35.225         13.1         Temperate           25. Soa of Japan/East Sea         0.0177         12.2366         14.9         Temperate           25. Board Japan/East Sea         0.0197         -24.1103         15.4         Temperate           26. New Zealand Shelf         0.0028         -0.2141         15.55848         17.0         Temperate	1. East Bering Sea				
59. elend Shelf         -0.0022         10.3775         6.0         Subpolar           23. Baltic Sea         0.0153         -22.3495         8.3         Subpolar           23. Norvegian Sea         0.0036         1.2815         8.6         Subpolar           51. Oysship Current         0.0037         -12.4524         7.0         Temperate           0.0036         1.2815         8.6         Subpolar         7.0         Temperate           0.0037         -12.4524         7.0         Temperate         7.0					
23. Baltic Sea         0.0153         -22.3495         8.6         Subpolar           21. Norwegian Sea         0.0036         1.2815         8.6         Subpolar           50. Oyashio Current         0.0235         -38.7342         8.4         Temperate           60. Farce Plateau         -0.0030         15.5008         9.6         Temperate           22. Outof Alasha         0.0073         -6.0887         9.6         Temperate           22. North Sea         0.0179         -25.3213         10.5         Temperate           23. Outof Alasha         0.0078         -6.0887         12.6         Temperate           24. Celtic-Biscay Shef         0.0017         -15.39861         13.4         Temperate           24. Celtic-Biscay Shef         0.0017         18.2366         14.9         Temperate           25. Sea of Japar/East Australia         0.0162         -15.848         17.0         Temperate           24. Sudhest Australia         0.0162         -15.5848         17.0         Temperate           25. Iberian Coastal         0.0162         -15.5848         17.0         Temperate           3. Celifornia Current         0.0086         0.4397         2.0         Subtropical           3. California Curren					
21. Norwegian Sea         0.0036         1.2815         8.6         Subpolar           51. Oyashio Current         0.0037         12.4524         7.0         Temperate           60. Farce Plateau         -0.0030         15.5008         9.6         Temperate           2. Gulf of Alaska         0.0078         -6.0887         10.8         Temperate           2. Gulf of Alaska         0.0079         -5.3213         10.6         Temperate           2. Gulf of Alaska         0.0081         -3.5225         13.1         Temperate           2. Southeast Australia         0.0107         19.366         14.9         Temperate           42. Southeast Australia         0.0108         -6.8315         14.9         Temperate           3. California Current         0.0065         -0.5484         17.0         Temperate           3. California Current         0.0054         9.9577         20.7         Subtropical           2. Benergio Current					
51. Oyashio Current       0.0097       -12.4524       7.0       Temperate         8. Sochan Shelf       0.0235       -38.7342       8.4       Temperate         2. Gulf of Alaska       0.0078       -6.0887       9.6       Temperate         2. Gulf of Alaska       0.0078       -6.0887       9.6       Temperate         2. Gulf of Alaska       0.0078       -6.0887       9.6       Temperate         2. North Sea       0.0179       -25.3213       10.5       Temperate         7. Northeast U.S. Continental Shelf       0.0221       -31.7350       12.6       Temperate         2. Bos Ga Japan/Yeats Sea       0.0167       -19.9861       13.4       Temperate         2. Bos Ga Japan/Yeats Sea       0.0167       -19.9861       13.4       Temperate         42. Southeast Australia       0.0018       -6.8315       14.9       Temperate         43. Network Australia       0.0168       -6.8315       14.9       Temperate         3. California Current       0.0065       4.3347       7.0       Temperate         23. California Current       0.0065       4.3347       7.0       Subtropical         23. California Current       0.0058       2.4479       2.0.0       Subtropical					
8. Socian Shelf         0.0235         -38.7342         8.4         Temperate           60. Face Plateau         -0.0030         15.5008         9.6         Temperate           2. Ourf of Jaska         0.0078         -6.0887         9.6         Temperate           14. Patagonian Shelf         0.0031         4.6785         10.8         Temperate           7. Northeast U.S. Continental Shelf         0.0221         -31.7350         12.6         Temperate           24. Celtic-Biscay Shelf         0.0033         -3.5225         13.1         Temperate           62. Black Sea         -0.0017         18.2366         14.9         Temperate           62. Black Sea         -0.0017         18.2366         14.9         Temperate           62. Black Sea         0.0167         -19.9861         15.4         Temperate           62. Black Sea         0.017         -24.103         15.4         Temperate           7.2. Stokand Shelf         0.0023         10.803         17.4         Temperate           13. Humboldt Current         0.0065         4.347         17.4         Subtropical           23. California Current         0.0058         4.2479         22.0         Subtropical           24. Subtropical         <			_		
60. Farce Plateau         -0.0030         15.5008         9.6         Temperate           2. Gui for Alaska         0.0078         -6.0887         9.6         Temperate           14. Patagonian Shelf         0.0017         -6.52313         10.5         Temperate           7. Northeast U.S. Continental Shelf         0.0021         -31.7350         12.6         Temperate           2. Celtro-Biscay Shelf         0.0033         -3.5225         13.1         Temperate           24. Celtro-Biscay Shelf         0.0017         -19.9861         13.4         Temperate           24. Southeast Australia         0.0167         -19.9861         13.4         Temperate           24. Southeast Australia         0.0102         10.8093         15.4         Temperate           24. Southeast Australia         0.0166         -15.5848         17.0         Temperate           25. Iberna Coastal         0.0165         4.3347         17.4         Subtropical           26. Mediterranean         0.0086         0.0699         17.2         Temperate           26. Mediterranean         0.0086         2.4479         22.0         Subtropical           27. Carany Current         0.0031         -3.556         22.9         Subtropical					
2. Gulf of Alaska         0.0078         -6.0887         9.6         Temperate           22. North Sea         0.0179         -25.3213         10.5         Temperate           12. North Sea         0.0011         4.6785         10.8         Temperate           24. Celtic-Biscay Shelf         0.0021         -31.7350         12.6         Temperate           24. Celtic-Biscay Shelf         0.0023         -3.5225         13.1         Temperate           25. Sea of Japan/East Sea         -0.0017         18.2366         14.9         Temperate           24. Southeast Australia         0.0167         -19.9861         13.4         Temperate           26. Black Sea         -0.0017         18.2366         14.9         Temperate           24. Southeast Australia         0.0187         -24.1103         15.4         Temperate           25. Iberian Coastal         0.0162         -15.5848         17.0         Temperate           25. Iberian Coastal         0.0065         4.3347         17.4         Southorpical           26. Additerranean         0.0088         2.2496         20.0         Subtropical           27. Camary Current         0.0098         2.4479         22.0         Subtropical           27. Camary Cu					
22. North Sea         0.0179         -25.3213         10.5         Temperate           14. Patagonian Shelf         0.0031         4.6785         10.8         Temperate           24. Cettic-Biscay Shelf         0.0221         -31.7350         12.6         Temperate           26. Black Sea         0.0167         -19.9861         13.4         Temperate           26. Black Sea         -0.017         18.2366         14.9         Temperate           27. Southeast Australia         0.0108         -6.8315         14.9         Temperate           27. Southeast Australia         0.0123         10.8093         15.4         Temperate           28. Veltov Sea         0.0127         -24.103         15.4         Temperate           28. Southwest Australia         0.065         4.3347         17.0         Temperate           28. Southwest Australia         0.0669         17.2         Temperate           28. Southwest Australia         0.0162         -15.548         17.0         Temperate           28. Southwest Australia         0.0164         -13.437         Temperate           29. Berguela Current         0.0084         2.4479         22.0         Subtropical           29. Subropical         0.0317         -41.					
14. Patagonian Shelf       0.0031       4.6785       10.8       Temperate         7. Northeast U.S. Continental Shelf       0.0221       -31.7350       12.6       Temperate         20. Sea of Japan/East Sea       0.0167       -19.9861       13.4       Temperate         20. Southeast Australia       0.0167       -19.9861       13.4       Temperate         22. Southeast Australia       0.0167       -19.9861       13.4       Temperate         46. New Zealand Shelf       0.0108       -6.8315       14.9       Temperate         47. Voltoward       0.0023       10.8093       15.4       Temperate         47. Voltoward       0.0162       -15.5848       17.0       Temperate         28. Iberian Coastal       0.0162       -15.5848       17.0       Temperate         29. Benguela Current       0.0065       4.3347       17.4       Subtropical         29. Renguela Current       0.0054       9.9577       20.7       Subtropical         27. Canary Current       0.0228       -22.466       20.0       Subtropical         29. Renguela Current       0.0137       -41.3278       22.2       Subtropical         24. Kurshin Current       0.0132       -3.4566       23.0       Subtropi					
7. Northeast U.S. Continental Shelf       0.0221       -31.7350       12.6       Temperate         24. Celic-Biscay Shelf       0.0083       -3.5225       13.1       Temperate         62. Black Sea       -0.017       18.2366       14.9       Temperate         62. Black Sea       -0.018       -6.8315       14.9       Temperate         64. New Zealand Shelf       0.0231       0.8093       15.4       Temperate         7. Northeast Australia       0.0197       -24.1103       15.4       Temperate         13. Humboldt Current       0.0083       -0.418       16.5       Temperate         25. Iberian Coastal       0.0167       -15.5848       17.0       Temperate         26. Mediterranean       0.0086       0.24479       20.0       Subtropical         26. Mediterranean       0.0088       2.4479       20.0       Subtropical         27. Canary Current       0.0084       9.9577       20.7       Subtropical         27. Canary Current       0.017       -41.3278       22.2       Subtropical         28. Southeest Current       0.0167       -11.1084       24.4       Subtropical         29. Enguela Current       0.0163       -2.6400       24.5       Subtropical <td></td> <td></td> <td></td> <td></td> <td></td>					
24. Celtic-Biscay Shelf       0.0083       -3.5225       13.1       Temperate         50. Sea of Japan/East Sea       0.0167       -19.9861       13.4       Temperate         26. Black Sea       -0.017       18.2366       14.9       Temperate         42. Southeast Australia       0.0108       -6.8315       14.9       Temperate         42. Southeast Australia       0.0102       18.2366       14.9       Temperate         43. Southwest Australia       0.0033       -0.1418       16.5       Temperate         13. Humboldt Current       0.0065       4.3347       17.4       Subtropical         25. Berlan Coastal       0.0054       9.9577       20.7       Subtropical         26. Mediterranean       0.0088       2.2496       20.0       Subtropical         27. Canary Current       0.0084       9.9577       20.7       Subtropical         27. Canary Current       0.0082       2.4496       22.0       Subtropical         24. West-Central Australia       0.0117       -11.1084       22.4       Subtropical         27. Canary Current       0.0284       -2.866       22.9       Subtropical         24. West-Central Australia       0.0115       -0.0330       23.0       Subtropi					
50. Sea of Japan/East Sea         0.0167         -19.9861         13.4         Temperate           62. Black Sea         -0.0117         18.2366         14.9         Temperate           42. Southeast Australia         0.0103         -6.8315         14.9         Temperate           46. New Zealand Shelf         0.0103         -6.8315         14.9         Temperate           47. Follow Sea         0.0107         -24.1103         15.4         Temperate           13. Humboldt Current         0.0083         -0.1418         16.5         Temperate           43. Southwest Australia         0.0066         0.0699         17.2         Temperate           3. California Current         0.0065         4.3347         17.4         Subtropical           28. Benguela Current         0.0054         9.5577         20.0         Subtropical           29. Benguela Current         0.0054         9.5577         20.0         Subtropical           29. Carary Current         0.0054         9.5577         20.0         Subtropical           14. East-Central Australia         0.0167         11.1084         22.4         Subtropical           15. Suth Brazil Shelf         0.0122         -2.8069         22.9         Subtropical	24. Celtic-Biscay Shelf				
42. Southeast Australia       0.0108       -6.8315       14.9       Temperate         46. New Zealand Shelf       0.0023       10.8093       15.4       Temperate         48. Yellow Sea       0.0197       -24.1103       15.4       Temperate         13. Humboldt Current       0.0083       -0.1418       15.4       Temperate         25. berian Coastal       0.0162       -15.5848       17.0       Temperate         3. Southwest Australia       0.0065       4.3347       7.4       Subtropical         26. Mediterranean       0.0088       2.2495       20.0       Subtropical         27. Canary Current       0.0098       2.4479       22.0       Subtropical         27. East China Sea       0.0117       -11.1084       22.4       Subtropical         28. Kuroshio Current       0.0128       -22.869       22.9       Subtropical         29. Subtropical       0.0131       -0.0330       23.0       Subtropical         29. Kuroshio Current       0.0132       -26.4000       24.5       Subtropical         30. Aguihas Current       0.0133       10.589       24.8       Subtropical         30. Aguihas Current       0.0038       18.4183       26.1       Subtropical	50. Sea of Japan/East Sea				
46. New Zealand Shelf       0.0023       10.8093       15.4       Temperate         48. Yellow Sea       0.0197       -24.1103       15.4       Temperate         13. Humboldt Current       0.0083       -0.1418       16.5       Temperate         43. Southwest Australia       0.0065       4.3347       17.4       Subtropical         26. Mediterranean       0.0065       4.3347       17.4       Subtropical         26. Mediterranean       0.0068       2.4479       22.0       Subtropical         27. Canary Current       0.0098       2.4479       22.0       Subtropical         27. Canary Current       0.00167       -11.1084       22.4       Subtropical         44. West-Central Australia       0.01167       -11.1084       22.4       Subtropical         45. South Brazil Shelf       0.023       -2.8099       22.9       Subtropical         40. Kurshio Current       0.0132       -3.4566       23.0       Subtropical         41. East-Central Australia       0.0157       -0.030       24.5       Subtropical         40. Kurshio Current       0.0132       -3.4566       23.0       Subtropical         5. Gulf of Mexico       0.038       18.4183       26.1       Subtropical <td>62. Black Sea</td> <td>-0.0017</td> <td>18.2366</td> <td>14.9</td> <td>Temperate</td>	62. Black Sea	-0.0017	18.2366	14.9	Temperate
48. Yellow Sea       0.0197       -24.1103       15.4       Temperate         13. Humboldt Current       0.0083       -0.1418       15.5       Temperate         25. Iberian Coastal       0.0162       -15.5848       17.0       Temperate         3. Southwest Australia       0.0065       4.3347       17.4       Subtropical         26. Mediterranean       0.0088       2.2496       20.0       Subtropical         27. Canary Current       0.0054       9.9577       20.7       Subtropical         27. Canary Current       0.0088       2.449       22.0       Subtropical         48. West-Central Australia       0.0167       -11.1084       22.4       Subtropical         49. Kuroshio Current       0.0122       -2.8069       22.0       Subtropical         49. Kuroshio Current       0.0124       -2.64000       24.5       Subtropical         40. Golf California       0.0254       -2.64000       24.5       Subtropical         30. Agulhas Current       0.0133       31.0589       24.8       Subtropical         30. Agulhas Current       0.0038       18.4183       25.5       Subtropical         30. Agulhas Current       0.0066       23.6974       25.0       Tropical     <	42. Southeast Australia	0.0108	-6.8315	14.9	Temperate
13. Humboldt Current       0.0083       -0.1418       16.5       Temperate         25. berian Coastal       0.0162       -15.5848       17.0       Temperate         3. California Current       0.0086       0.0699       17.2       Temperate         3. California Current       0.0065       4.3347       17.4       Subtropical         29. Benguela Current       0.0054       9.9577       20.7       Subtropical         27. Canary Current       0.0017       -11.1084       22.4       Subtropical         15. South Brazil Shelf       0.0228       -22.8069       22.9       Subtropical         41. East-Central Australia       0.0112       -3.4566       23.0       Subtropical         41. East-Central Australia       0.0112       -3.4566       23.0       Subtropical         41. East-Central Australia       0.0113       -0.0330       23.0       Subtropical         0.0132       -3.4566       25.5       Subtropical         0.0132       -3.4566       25.5       Subtropical         0.0133       10.589       24.8       Subtropical         0.0133       13.0589       24.8       Subtropical         10. Insular Pacific Hawalian       0.0006       23.6974       2	46. New Zealand Shelf	0.0023	10.8093	15.4	Temperate
25. Iberian Coastal         0.0162         -15.5848         17.0         Temperate           43. Southwest Australia         0.0066         0.0699         17.2         Temperate           3. California Current         0.0065         4.3347         17.4         Subtropical           26. Mediterranean         0.0064         9.9577         20.7         Subtropical           27. Canary Current         0.0098         2.4479         22.0         Subtropical           44. West-Central Australia         0.0167         11.1084         22.4         Subtropical           45. South Brazil Shelf         0.0254         -2.869         22.9         Subtropical           45. South Startlia         0.0157         -10.0330         23.0         Subtropical           46. Gulf of California         0.0254         -26.4000         24.5         Subtropical           0.0139         -2.4145         25.5         Subtropical         3.0589         24.8         Subtropical           0.0416         31.0589         24.8         Subtropical         3.058         27.2         Tropical           10. Insular Pacific-Havalian         0.0006         23.6974         25.0         Tropical           10. Insular Pacific-Havalian         0.0006	48. Yellow Sea	0.0197	-24.1103	15.4	Temperate
43. Southwest Australia         0.0086         0.0699         17.2         Temperate           3. California Current         0.0065         4.3347         17.4         Subtropical           26. Mediterranean         0.0088         2.2496         20.0         Subtropical           29. Benguela Current         0.0054         9.9577         20.7         Subtropical           27. Canary Current         0.0054         9.9577         20.3         Subtropical           47. East China Sea         0.0317         -41.3278         22.2         Subtropical           47. East China Sea         0.0167         -11.1084         22.4         Subtropical           49. Kuroshio Current         0.0128         -22.8069         22.0         Subtropical           49. Kuroshio Current         0.0115         -0.0330         23.0         Subtropical           41. East-Central Australia         0.0115         -0.0330         24.8         Subtropical           6. Southeast U.S. Continental Shelf         -0.0313         -2.1445         25.5         Subtropical           10. Insular Pacific Hawaiian         0.0006         23.6974         25.0         Tropical           11. Pacific Central-American         0.0006         23.6974         27.2         Trop	13. Humboldt Current				
3. California Current       0.0065       4.3347       17.4       Subtropical         26. Mediterranean       0.0054       9.9577       20.7       Subtropical         27. Canary Current       0.0098       2.4479       20.0       Subtropical         47. East China Sea       0.0317       41.3278       22.2       Subtropical         44. West-Central Australia       0.0167       -11.1084       22.4       Subtropical         45. South Brazil Shelf       0.0228       -22.8069       22.9       Subtropical         46. Guif of California       0.0157       -10.330       23.0       Subtropical         47. East Central Australia       0.0115       -0.0330       23.0       Subtropical         46. Guif of California       0.0224       -26.4000       24.5       Subtropical         6. Southeast U.S. Continental Shelf       -0.0031       31.0589       24.8       Subtropical         20. Aguihas Current       0.0016       3.9558       27.2       Tropical         10. Insular Pacific-Hawaijan       0.0060       23.6974       26.0       Tropical         10. Insular Pacific-Hawaijan       0.0060       3.6974       27.2       Tropical         11. Pacific Central-American       0.0060       15.494					
26. Mediterranean       0.0088       2.2496       20.0       Subtropical         29. Benguela Current       0.0054       9.9577       20.7       Subtropical         27. Canary Current       0.0098       2.4479       22.0       Subtropical         27. Earst China Sea       0.0317       41.3278       22.2       Subtropical         24. West-Central Australia       0.0167       -11.1084       22.2       Subtropical         15. South Brazil Shelf       0.0228       -22.8069       22.9       Subtropical         44. West-Central Australia       0.0112       -3.4566       23.0       Subtropical         45. Guif of California       0.0254       -26.4000       24.5       Subtropical         6. Southeast U.S. Continental Shelf       -0.031       31.0589       24.8       Subtropical         30. Aguhas Current       0.0139       -2.4145       25.5       Subtropical         10. Insular Pacific-Hawaiian       0.0005       23.6974       25.0       Tropical         10. Northeast Australia       0.0095       7.7313       26.7       Tropical         11. Pacific Central American       0.0086       15.4948       27.5       Tropical         24. Subiras       0.0116       3.9558       2	43. Southwest Australia	0.0086	0.0699	17.2	Temperate
29. Benguela Current       0.0054       9.9577       20.7       Subtropical         27. Canary Current       0.0098       2.4479       22.0       Subtropical         47. East China Sea       0.0317       -41.3278       22.2       Subtropical         44. West-Central Australia       0.0167       -11.1084       22.4       Subtropical         15. South Brazil Shelf       0.0228       -22.8069       22.9       Subtropical         49. Kuroshio Current       0.0132       -3.4566       23.0       Subtropical         41. East-Central Australia       0.0115       -0.0330       23.0       Subtropical         4. Gulf of California       0.0224       -26.4000       24.8       Subtropical         6. Southeast U.S. Continental Shelf       -0.0031       31.0589       24.8       Subtropical         5. Gulf of Mexico       0.0038       18.4183       26.1       Subtropical         10. Insular Pacific-Hawaiian       0.0006       23.6974       25.0       Tropical         11. Pacific Central-American       0.0006       15.4948       27.3       Tropical         11. Insular Pacific-Hawaiian       0.0005       7.7313       26.7       Tropical         12. Caribbeast Australia       0.0016       15	3. California Current	0.0065			Subtropical
27. Canary Current       0.0098       2.4479       22.0       Subtropical         47. East China Sea       0.0317       -41.3278       22.2       Subtropical         44. West-Central Australia       0.0167       -11.1084       22.4       Subtropical         15. South Brazil Shelf       0.0228       -22.8069       22.9       Subtropical         49. Kuroshio Current       0.0132       -3.4566       23.0       Subtropical         41. East-Central Australia       0.0115       -0.0330       23.0       Subtropical         4. Gulf of California       0.0254       -26.4000       24.5       Subtropical         6. Southeast U.S. Continental Shelf       -0.0031       31.0589       24.8       Subtropical         10. Insular Pacific-Hawatian       0.0006       23.6974       25.0       Tropical         10. Northeast Australia       0.0095       7.7313       26.7       Tropical         11. Pacific Central-American       0.0060       15.4948       27.5       Tropical         12. Caribbean Sea       0.0005       26.756       27.7       Tropical         13. Normali Coastal Current       0.0118       3.8046       27.6       Tropical         13. Adbian Sea       0.0005       26.7566					
47. East China Sea       0.0317       -41.3278       22.2       Subtropical         44. West-Central Australia       0.0167       -11.1084       22.4       Subtropical         15. South Brazil Shelf       0.0228       -22.8069       22.9       Subtropical         49. Kuroshio Current       0.0132       -3.4566       23.0       Subtropical         41. East-Central Australia       0.0115       -0.0330       23.0       Subtropical         4. Gulf of California       0.0254       -26.4000       24.5       Subtropical         6. Southeast U.S. Continental Shelf       -0.031       31.0589       24.8       Subtropical         30. Agulhas Current       0.0139       -2.4145       25.5       Subtropical         10. Insular Pacific-Hawaiian       0.0006       23.6974       25.0       Tropical         10. Insular Pacific-Hawaiian       0.0006       23.6974       27.0       Tropical         11. Pacific Central-American       0.0094       8.4143       27.3       Tropical         13. Somali Coastal Current       0.0094       8.4143       27.5       Tropical         12. Caribbean Sea       0.0005       26.7566       27.8       Tropical         13. Somali Coastal Current       0.0085 <td< td=""><td></td><td></td><td></td><td></td><td></td></td<>					
44. West-Central Australia       0.0167       -11.1084       22.4       Subtropical         15. South Brazil Shelf       0.0228       -22.8069       22.9       Subtropical         49. Kuroshio Current       0.0132       -3.4566       23.0       Subtropical         41. East-Central Australia       0.0115       -0.0330       23.0       Subtropical         4. Gulf of California       0.0254       -26.4000       24.5       Subtropical         6. Southeast U.S. Continental Shelf       -0.031       31.0589       24.8       Subtropical         30. Agulhas Current       0.0139       -2.4145       25.5       Subtropical         30. Agulhas Current       0.0038       18.4183       26.1       Subtropical         40. Northeast Australia       0.0095       7.7313       26.7       Tropical         10. Insular Pacific-Hawaiian       0.0095       7.7313       26.7       Tropical         11. Pacific Central American       0.0060       15.4948       27.5       Tropical         23. Arabian Sea       0.0055       26.756       27.8       Tropical         23. Arabian Sea       0.005       26.756       27.8       Tropical         23. Northwest Australia       0.0086       10.5848					
15. South Brazil Shelf       0.0228       -22.8069       22.9       Subtropical         49. Kuroshio Current       0.0132       -3.4566       23.0       Subtropical         41. East-Central Australia       0.0115       -0.0330       23.0       Subtropical         4. Gulf of California       0.0254       -26.4000       24.5       Subtropical         6. Southeast U.S. Continental Shelf       -0.031       31.0589       24.8       Subtropical         30. Agulhas Current       0.0139       -2.4145       25.5       Subtropical         5. Gulf of Mexico       0.0006       23.6974       25.0       Tropical         10. Insular Pacific-Hawaiian       0.0006       23.6974       25.0       Tropical         10. Northeast Australia       0.0095       7.7313       26.7       Tropical         13. Somali Coastal Current       0.0094       8.4143       27.3       Tropical         14. Pacific Central-American       0.0060       15.4948       27.5       Tropical         13. Somali Coastal Current       0.0116       3.9578       27.7       Tropical         12. Caribbean Sea       0.0085       10.5733       27.7       Tropical         13. Northwest Australia       0.0086       10.5848					
49. Kuroshio Current       0.0132       -3.4566       23.0       Subtropical         41. East-Central Australia       0.0115       -0.0330       23.0       Subtropical         4. Gulf of California       0.0254       -26.4000       24.5       Subtropical         6. Southeast U.S. Continental Shelf       -0.031       31.0589       24.8       Subtropical         30. Agulhas Current       0.0139       -2.4145       25.5       Subtropical         5. Gulf of Mexico       0.0038       18.4183       26.1       Subtropical         10. Insular Pacific-Hawaiian       0.0006       23.6974       25.0       Tropical         10. Northeast Australia       0.0095       7.7313       26.7       Tropical         11. Somali Coastal Current       0.0094       8.4143       27.3       Tropical         12. Caribbean Sea       0.0055       10.5733       27.7       Tropical         12. Caribbean Sea       0.0055       26.756       27.8       Tropical         13. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         12. Caribbean Sea       0.0055       26.756       27.8       Tropical         13. North Mestal Matralia       0.0086       10.5848       27.9					
41. East-Central Australia       0.0115       -0.030       23.0       Subtropical         4. Gulf of California       0.0254       -26.4000       24.5       Subtropical         6. Southeast U.S. Continental Shelf       -0.031       31.0589       24.8       Subtropical         30. Agulhas Current       0.0139       -2.4145       25.5       Subtropical         5. Gulf of Mexico       0.006       23.6974       25.0       Tropical         10. Insular Pacific-Hawaiian       0.0005       7.7313       26.7       Tropical         10. Seat Brazil Shelf       0.0116       .9558       27.2       Tropical         11. Pacific-Central-American       0.0060       15.4948       27.5       Tropical         12. Garibbean Sea       0.0055       16.733       27.7       Tropical         23. Northwest Australia       0.0085       10.5733       27.7       Tropical         24. Subtropical       0.0085       10.5733       27.8       Tropical         25. Northwest Australia       0.0086       10.5748       27.8       Tropical         25. Northwest Australia       0.0086       10.5748       27.8       Tropical         26. Northwest Australia       0.0086       10.5748       27.8					
4. Gulf of California       0.0254       -26.4000       24.5       Subtropical         6. Southeast U.S. Continental Shelf       -0.0031       31.0589       24.8       Subtropical         30. Agulhas Current       0.0139       -2.4145       25.5       Subtropical         5. Gulf of Mexico       26.1       Subtropical       26.1       Subtropical         10. Insular Pacific-Hawaiian       0.0006       23.6974       25.0       Tropical         10. Insular Pacific-Hawaiian       0.0095       7.7313       26.7       Tropical         10. East Brazil Shelf       0.0116       3.9558       27.2       Tropical         11. Pacific Central-American       0.0060       15.4948       27.5       Tropical         22. Arabian Sea       0.0005       26.7566       27.8       Tropical         23. Northwest Australia       0.0085       10.5733       27.7       Tropical         24. Subtropical       0.0085       10.5733       27.8       Tropical         25. Northwest Australia       0.0086       10.5848       27.8       Tropical         25. Northwest Australia       0.0086       10.5848       27.8       Tropical         26. South China Sea       0.0163       -4.5643       28.0	41. East-Central Australia				
6. Southeast U.S. Continental Shelf       -0.0031       31.0589       24.8       Subtropical         30. Agulhas Current       0.0139       -2.4145       25.5       Subtropical         5. Gulf of Mexico       0.0038       18.4183       26.1       Subtropical         10. Insular Pacific-Hawaiian       0.0006       23.6974       25.0       Tropical         40. Northeast Australia       0.0095       7.7313       26.7       Tropical         15. East Brazil Shelf       0.0116       3.9558       27.2       Tropical         11. Pacific Central-American       0.0060       15.4948       27.5       Tropical         28. Guinea Current       0.0118       3.8046       27.6       Tropical         29. Arabian Sea       0.0005       26.7566       27.8       Tropical         21. Caribbean Sea       0.0005       26.7566       27.8       Tropical         21. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         32. Red Sea       0.0163       -4.5643       28.0       Tropical         33. Red Sea       0.0065       11.1456       28.2       Tropical         34. Bay of Bengal       0.0102       8.3154       28.7       Tropical	4. Gulf of California				
5. Gulf of Mexico       0.0038       18.4183       26.1       Subtropical         10. Insular Pacific-Hawaiian       0.0006       23.6974       25.0       Tropical         40. Northeast Australia       0.0095       7.7313       26.7       Tropical         16. East Brazil Shelf       0.0116       3.9558       27.2       Tropical         31. Somali Coastal Current       0.0094       8.4143       27.3       Tropical         11. Pacific Central-American       0.0060       15.4948       27.5       Tropical         28. Guinea Current       0.0118       3.8046       27.6       Tropical         20. Arabian Sea       0.0005       26.7566       27.8       Tropical         17. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         18. South China Sea       0.0163       -4.5643       28.0       Tropical         38. Red Sea       0.0065       11.1456       28.2       Tropical         39. North Australia       0.0085       11.1456       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical <td< td=""><td>6. Southeast U.S. Continental Shelf</td><td>-0.0031</td><td>31.0589</td><td>24.8</td><td></td></td<>	6. Southeast U.S. Continental Shelf	-0.0031	31.0589	24.8	
Io. Insular Pacific-Hawaiian         0.0006         23.6974         25.0         Tropical           40. Northeast Australia         0.0095         7.7313         26.7         Tropical           16. East Brazil Shelf         0.0116         3.9558         27.2         Tropical           31. Somali Coastal Current         0.0094         8.4143         27.3         Tropical           17. Pacific Central-American         0.0060         15.4948         27.5         Tropical           28. Guinea Current         0.0118         3.8046         27.6         Tropical           21. Caribbean Sea         0.0085         10.5733         27.7         Tropical           21. Caribbean Sea         0.0086         10.5848         27.8         Tropical           21. Caribbean Sea         0.0044         19.0068         27.9         Tropical           23. North west Australia         0.0044         19.0068         27.9         Tropical           33. Red Sea         0.0060         16.1768         28.1         Tropical           39. North Australia         0.0085         11.1456         28.7         Tropical           38. Indonesian Sea         0.0109         6.9714         28.7         Tropical           38. Indonesian Sea<	30. Agulhas Current	0.0139	-2.4145	25.5	Subtropical
40. Northeast Australia       0.0095       7.7313       26.7       Tropical         16. East Brazil Shelf       0.0116       3.9558       27.2       Tropical         31. Somali Coastal Current       0.0094       8.4143       27.3       Tropical         11. Pacific Central-American       0.0060       15.4948       27.5       Tropical         28. Guinea Current       0.0118       3.8046       27.6       Tropical         21. Caribbean Sea       0.0055       10.5733       27.7       Tropical         21. Caribbean Sea       0.0005       26.7566       27.8       Tropical         25. Northwest Australia       0.0086       10.5848       27.8       Tropical         26. South China Sea       0.0163       -4.5643       28.0       Tropical         38. Red Sea       0.0065       11.1456       28.2       Tropical         39. North Australia       0.0085       11.1456       28.2       Tropical         34. Bay of Bengal       0.0102       8.3154       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         38. Indones	5. Gulf of Mexico	0.0038	18.4183	26.1	Subtropical
40. Northeast Australia       0.0095       7.7313       26.7       Tropical         16. East Brazil Shelf       0.0116       3.9558       27.2       Tropical         31. Somali Coastal Current       0.0094       8.4143       27.3       Tropical         11. Pacific Central-American       0.0060       15.4948       27.5       Tropical         28. Guinea Current       0.0118       3.8046       27.6       Tropical         23. Arabian Sea       0.0050       26.756       27.8       Tropical         12. Caribbean Sea       0.0005       26.756       27.8       Tropical         17. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         36. South China Sea       0.0163       -4.5643       28.0       Tropical         39. North Australia       0.0085       11.1456       28.2       Tropical         34. Bay of Bengal       0.012       8.3154       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         39. South China Sea       0.0109       6.9714       28.7       Tropical         38. Indone	10. Insular Pacific-Hawaiian	0.0006	23.6974	25.0	Tropical
31. Somali Coastal Current       0.0094       8.4143       27.3       Tropical         11. Pacific Central-American       0.0060       15.4948       27.5       Tropical         28. Guinea Current       0.0118       3.8046       27.6       Tropical         22. Arabian Sea       0.0085       10.5733       27.7       Tropical         12. Caribbean Sea       0.0085       10.5733       27.8       Tropical         13. North West Australia       0.0086       10.5848       27.8       Tropical         17. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         36. South China Sea       0.0163       -4.5643       28.0       Tropical         37. North Australia       0.0085       11.1456       28.2       Tropical         39. North Australia       0.0085       11.1456       28.7       Tropical         34. Bay of Bengal       0.0102       8.3154       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         35. Gulf of Thailand       0.0082       12.3672       28.9       Tropical	40. Northeast Australia	0.0095	7.7313	26.7	
11. Pacific Central-American       0.0060       15.4948       27.5       Tropical         28. Guinea Current       0.0118       3.8046       27.6       Tropical         32. Arabian Sea       0.0085       10.5733       27.7       Tropical         12. Caribbean Sea       0.0005       26.7566       27.8       Tropical         45. Northwest Australia       0.0086       10.5848       27.8       Tropical         17. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         36. South China Sea       0.0163       -4.5643       28.0       Tropical         33. Red Sea       0.0060       16.1768       28.1       Tropical         39. North Australia       0.0012       8.3154       28.2       Tropical         34. Bay of Bengal       0.0102       8.3154       28.7       Tropical         35. Gulf of Thailand       0.0082       12.3672       28.9       Tropical	16. East Brazil Shelf		3.9558	27.2	
28. Guinea Current       0.0118       3.8046       27.6       Tropical         32. Arabian Sea       0.0085       10.5733       27.7       Tropical         12. Caribbean Sea       0.0005       26.7566       27.8       Tropical         45. Northwest Australia       0.0086       10.5848       27.8       Tropical         17. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         36. South China Sea       0.0163       -4.5643       28.0       Tropical         33. Red Sea       0.0060       16.1768       28.2       Tropical         39. North Australia       0.0085       11.1456       28.2       Tropical         34. Bay of Bengal       0.0102       8.3154       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         35. Gulf of Thailand       0.0082       12.3672       28.9       Tropical	31. Somali Coastal Current				
32. Arabian Sea       0.0085       10.5733       27.7       Tropical         12. Caribbean Sea       0.0005       26.7566       27.8       Tropical         45. Northwest Australia       0.0086       10.5848       27.8       Tropical         17. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         36. South China Sea       0.0163       -4.5643       28.0       Tropical         33. Red Sea       0.0060       16.1768       28.2       Tropical         39. North Australia       0.0085       11.1456       28.2       Tropical         34. Bay of Bengal       0.0102       8.3154       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         35. Gulf of Thailand       0.0082       12.3672       28.9       Tropical	11. Pacific Central-American				
12. Caribbean Sea       0.0005       26.7566       27.8       Tropical         45. Northwest Australia       0.0086       10.5848       27.8       Tropical         17. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         36. South China Sea       0.0163       -4.5643       28.0       Tropical         33. Red Sea       0.0060       16.1768       28.2       Tropical         34. Bay of Bengal       0.0102       8.3154       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         35. Gulf of Thailand       0.0082       12.3672       28.9       Tropical					
45. Northwest Australia       0.0086       10.5848       27.8       Tropical         17. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         36. South China Sea       0.0163       -4.5643       28.0       Tropical         33. Red Sea       0.0060       16.1768       28.1       Tropical         39. North Australia       0.0085       11.1456       28.2       Tropical         34. Bay of Bengal       0.0102       8.3154       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         35. Gulf of Thailand       0.0082       12.3672       28.9       Tropical					
17. North Brazil Shelf       0.0044       19.0068       27.9       Tropical         36. South China Sea       0.0163       -4.5643       28.0       Tropical         33. Red Sea       0.0060       16.1768       28.1       Tropical         39. North Australia       0.0085       11.1456       28.2       Tropical         34. Bay of Bengal       0.0102       8.3154       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         35. Gulf of Thailand       0.0082       12.3672       28.9       Tropical					
36. South China Sea       0.0163       -4.5643       28.0       Tropical         33. Red Sea       0.0060       16.1768       28.1       Tropical         39. North Australia       0.0085       11.1456       28.2       Tropical         34. Bay of Bengal       0.0102       8.3154       28.7       Tropical         38. Indonesian Sea       0.0109       6.9714       28.7       Tropical         35. Gulf of Thailand       0.0082       12.3672       28.9       Tropical					
33. Red Sea     0.0060     16.1768     28.1     Tropical       39. North Australia     0.0085     11.1456     28.2     Tropical       34. Bay of Bengal     0.0102     8.3154     28.7     Tropical       38. Indonesian Sea     0.0109     6.9714     28.7     Tropical       35. Gulf of Thailand     0.0082     12.3672     28.9     Tropical					
39. North Australia         0.0085         11.1456         28.2         Tropical           34. Bay of Bengal         0.0102         8.3154         28.7         Tropical           38. Indonesian Sea         0.0109         6.9714         28.7         Tropical           35. Gulf of Thailand         0.0082         12.3672         28.9         Tropical					
34. Bay of Bengal         0.0102         8.3154         28.7         Tropical           38. Indonesian Sea         0.0109         6.9714         28.7         Tropical           35. Gulf of Thailand         0.0082         12.3672         28.9         Tropical					
38. Indonesian Sea         0.0109         6.9714         28.7         Tropical           35. Gulf of Thailand         0.0082         12.3672         28.9         Tropical					
35. Gulf of Thailand 0.0082 12.3672 28.9 Tropical	38. Indonesian Sea				
	35. Gulf of Thailand				
	37. Sulu-Celebes Sea	0.0126	3.6460	29.0	Tropical





101

#### Appendix 3-III. Nitrogen losses in the marine compartment

**Table 3.6:** Residence times (from sources or by defined archetype) of the receiving Large Marine ecosystems (LME). *Reference sources listed in the following pages.* 

LME	Residen	ce time	]
#. name	archetype	used [yr]	Reference source
1. East Bering Sea	2	2.00	
2. Gulf of Alaska	1	0.25	
3. California Current	1	0.25	j
4. Gulf of California	1-2	1.50	Lopez & Garcia (2003)
5. Gulf of Mexico	4	90.00	Turner & Rabalais (2009); USGS (2012); Rivas et al. (2005)
6. Southeast U.S. Continental Shelf	1	0.25	Alegria et al. (2000)
7. Northeast U.S. Continental Shelf	1	0.25	1
8. Scotian Shelf	1	0.88	Smith et al. (2003)
9. Newfoundland-Labrador Shelf	1	0.25	
10. Insular Pacific-Hawaiian	1	0.25	i l
11. Pacific Central-American	1	0.25	
12. Caribbean Sea	1	0.21	Molinari et al. (1980)
13. Humboldt Current	1	0.03	Hall et al. (1996)
14. Patagonian Shelf	1	0.25	1
15. South Brazil Shelf	1	0.25	
16. East Brazil Shelf	1	0.25	Attisano et al. (2008)
17. North Brazil Shelf		0.25	Limeburner et al. (1995)
18. West Greenland Shelf	1	0.25	
19. East Greenland Shelf	1	0.25	
20. Barents Sea	2	2.00	
21. Norwegian Sea	2	2.00	
22. North Sea	2	2.00	Blaas et al. (2001)
23. Baltic Sea	1	25.00	Jansson B-O (1980); Matthäus & Schinke (1999)
24. Celtic-Biscay Shelf	2	2.00	
25. Iberian Coastal		0.25	Direct DD (2008)
26. Mediterranean	4	90.00	Pinet PR (2008)
27. Canary Current	1 2	0.25	Hell st sl. (1000)
28. Guinea Current		3.10	Hall et al. (1996)
29. Benguela Current	1	0.25 2.00	
30. Agulhas Current 31. Somali Coastal Current		0.25	Naqvi (2012)
32. Arabian Sea	2-3	6.50	Sarma (2002)
33. Red Sea	2-3	40.00	Smeed (2010); Grasshoff (1969); Tomczak & Godfrey (2003)
34. Bay of Bengal	2-3	12.00	Sarma (2002)
35. Gulf of Thailand	1-2	0.04	IDulaiova et al. (2006)
36. South China Sea	3	25.00	
37. Sulu-Celebes Sea	3	25.00	Tessler (2012); Tessler et al. (2011).
38. Indonesian Sea	1-2	0.75	Ffield & Gordon (1992)
39. North Australia	1	0.25	
40. Northeast Australia	1	0.25	Choukroun et al. (2010)
41. East-Central Australia	1	0.25	
42. Southeast Australia	1 1	0.25	
43. Southwest Australia	1	0.25	
44. West-Central Australia	1	0.25	
45. Northwest Australia	1	0.25	
46. New Zealand Shelf	1	0.25	
47. East China Sea		1.90	Tsunogai et al. (1997); Tomczak & Godfrey (2003); Hall et al. (1996)
48. Yellow Sea		2.00	Tsunogai et al. (1997); Tomczak & Godfrey (2003)
49. Kuroshio Current	1	2.30	Matsuno et al. (2009)
50. Sea of Japan/East Sea	3	25.00	
51. Oyashio Current	1	0.25	1
52. Sea of Okhotsk	2	2.00	Yamamoto et al. (2001)
53. West Bering Sea	1	0.25	
54. Chukchi Sea		3.50	Schlosser et al. (1994)
55. Beaufort Sea		3.50	ISchlosser et al. (1994)
56. East Siberian Sea	1	3.50	Schlosser et al. (1994)
57. Laptev Sea	1	3.50	Schlosser et al. (1994)
58. Kara Sea	1	3.50	Schlosser et al. (1994)
59. Iceland Shelf	1	0.25	
60. Faroe Plateau	1	0.25	Gaard (2000)
61. Antarctic	2-3	6.00	Jacobs et al. (1985)
62. Black Sea	4	90.00	Murray et al. (2007)
63. Hudson Bay	2-3	6.60	Ingram & Prinsenberg (1998)
64. Arctic Ocean	2-3	11.00	Jahn et al. (2010)

Continental shelves' bathymetry consulted from Liu et al. (2012).





#### References used to compile the LMEs' residence time:

- Alegria HA, D'Autel JP & Shaw TJ (2000). Offshore Transport of Pesticides in the South Atlantic Bight: Preliminary Estimate of Export Budgets. Marine Pollution Bulletin 40(12): 1178-1185.
- Attisano KK, Niencheski LFH, Milani ICB, Machado CS, Milani MR, Zarzur S & Andrade CFF (2008). Evidences of continental groundwater inputs to the shelf zone in Albardão, RS, Brazil. Brazilian Journal of Oceanography 56(3): 189-200.
- Blaas M, Kerkhoven D & de Swart HE (2001). Large-scale circulation and flushing characteristics of the North Sea under various climate forcings. Climate Research 18: 47–54.
- Choukroun S, Ridd PV, Brinkman R & McKinna LIW (2010). On the surface circulation in the western Coral Sea and residence times in the Great Barrier Reef. Journal of Geophysical Research 115, C06013.
- Dulaiova H, Burnett WC, Wattayakorn G & Sojisuporn P (2006). Are groundwater inputs into riverdominated areas important? The Chao Phraya River – Gulf of Thailand. Limnology and Oceanography 51(5): 2232–2247.
- Ffield A & Gordon AL (1992). Vertical mixing in the Indonesian Thermocline. Journal of Physical Oceanography 22: 184–195.
- Gaard E (2000). Seasonal abundance and development of Calanus finmarchicus in relation to phytoplankton and hydrography on the Faroe Shelf. ICES Journal of Marine Science 57: 1605–16711.
- Gordon AL, Tessler ZD & Villanoy C (2011). Dual overflows into the deep Sulu Sea. Geophysical Research Letters 38, L18606.
- Grasshoff K (1969). Chemical observations in the Red Sea and the inner Gulf of Aden during the International Indian Ocean Expedition 1964/65. Supplement to: Grasshoff K (1969): Zur Chemie des Roten Meeres und des Inneren Golfs von Aden nach Beobachtungen von F.S. "Meteor" während der Indischen Ozean Expedition 1964/65. Meteor Forschungsergebnisse, Deutsche Forschungsgemeinschaft, Reihe A Allgemeines, Physik und Chemie des Meeres, Gebrüder Bornträger, Berlin, Stuttgart, A6: 1-76.
- Hall J, Smith SV & Boudreau PR (eds.) (1996). "Report on the International Workshop on Continental Shelf Fluxes of Carbon, Nitrogen and Phosphorus". LOICZ/R&S/96-9. LOICZ, Texel, The Netherlands.
- Ingram RG & Prinsenberg S (1998). Chapter 29. Coastal oceanography of Hudson Bay and surrounding eastern Canadian arctic waters coastal segment. In Allan R Robinson & Kenneth H Brink (eds.), "The Sea Volume 11". John Wiley & Sons, Inc.
- Jacobs SS, Fairbanks RG & Horibe YG (1985). Origin and evolution of water masses near the Antarctic continental margin: Evidence from H218O/H216O ratios in seawater. In S. Jacobs (ed), "Oceanology of the Antarctic Continental Shelf", AGU, Washington, D.C., Antarctic Research Series 43: 59–85.
- Jahn A, Tremblay LB, Newton R, Holland MM, Mysak LA & Dmitrenko IA (2010). A tracer study of the Arctic Ocean's liquid freshwater export variability. Journal of Geophysical Research 115, C07015.
- Jansson B-O. 1980. Natural Systems of the Baltic Sea. Ambio 9: 128.
- Limeburner R, Beardsley RC, Soares ID, Lentz SJ & Candela J (1995). Lagrangian flow observations of the Amazon River discharge into the North Atlantic. Journal of Geophysical Research 100(C2): 2401–2415.
- Liu K-K, Dittert N, Lei KR, Kremer HH & Maddison L (2012). Web-based Resources for Continental Margins Biogeochemical Research and Education. Retrieved from
  - http://cmtt.tori.org.tw/data/App\_map/maplist.htm on 12/09/2012.
- Lopez M & Garcia J (2003). Moored observations in the northern Gulf of California: A strong bottom current. Journal of Geophysical Research 108(C2): 3048.
- Matthäus W & Schinke H (1999). The influence of river runoff on deep water conditions of the Baltic Sea. Hydrobiologia 393: 1–10.
- Matsuno T, Lee J-S & Yanao S (2009). Influence of the Kuroshio on the water properties in the shelf. Ocean Science Discussions 6: 741–764.





Molinari RL, Atwood DK, Duckett C, Spillane M & Brooks I (1980). Surface currents in the Caribbean Sea as deducted from satellite tracked drifting buoys. Proceedings of the 32nd Annual Gulf and Caribbean Fisheries Institute 106-113.

Murray JW, Stewart K, Kassakian S, Krynytzky M & DiJulio D (2007). Oxic, suboxic, and anoxic conditions in the Black Sea. In V Yanko-Hombach, AS Gilbert, N Panin & PM Dolukhanov (eds), "The Black Sea Flood Question: Changes in Coastline, Climate and Human Settlement". Springer, pp. 1-22.

Naqvi W (2012). Intensification of seasonal oxygen-deficient zone over the western Indian shelf. Retrieved from http://www.unep.org/stap/Portals/61/stap/Naqvi.pdf on 12/09/2012.

Pinet PR (2008). "Invitation to Oceanography". Jones & Barlett Learning, 220 pp.

Rivas D, Badan A & Ochoa J (2005): The Ventilation of the Deep Gulf of Mexico. Journal of Physical Oceanography 35: 1763–1781.

Sarma VVSS (2002). An evaluation of physical and biogeochemical processes regulating perennial suboxic conditions in the water column of the Arabian Sea. *Global Biogeochemical Cycles* **16**(4): 1082.

Schlosser P, Bauch D, Bonisch G & Fairbanks RF (1994). Arctic river-runoff: mean residence time on the shelves and in the halocline. *Deep-Sea Research I* **41**(7): 1053–1068.

Smeed D (2010). The circulation of the Red Sea. *Red Sea Research Workshop: Past & Present*. Retrieved from http://krse.kaust.edu.sa/spring-2010/downloads/David%20Smeed\_Southampton.pdf on 12/09/2012.

Smith PC, Flagg CN, Limeburner R, Fuentes-Yaco C, Hannah C, Beardsley RC & Irish JD (2003). Scotian Shelf crossovers during winter/spring 1999. *Journal of Geophysical Research* **108**: 8013.

Tessler ZD (2012). "*Still overflow processes in the Philippine Archipelago*". PhD Thesis. Columbia University. Retrieved from http://academiccommons.columbia.edu/catalog/ac%3A143841 on 12/09/2012.

Tomczak M & Godfrey JS (2003). "*Regional Oceanography: an Introduction*". 2<sup>nd</sup> edition. Pergamon. Tsunogai S, Watanabe S, Nakamura J, Ono T & Sato T (1997). A Preliminary Study of Carbon System in the East China Sea. *Journal of Oceanography* **53**: 9-17.

Turner E & Rabalais N (2009). 2009 Forecast of the Summer Hypoxic Zone Size, Northern Gulf of Mexico. Retrieved from

http://www.gulfhypoxia.net/research/Shelfwide%20Cruises/2009/Files/2009\_Hypoxia\_Forecast.pdf on 12/09/2012.

USGS (2012). Streamflow and Nutrient Delivery to the Gulf of Mexico for October 2011 to May 2012 (Preliminary). Retrieved from http://toxics.usgs.gov/hypoxia/mississippi/oct\_jun/index.html on 12/09/2012.

Yamamoto M, Tanaka N & Tsunogai S (2001). Okhotsk Sea intermediate water formation deduced from oxygen isotope systematics. *Journal of Geophysical Research* **106**(C12): 31075–31084.





**Table 3.7:** Estimation of the Nitrogen loss rate coefficient ( $\lambda$ ) in marine coastal waters.

LME		Loss rate	Adv	Denitr	Sedim	Adv	Denitr	Sedim
#. name	unit:	d <sup>-1</sup>	d	d <sup>-1</sup>	d <sup>-1</sup>	yr	yr <sup>-1</sup>	yr⁻¹
1. East Bering Sea	1	2.49E-03	7.31E+02	9.77E-04	1.40E-04	2.00	0.36	0.05
2. Gulf of Alaska	2	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
3. California Current	3	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
4. Gulf of California	4	2.94E-03	5.48E+02	9.77E-04	1.40E-04	1.50	0.36	0.05
5. Gulf of Mexico	5	1.15E-03	3.29E+04	9.77E-04	1.40E-04	90.00	0.36	0.05
6. Southeast U.S. Continental Shelf	6	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
7. Northeast U.S. Continental Shelf	7	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
8. Scotian Shelf	8	4.25E-03	3.20E+02	9.77E-04	1.40E-04	0.88	0.36	0.05
9. Newfoundland-Labrador Shelf	9	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
10. Insular Pacific-Hawaiian	10	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
11. Pacific Central-American	11	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
12. Caribbean Sea	12	1.44E-02	7.51E+01	9.77E-04	1.40E-04	0.21	0.36	0.05
13. Humboldt Current	13	9.20E-02	1.10E+01	9.77E-04	1.40E-04	0.03	0.36	0.05
14. Patagonian Shelf	14	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
15. South Brazil Shelf	15	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
16. East Brazil Shelf	16	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
17. North Brazil Shelf	17	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
18. West Greenland Shelf	18	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
19. East Greenland Shelf	19	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
20. Barents Sea	20	2.49E-03	7.31E+02	9.77E-04	1.40E-04	2.00	0.36	0.05
21. Norwegian Sea	21	2.49E-03	7.31E+02	9.77E-04	1.40E-04	2.00	0.36	0.05
22. North Sea	22	2.49E-03	7.31E+02	9.77E-04	1.40E-04	2.00	0.36	0.05
23. Baltic Sea	23	1.23E-03	9.13E+03	9.77E-04	1.40E-04	25.00	0.36	0.05
24. Celtic-Biscay Shelf	24	2.49E-03	7.31E+02	9.77E-04	1.40E-04	2.00	0.36	0.05
25. Iberian Coastal	25	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
26. Mediterranean	26	1.15E-03	3.29E+04	9.77E-04	1.40E-04	90.00	0.36	0.05
27. Canary Current	27	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
28. Guinea Current	28	2.00E-03	1.13E+03	9.77E-04	1.40E-04	3.10	0.36	0.05
29. Benguela Current	29	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
30. Agulhas Current	30	2.49E-03	7.31E+02	9.77E-04	1.40E-04	2.00	0.36	0.05
31. Somali Coastal Current	31	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
32. Arabian Sea	32	1.54E-03	2.37E+03	9.77E-04	1.40E-04	6.50	0.36	0.05
33. Red Sea	33	1.19E-03	1.46E+04	9.77E-04	1.40E-04	40.00	0.36	0.05
34. Bay of Bengal	34	1.35E-03	4.38E+03	9.77E-04	1.40E-04	12.00	0.36	0.05

104





LME		Loss rate	Adv	Denitr	Sedim	Adv	Denitr	Sedim
#. name	unit:	d <sup>-1</sup>	d	d <sup>-1</sup>	d <sup>-1</sup>	yr	yr <sup>-1</sup>	yr <sup>-1</sup>
35. Gulf of Thailand	35	7.25E-02	1.40E+01	9.77E-04	1.40E-04	0.04	0.36	0.05
36. South China Sea	36	1.23E-03	9.13E+03	9.77E-04	1.40E-04	25.00	0.36	0.05
37. Sulu-Celebes Sea	37	1.23E-03	9.13E+03	9.77E-04	1.40E-04	25.00	0.36	0.05
38. Indonesian Sea	38	4.77E-03	2.74E+02	9.77E-04	1.40E-04	0.75	0.36	0.05
39. North Australia	39	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
40. Northeast Australia	40	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
41. East-Central Australia	41	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
42. Southeast Australia	42	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
43. Southwest Australia	43	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
44. West-Central Australia	44	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
45. Northwest Australia	45	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
46. New Zealand Shelf	46	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
47. East China Sea	47	2.56E-03	6.94E+02	9.77E-04	1.40E-04	1.90	0.36	0.05
48. Yellow Sea	48	2.49E-03	7.31E+02	9.77E-04	1.40E-04	2.00	0.36	0.05
49. Kuroshio Current	49	2.31E-03	8.40E+02	9.77E-04	1.40E-04	2.30	0.36	0.05
50. Sea of Japan/East Sea	50	1.23E-03	9.13E+03	9.77E-04	1.40E-04	25.00	0.36	0.05
51. Oyashio Current	51	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
52. Sea of Okhotsk	52	2.49E-03	7.31E+02	9.77E-04	1.40E-04	2.00	0.36	0.05
53. West Bering Sea	53	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
54. Chukchi Sea	54	1.90E-03	1.28E+03	9.77E-04	1.40E-04	3.50	0.36	0.05
55. Beaufort Sea	55	1.90E-03	1.28E+03	9.77E-04	1.40E-04	3.50	0.36	0.05
56. East Siberian Sea	56	1.90E-03	1.28E+03	9.77E-04	1.40E-04	3.50	0.36	0.05
57. Laptev Sea	57	1.90E-03	1.28E+03	9.77E-04	1.40E-04	3.50	0.36	0.05
58. Kara Sea	58	1.90E-03	1.28E+03	9.77E-04	1.40E-04	3.50	0.36	0.05
59. Iceland Shelf	59	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
60. Faroe Plateau	60	1.21E-02	9.13E+01	9.77E-04	1.40E-04	0.25	0.36	0.05
61. Antarctic	61	1.57E-03	2.19E+03	9.77E-04	1.40E-04	6.00	0.36	0.05
62. Black Sea	62	1.15E-03	3.29E+04	9.77E-04	1.40E-04	90.00	0.36	0.05
63. Hudson Bay	63	1.53E-03	2.41E+03	9.77E-04	1.40E-04	6.60	0.36	0.05
64. Arctic Ocean	64	1.37E-03	4.02E+03	9.77E-04	1.40E-04	11.00	0.36	0.05





106

#### Appendix 3-IV: Nitrogen conversion in the photic zone

#### **Table 3.8:** Calculation of the Nitrogen Incorporation Efficiency (NIE) coefficient.

LME	LME Area	РР	DIN	EmpN <sub>input</sub> /∞ <sub>LME</sub>	EmpN <sub>input</sub>	TheorN <sub>input</sub>	NIE
unit:	km <sup>2</sup>	gC·m <sup>-2</sup> ·yr <sup>-1</sup>	molDIN·m <sup>-2</sup> ·yr <sup>-1</sup>	gN·m⁻²·yr⁻¹	gN·yr⁻¹	gN·γr⁻¹	[-]
#. name				logDIN + 2.332		(gC*m <sup>-2</sup> *y <sup>-1</sup> )*(gN/gC)*m <sup>2</sup>	EmpN/ThN
1. East Bering Sea	1,193,601	285.43	1.903	66.63	7.95E+13	6.00E+13	1.326
2. Gulf of Alaska	1,491,252	330.69	2.655	92.96	1.39E+14	8.68E+13 8.76E+13	1.597
<ol> <li>California Current</li> <li>Gulf of California</li> </ol>	2,224,665 216,344	223.75 437.64	1.097 5.004	38.41 175.24	8.54E+13 3.79E+13	1.67E+13	0.975 2.275
5. Gulf of Mexico	42,846	208.05	0.930	32.58	1.40E+12	1.57E+12	0.890
6. Southeast U.S. Continental Shelf	303,029	263.17	1.583	55.45	1.68E+13	1.40E+13	1.197
7. Northeast U.S. Continental Shelf	308,554	560.64	8.764	306.90	9.47E+13	3.05E+13	3.110
8. Scotian Shelf	412,676	509.18	7.049	246.83	1.02E+14	3.70E+13	2.754
9. Newfoundland-Labrador Shelf	674,862	295.29	2.055	71.95	4.86E+13	3.51E+13	1.384
10. Insular Pacific-Hawaiian	975,493	84.68	0.122	4.26	4.16E+12	1.45E+13	0.286
11. Pacific Central-American	1,996,659	243.82	1.332	46.65	9.31E+13	8.57E+13	1.087
12. Caribbean Sea	3,305,077	174.47	0.625	21.88	7.23E+13	1.02E+14	0.712
13. Humboldt Current	2,619,386	319.74	2.460	86.14	2.26E+14	1.47E+14	1.531
14. Patagonian Shelf	1,173,332	509.18	7.049	246.83	2.90E+14	1.05E+14	2.754
15. South Brazil Shelf	566,397	282.88	1.865	65.29	3.70E+13	2.82E+13	1.311
16. East Brazil Shelf	1,073,210	130.31	0.323	11.30	1.21E+13	2.46E+13	0.493
17. North Brazil Shelf	1,034,575	442.02	5.118	179.23	1.85E+14	8.05E+13	2.304
18. West Greenland Shelf	359,422	151.84	0.456	15.98	5.74E+12 2.56E+13	9.61E+12	0.598
19. East Greenland Shelf	1,176,522 2,023,335	174.11	0.622 0.451	21.78 15.80	2.56E+13 3.20E+13	3.61E+13 5.38E+13	0.711
20. Barents Sea 21. Norwegian Sea	2,023,335 1,109,613	151.11 179.22	0.451	23.25	2.58E+13	3.50E+13	0.594 0.737
22. North Sea	690,041	406.98	4.246	148.68	1.03E+14	4.94E+13	2.075
23. Baltic Sea	396,838	697.15	14.350	502.48	1.03L+14 1.99E+14	4.87E+13	4.095
24. Celtic-Biscay Shelf	766,550	348.94	2.998	104.98	8.05E+13	4.71E+13	1.709
25. Iberian Coastal	300,915	276.67	1.773	62.10	1.87E+13	1.47E+13	1.275
26. Mediterranean	2,528,398	157.68	0.497	17.40	4.40E+13	7.02E+13	0.627
27. Canary Current	1,120,439	436.54	4.976	174.25	1.95E+14	8.61E+13	2.268
28. Guinea Current	1,958,802	357.70	3.171	111.03	2.17E+14	1.23E+14	1.763
29. Benguela Current	1,470,134	506.26	6.958	243.64	3.58E+14	1.31E+14	2.734
30. Agulhas Current	2,615,294	220.83	1.065	37.29	9.75E+13	1.02E+14	0.959
31. Somali Coastal Current	844,524	249.30	1.401	49.06	4.14E+13	3.71E+13	1.118
32. Arabian Sea	3,950,421	390.19	3.860	135.16	5.34E+14	2.71E+14	1.968
33. Red Sea	480,385	298.21	2.101	73.57	3.53E+13	2.52E+13	1.402
34. Bay of Bengal	3,657,502	264.99	1.608	56.32	2.06E+14	1.71E+14	1.207
35. Gulf of Thailand	391,665	284.70	1.892	66.25	2.59E+13	1.96E+13	1.322
36. South China Sea	5,662,985	174.11	0.622	21.78	1.23E+14	1.74E+14	0.711
37. Sulu-Celebes Sea	1,015,737	209.15	0.942	32.97	3.35E+13	3.74E+13	0.896
38. Indonesian Sea 39. North Australia	2,289,597 772,214	263.53 328.50	1.588 2.615	55.62 91.57	1.27E+14 7.07E+13	1.06E+14 4.47E+13	1.199 1.584
40. Northeast Australia	1,299,112	130.67	0.325	11.38	1.48E+13	2.99E+13	0.495
41. East-Central Australia	660,679	157.32	0.494	17.31	1.48L+13 1.14E+13	1.83E+13	0.625
42. Southeast Australia	1,199,787	186.88	0.730	25.56	3.07E+13	3.95E+13	0.777
43. Southwest Australia	1,046,368	180.68	0.676	23.68	2.48E+13	3.33E+13	0.745
44. West-Central Australia	543,577	173.74	0.619	21.67	1.18E+13	1.66E+13	0.709
45. Northwest Australia	911,812	185.79	0.720	25.22	2.30E+13	2.98E+13	0.771
46. New Zealand Shelf	980,420	208.05	0.930	32.58	3.19E+13	3.59E+13	0.890
47. East China Sea	1,008,066	325.22	2.556	89.52	9.02E+13	5.77E+13	1.564
48. Yellow Sea	438,619	588.75	9.790	342.82	1.50E+14	4.55E+13	3.308
49. Kuroshio Current	1,333,074	154.03	0.471	16.50	2.20E+13	3.61E+13	0.609
50. Sea of Japan/East Sea	1,054,305	220.46	1.061	37.15	3.92E+13	4.09E+13	0.957
51. Oyashio Current	663,609	261.34	1.559	54.58	3.62E+13	3.05E+13	1.186
52. Sea of Okhotsk	1,627,284	297.48	2.089	73.16	1.19E+14	8.52E+13	1.397
53. West Bering Sea 54. Chukchi Sea	2,182,768	213.89	0.991	34.69	7.57E+13	8.22E+13	0.921
55. Beaufort Sea	783,245 664,752	90.89 118.99	0.143 0.263	5.00 9.20	3.92E+12 6.12E+12	1.25E+13 1.39E+13	0.313 0.439
56. East Siberian Sea	1,024,100	54.39	0.203	9.20 1.57	1.60E+12	9.80E+12	0.164
57. Laptev Sea	539,035	156.59	0.489	17.13	9.23E+12	1.49E+13	0.621
58. Kara Sea	970,089	126.66	0.303	10.60	1.03E+13	2.16E+13	0.475
59. Iceland Shelf	521,237	201.12	0.862	30.18	1.57E+13	1.85E+13	0.852
60. Faroe Plateau	151,005	154.03	0.471	16.50	2.49E+12	4.09E+12	0.609
61. Antarctic	3,486,169	99.65	0.176	6.16	2.15E+13	6.11E+13	0.351
62. Black Sea	461,398	376.32	3.556	124.54	5.75E+13	3.06E+13	1.880
63. Hudson Bay	1,247,246	152.57	0.461	16.15	2.01E+13	3.35E+13	0.601
64. Arctic Ocean	3,522,239	8.40	0.001	0.02	8.05E+10	5.21E+12	0.015





#### Appendix 3-V: Testing normality of species sensitivity data: goodness-of-fit test

The goodness-of-fit tests focus on testing the hypothesis (H<sub>0</sub>) of a given sample (sensitivity data in the present case) being part of a population with a distribution function f(x). Common statistical goodness-of-fit tests (or tests for distributional adequacy) include the chi-square ( $\chi^2$ ) tests (such as Pearson's chi-square test), EDF-based tests (such as the Kolmogorov–Smironov (K-S) test, and the Anderson-Darling (A-D) test), and regression and correlation tests (such as the Shapiro-Wilk test).

The classical option would be the  $\chi^2$ -tests, but the limited amount of data for certain concentrationclasses hinders its application. Another alternative is the use of the empirical distribution function (EDF) statistics, which are based on the sample distribution function  $f_n(x)$  with the comparison of f(x) (Stephens 1979), meaning that if  $f_n(x)$  is shown as part of f(x) and that this latter is normally (or log-normally) distributed, then  $f_n(x)$  is also normally (or log-normally) distributed (as required to proceed with SSD). Additionally, EDF tests were shown more powerful than other tests (including the  $\chi^2$ -test) (Stephens 1976), and the Anderson-Darling (A-D) test is one of the most powerful of the EDF tests (Stephens 1974). The A-D test (Anderson & Darling 1952) is a more sensitive modification of the K-S test, putting more weight to the tails and calculating critical values (Stephens 1974).

The A-D test aims at reducing errors in the stochastic progress using a "test statistic of the sum of squares of the differences between the empirical and theoretical distribution functions with a weight function that emphasizes discrepancies in both tails" (Shin 2012, 105). This method concludes on the goodness-of-fit by comparing the ideal probability density function (PDF) (population's) and the empirical density function (EDF) (data's), and it is defined and calculated as shown in Box 3.1.

#### Box 3.1. Anderson-Darling goodness-of-fit statistical test

Test distribution function (PDF of a standard normal distribution, with mean  $\mu$  and standard deviation  $\sigma$ ):

$$F(x) = \frac{1}{\sigma\sqrt{2\pi}} \cdot e^{-\left(\frac{(x-\mu)^2}{2\sigma^2}\right)}$$

 $H_0$ : The lognormal sample data are normally distributed, *i.e.* no significant departure from normality is found on the distribution of sensitivity data (logEC<sub>50</sub> values).

 $H_a$ : The lognormal sample data are not normally distributed.

The equation for the test statistic is:

$$A^{2} = -n - 2\sum_{i=1}^{n} \left[ \left( \frac{1 - 0.5}{n} \right) \cdot \ln(z_{i}) + \left( 1 - \left( \frac{1 - 0.5}{n} \right) \right) \cdot \ln(1 - z_{i}) \right]$$

Where:

With:

$$z_i = \Phi\left(\frac{(x_i - \bar{x})}{s}\right)$$
  $\bar{x} = \frac{1}{n} \cdot \sum_{i=1}^n x_i$  and  $s = \sqrt{\frac{1}{n-1} \cdot \sum_{i=1}^n (x_i - \bar{x})^2}$ 

And the function  $\Phi_{(x)}$  is the cumulative distribution function (CDF) of the standard normal PDF.  $\Phi_{(x)}$  is also available in MSExcel as NORMDIST(x) for a standard normal distribution of mean x and standard deviation s.

As both the mean ( $\mu$ ) and variance ( $\sigma^2$ ) are unknown, D'Agostino (1986) proposed a modified A-D test (A<sup>\*2</sup>):

$$A^{*2} = A^2 \left( 1 + \frac{0.75}{n} + \frac{2.25}{n^2} \right)$$

Normality is rejected if  $A^{*2}$  exceeds the critical value.





The test was applied to the lognormal data referring to the 5 climate zones for a significance level of 5% ( $\alpha$ =0.05) with a critical value of 0.752. Therefore, at the critical region of the distribution, normality is rejected (H<sub>0</sub>) if  $A^2$  > 0.752. The results are shown in Table 3.9.

The log-normality test applied to the 'global' region was performed for a significance level of 10% ( $\alpha$ =0.1) with a critical value of 0.631. The result is shown in Table 3.9.

**Table 3.9.** Results of the Anderson-Darling test (modified version) for good-of-fitness statistics of the sensitivity data per geographical unit.

Region	α	Crit. value	A* <sup>2</sup>	H <sub>o</sub>	Result
Global	0.1	0.631	0.268	$\checkmark$	Log-normality of data not discarded
Climate zone	α	Crit. value	A* <sup>2</sup>	Ho	Result
Polar	0.05	0.752	0.646	√	Log-normality of data not discarded
Cubaclas	0.05	0.752	0.750	×	Log-normality rejected with 95% confidence
Subpolar	0.025	0.873	0.756	$\checkmark$	Log-normality of data not discarded ( $\alpha$ =0.025)
Temperate	0.05	0.752	0.309	$\checkmark$	Log-normality of data not discarded
Subtropical	0.05	0.752	0.320	$\checkmark$	Log-normality of data not discarded
Tropical	0.05	0.752	0.585	$\checkmark$	Log-normality of data not discarded

The A-D test results show that the distribution of the sensitivity data (EC<sub>50</sub>) for the 'Global' region at a 90% significance level has no significant departures from normality. Similarly, log-normality cannot be rejected for the data from all the climate zones at a significant level of 5%, except for the 'Subpolar' climate zone, which failed the normality test at this level. The rejection of normality for the 'Subpolar' climate zone may be related to the number of highly tolerant species (*ca.* 40% of species show HC<sub>50</sub>  $\leq$ 1 mg/L) and occurrence of several ties in the data.





#### Appendix 3-VI: Generation of Species Sensitivity Distributions (SSD)

The estimation of Species Sensitivity Distributions (SSD) curves used the USEPA's SSD generator (USEPA 2004) for its easiness of application and transparent calculations.

Briefly the method involves three basic steps (USEPA 2004):

- a) Selection of data for the exposure intensities at which different species exhibit a standard response to the stressor.
- b) Calculation of proportions by first ranking these data from lowest to highest, then converting ranks to proportions:  $Proportion = \frac{rank-0.5}{NumSpecies}$
- c) Fitting a statistical or empirical distribution to:

Proportion (Y axis) vs. Stressor Intensity (X axis)

The following steps of the calculations (Box 3.2) are directly extracted from the generator's "How are SSDs generated" page.

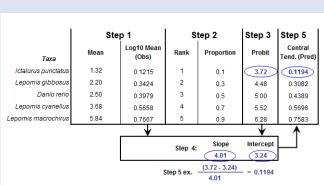
#### Box 3.2. Generation of SSDs (USEPA 2004).

**A** – Regress  $log_{10} Mean(X axis) * Probit(Y axis)$  to obtain central tendency.

1) Calculate the *Mean* and log10 of the mean for each taxon (Obs). A geometric mean may be more appropriate for highly skewed data, but this may give an outlier excessive weight if there are few data.

The arithmetic mean is given by:  $(x_1 + x_2 + x_3 \dots x_n)/n$ The geometric mean is given by:  $(x_1 * x_2 * x_3 \dots x_n)^{1/n}$ 

- 2) Convert ranks to proportions:  $Proportion = \frac{rank-0.5}{NumSpecies}$
- 3) Transform proportions to probit. The probit is the inverse cumulative distribution function of the normal distribution with a mean of 5 and a standard deviation of 1. A mean of 5 is chosen to ensure that all probit values are non-negative.
- 4) Calculate the slope and intercept for:  $log_{10} Mean(X axis) * Probit(Y axis)$
- 5) Calculate the  $log_{10}$  CentralTendency (Pred) for the regression line:



 $log_{10} CentralTendency = \frac{Probit - Intercept}{Slope}$ 

B - Calculate Prediction Intervals (after Neter et al. 1990).

6) Calculate the *Mean Squared Error* (*MSE*): For each taxon, subtract the observed  $\log_{10} Mean(Obs)$  from the  $\log_{10} CentralTendency(Pred)$ , square, add these values and divide by n - 2. In this case with 5 taxa, divide by 3.





- 7) Calculate the *Corrected Sum of Squares* (*CSSQ*): For each taxon, square each probit value then sum (this is the sum of squares). Next, sum the probit values for all taxa, square that and divide by the number of taxa (this is the average sum squared). Subtract the average sum squared from the total sum of squares to get the CSSQ.
- 8) Calculate the *GrandMean* this is the average of all  $log_{10}$  exposure values.
- 9) Calculate the *PointError*:

$$\frac{MSE}{Slope^2} * (1 + \frac{1}{n} + \frac{(Pred - GrandMean)^2}{CSSQ})$$

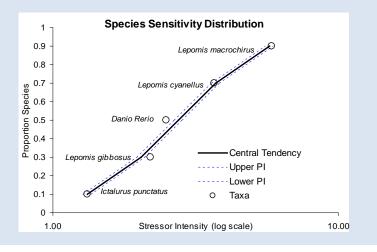
10) Calculate the prediction intervals (*PI*) using the critical t value (for n = 5, tCrit = 2.02)

 $\log_{10} PI = \log_{10} CentralTendency \pm t_{crit} * \sqrt{PointError}$ 

11) Back convert from log value:  $10^{value}$ 

	Step 6	Step 7	Step 9	Step	10		Step 11	
Таха	(Obs-Pred) <sup>2</sup>	Probit <sup>2</sup>	Point Error	log10 Upper Pl	log 10 Lower Pl	Central Tendency	Upper PI	Lower Pl
Ictalurus punctatus	4.13E-06	13.83	4.48E-05	0.13	0.11	1.32	1.36	1.28
Lepomis gibbosus	1.17E-03	20.03	4.40E-05	0.32	0.29	2.03	2.10	1.97
Danio rerio	1.68E-03	25.00	4.38E-05	0.45	0.43	2.75	2.83	2.66
Lepomis cyanellus	1.40E-05	30.52	4.40E-05	0.58	0.56	3.71	3.83	3.60
Lepomis macrochirus	7.03E-05	39.46	4.48E-05	0.77	0.74	5.73	5.91	5.56
MSE	<b>Ξ Σ/n =</b> 5.88E-04	Σ =128.83					_	
	n = 125.00	Step 8: 0	Step 8: Grand Mean ΣObs/n = 0.44					
	CSSQ =	3.83					-	

Plot results: (example with the data and calculations above)

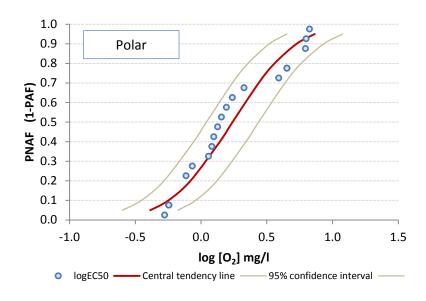


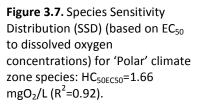


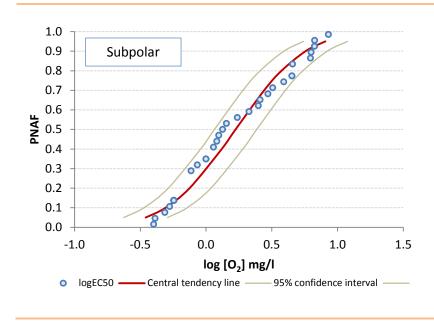


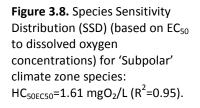
#### Appendix 3-VII: Species Sensitivity Distribution (SSD) curves

The Potentially Not-Affected Fraction of species (PNAF) is introduced instead of Potentially Affected Fraction of species (PAF), where PNAF=1-PAF, as the environmental stressor is hypoxia, thus meaning that a higher effect is expected with decreasing concentration of dissolved oxygen (instead of increasing concentration of a traditional contaminant).



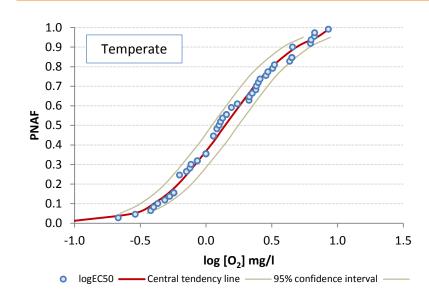


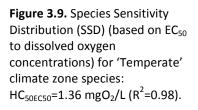


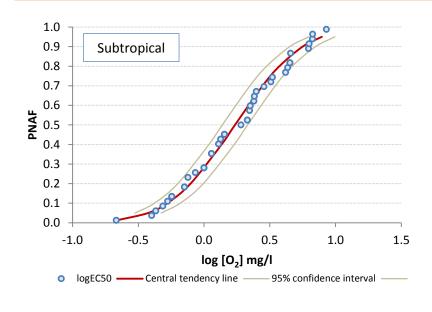


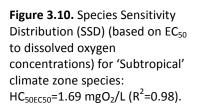
















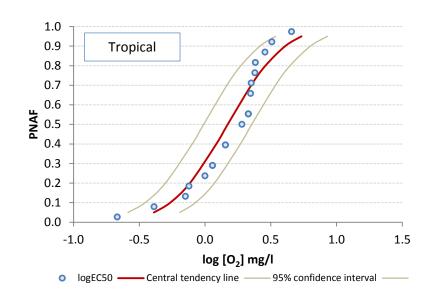
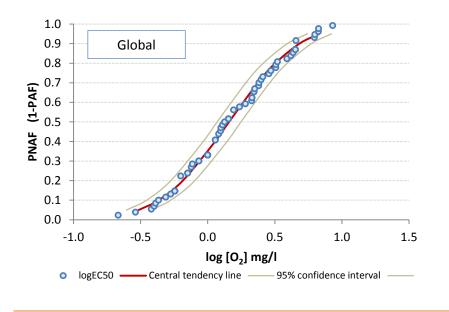


Figure 3.11. Species Sensitivity Distribution (SSD) (based on  $EC_{50}$ to dissolved oxygen concentrations) for 'Tropical' climate zone species:  $HC_{50EC50}$ =1.46 mgO<sub>2</sub>/L (R<sup>2</sup>=0.91).



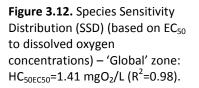


Table 3.10: Summarised results obtained from the Species Sensitivity Distribution (SSD) method.

									mgO <sub>2</sub> /L	kgO <sub>2</sub> /m <sup>3</sup>	PAF.m <sup>3</sup> /kgO <sub>2</sub>
Climate zone	LME	taxa	n	α	β	Slope	Inters.	R <sup>2</sup>	HC50	mg/L	EF
Polar	11	20	20	0.220	0.344	2.632	4.371	0.924	1.661	1.66E-03	3.01E+02
Subpolar	7	33	33	0.207	0.541	2.408	4.460	0.954	1.611	1.61E-03	3.10E+02
Temperate	16	55	55	0.133	0.723	2.361	4.659	0.981	1.357	1.36E-03	3.68E+02
Subtropical	13	41	41	0.228	0.554	2.492	4.414	0.981	1.691	1.69E-03	2.96E+02
Tropical	17	19	19	0.165	0.247	2.932	4.495	0.914	1.461	1.46E-03	3.42E+02
Global	64	65	65	0.149	0.735	2.443	4.612	0.984	1.409	1.41E-03	3.55E+02





#### Appendix 3-VIII: Residence time variation range

**Table 3.11:** Criteria used in the uncertainty estimation of the residence time in the marine-N loss rate.Criteria used to define the residence time variation range.

Abbreviations used: 'cont shelf' (continental shelf), 'avg depth' (average depth), 'curr exp' (current exposition). The references for the sources mentioned match the ones listed in Table 3.6.

LME	i U	ME propertie	s	Residen	ice time	ne Variation range		e	
#. name	cont shelf	avg depth	curr exp	archetype	used [yr]	Min	Max	Notes	Reference source
1. East Bering Sea	broad	shallow	+	2	2.00	0.25	25.00	arch / arch	
2. Gulf of Alaska	narrow	deep	+	1	0.25	0.13	2.00	-50% / arch	
3. California Current	medium	sh-de	+	1	0.25	0.13	2.00	-50% / arch	1
4. Gulf of California	medium	sh-de		1-2	1.50	0.25	2.00		Lopez & Garcia (2003)
5. Gulf of Mexico	medium	sh-de	+	4	90.00	0.17	250.00	lit/lit	Turner & Rabalais (2009); USGS (2012); Rivas et al. (2005)
6. Southeast U.S. Continental Shelf	broad	shallow	+	1	0.25	0.13	2.00	-50% / arch	Alegria et al. (2000)
7. Northeast U.S. Continental Shelf	broad	shallow	++	1	0.25	0.13	2.00	-50% / arch	
8. Scotian Shelf	broad	shallow	++	1	0.88	0.44	2.00	-50% / arch	Smith et al. (2003)
9. Newfoundland-Labrador Shelf	broad	shallow	+	1	0.25	0.13	2.00	-50% / arch	
10. Insular Pacific-Hawaiian	narrow	deep	++	1	0.25	0.13	2.00	-50% / arch	
11. Pacific Central-American	narrow	deep	++	1	0.25	0.13	2.00	-50% / arch	
12. Caribbean Sea	narrow	deep	++	1	0.21	0.10	0.25		Molinari et al. (1980)
13. Humboldt Current	narrow	deep		1	0.03	0.02	0.25	lit / arch	Hall et al. (1996)
14. Patagonian Shelf	broad	shallow	+	1	0.25	0.13	2.00	-50% / arch	
15. South Brazil Shelf	narrow	deep	++	1	0.25	0.13	2.00	-50% / arch	
16. East Brazil Shelf	narrow	deep	++	1	0.25	0.13	2.00	-50% / arch	Attisano et al. (2008)
17. North Brazil Shelf	medium	sh-de	++		0.25	0.01	0.38	lit / +50%	Limeburner et al. (1995)
18. West Greenland Shelf	medium	deep	++	1	0.25	0.01	2.00	-50% / arch	amesamer et di. (1995)
19. East Greenland Shelf	medium	deep	+	1	0.25	0.13	2.00	-50% / arch	
20. Barents Sea	broad	shallow	*	2	2.00	0.13	2.00	arch / arch	
20. Barents Sea 21. Norwegian Sea	broad	shallow sh-de	+	2	2.00	0.25	25.00	arch / arch	1
			+	2		0.25			Plans et al. (2001)
22. North Sea 23. Baltic Sea	broad broad	shallow shallow	+	2	2.00 25.00	25.00	3.00 35.00	arch / +50% -50% / lit	Blaas et al. (2001) Jansson B-O (1980); Matthäus & Schinke (1999)
23. Battic Sea 24. Celtic-Biscay Shelf	broad	shallow sh-de	+	2	25.00	0.25	35.00	-50% / Ift arch / +50%	I Dausson p-O (1300), Mattilanz & Scilling (1333)
24. Certic-Biscay Sherr 25. Iberian Coastal	medium	deep	+	1	0.25	0.25	2.00	-50% / arch	I.
	1		+						Direct DD (2000)
26. Mediterranean	medium	sh-de	-	4	90.00	25.00	135.00	arch / +50%	Pinet PR (2008)
27. Canary Current	narrow	deep	++	1	0.25	0.13	2.00	-50% / arch	
28. Guinea Current	narrow	deep	++	2	3.10	2.00	4.65		Hall et al. (1996)
29. Benguela Current	narrow	deep	++	1	0.25	0.13	2.00	-50% / arch	1
30. Agulhas Current	narrow	deep	++	2	2.00	0.25	3.00	arch / +50%	
31. Somali Coastal Current	narrow	deep	++	1	0.25	0.13	2.00		Naqvi (2012)
32. Arabian Sea	narrow	deep	+	2-3	6.50	2.00	9.75	arch / +50%	Sarma (2002)
33. Red Sea	broad	sh-de	-		40.00	10.00	70.00	lit/lit	Smeed (2010); Grasshoff (1969); Tomczak & Godfrey (2003)
34. Bay of Bengal	narrow	deep	+	2-3	12.00	2.00	25.00	arch / arch	Sarma (2002)
35. Gulf of Thailand	broad	shallow	-	1-2	0.04	0.02	2.00	-50% / arch	Dulaiova et al. (2006)
36. South China Sea	broad	shallow	-	3	25.00	2.00	90.00	arch / arch	1
37. Sulu-Celebes Sea	broad	sh-de	+	3	25.00	2.00	37.50	arch / +50%	Tessler (2012); Tessler et al. (2011).
38. Indonesian Sea	broad	shallow	+	1-2	0.75	0.50	2.00		Ffield & Gordon (1992)
39. North Australia	broad	shallow	+	1	0.25	0.13	2.00	-50% / arch	
40. Northeast Australia	broad	shallow	+	1	0.25	0.04	2.00	lit / arch	Choukroun et al. (2010)
41. East-Central Australia	narrow	shallow	+	1	0.25	0.13	2.00	-50% / arch	
42. Southeast Australia	medium	sh-de	+	1	0.25	0.13	2.00	-50% / arch	i i i i i i i i i i i i i i i i i i i
43. Southwest Australia	narrow	sh-de	+	1	0.25	0.13	2.00	-50% / arch	
44. West-Central Australia	medium	sh-de	+	1	0.25	0.13	2.00	-50% / arch	
45. Northwest Australia	medium	sh-de	+	1	0.25	0.13	2.00	-50% / arch	
46. New Zealand Shelf	broad	shallow	+	1	0.25	0.13	2.00	-50% / arch	1
47. East China Sea	medium	sh-de	+	i	1.90	0.80	2.60	lit/lit	Tsunogai et al. (1997); Tomczak & Godfrey (2003); Hall et al. (1996)
48. Yellow Sea	broad	shallow	-	1	2.00	0.80	2.30	lit/lit	Tsunogai et al. (1997); Tomczak & Godfrey (2003)
49. Kuroshio Current	narrow	deep	++	1	2.30	1.15	3.45	-50% / +50%	Matsuno et al. (2009)
50. Sea of Japan/East Sea	broad	shallow	-	3	25.00	2.00	90.00	arch / arch	1
51. Oyashio Current	narrow	deep	++	1	0.25	0.13	2.00	-50% / arch	1
52. Sea of Okhotsk	broad	shallow	-	2	2.00	0.25	25.00	arch / arch	Yamamoto et al. (2001)
53. West Bering Sea	narrow	deep	+	1	0.25	0.13	2.00	-50% / arch	
54. Chukchi Sea	broad	shallow	+	1	3.50	1.50	5.50	lit/lit	Schlosser et al. (1994)
55. Beaufort Sea	broad	shallow	+		3.50 I	1.50	5.50	lit/lit	Schlosser et al. (1994)
56. East Siberian Sea	broad	shallow	+	i i	3.50	1.50	5.50	lit/lit	Schlosser et al. (1994)
57. Laptev Sea	broad	shallow	+	1	3.50	1.50	5.50	lit/lit	Schlosser et al. (1994)
58. Kara Sea	broad	shallow	+	1	3.50	1.50	5.50	lit/lit	Schlosser et al. (1994)
59. Iceland Shelf	narrow	deep	+	1	0.25	0.13	2.00	-50% / arch	1
60. Faroe Plateau	broad	shallow	++	1	0.25	0.13	2.00	-50% / arch	Gaard (2000)
61. Antarctic	narrow	deep	+	2-3	6.00	2.00	25.00	arch / arch	Jacobs et al. (1985)
							135.00	arch / +50%	
	broad	shallow	-	4	90.00	25.00	135.00	diuii/ +50%	Nurray et al. (2007)
62. Black Sea 63. Hudson Bay	broad broad	shallow shallow	-	4 2-3	90.00 6.60	25.00	25.00		Murray et al. (2007) Ingram & Prinsenberg (1998)

Continental shelves' bathymetry consulted from Liu et al. (2012).





### Appendix 3-IX: Fate

**Table 3.12:** Fate Factors (FF) per emission route for Countries and Countries-to-LME scales.

	emis	sion route: N t	N to Air		N to sfw		N to gw		mw
		atial scale: Country	Country-to-LME	Country	Country-to-LME	Country	Country-to-LME		Country-to-LM
Country Albania	Country-to-LME unit: Albania to LME#26. Mediterranean	d 281.75	d 281.75	d 412.24	d 412.24	d 145.95	d 145.95	d 871.55	d 871.5
Algeria	Algeria to LME#26. Mediterranean	267.13		412.24	412.24	145.95	145.95	871.55	871.5
Angola	Angola to LME#29. Benguela Current	21.15		39.19	39.19	13.88	13.88	82.86	82.8
Argentina	Argentina to LME#14. Patagonian Shelf	29.88		39.19	39.19	13.88	13.88	82.86	82.8
Australia	Australia to LME#39. North Australia	13.71		274.35	39.19	97.13	13.88	580.03	82.8
	Australia to LME#40. Northeast Australia		1.96		39.19		13.88		82.8
	Australia to LME#41. East-Central Australia		1.96		39.19		13.88		82.8
	Australia to LME#42. Southeast Australia		1.96		39.19		13.88		82.8
	Australia to LME#43. Southwest Australia		1.96		39.19		13.88		82.8
	Australia to LME#44. West-Central Australia		1.96		39.19		13.88		82.8
	Australia to LME#45. Northwest Australia		1.96		39.19		13.88		82.8
Austria	Austria to LME#26. Mediterranean	221.76	221.76	412.24	412.24	145.95	145.95	871.55	871.5
Bahamas	Bahamas to LME#12. Caribbean Sea	41.98	41.98	32.75	32.75	11.60	11.60	69.25	69.2
Bangladesh	Bangladesh to LME#34. Bay of Bengal	184.52	184.52	351.64	351.64	124.50	124.50	743.43	743.4
Belgium	Belgium to LME#22. North Sea	127.00	127.00	190.27	190.27	67.36	67.36	402.27	402.2
Bhutan	Bhutan to LME#34. Bay of Bengal	161.86	6 161.86	351.64	351.64	124.50	124.50	743.43	743.4
Bolivia	Bolivia to LME#13. Humboldt Current	2.61	2.61	5.14	5.14	1.82	1.82	10.87	10.8
Bosnia and Herzegovina	Bosnia and Herzegovina to LME#26. Mediterranean	238.30	238.30	412.24	412.24	145.95	145.95	871.55	871.5
Botswana	Botswana to LME#30. Agulhas Current	113.53	113.53	190.27	190.27	67.36	67.36	402.27	402.2
Brazil	Brazil to LME#15. South Brazil Shelf	14.93	4.98	117.58	39.19	41.63	13.88	248.58	82.8
	Brazil to LME#16. East Brazil Shelf		4.98		39.19		13.88		82.8
	Brazil to LME#17. North Brazil Shelf		4.98		39.19		13.88		82.8
Belize	Belize to LME#12. Caribbean Sea	30.89	30.89	32.75	32.75	11.60	11.60	69.25	69.2
Virgin Islands (British)	Virgin Islands (British) to LME#12. Caribbean Sea	47.65	47.65	32.75	32.75	11.60	11.60	69.25	69.2
Bulgaria	Bulgaria to LME#26. Mediterranean	172.65	86.33	824.49	412.24	291.90	145.95	1,743.11	871.5
	Bulgaria to LME#62. Black Sea		86.33		412.24		145.95		871.
Myanmar	Myanmar to LME#34. Bay of Bengal	199.90	199.90	351.64	351.64	124.50	124.50	743.43	743.4
Belarus	Belarus to LME#23. Baltic Sea	161.35		385.66	385.66	136.54	136.54	815.35	815.
Cambodia	Cambodia to LME#3. California Current	28.28	28.28	39.19	39.19	13.88	13.88	82.86	82.
Cameroon	Cameroon to LME#28. Guinea Current	119.54		236.48	236.48	83.72	83.72	499.97	499.
Canada	Canada to LME#2. Gulf of Alaska	54.42		844.88	39.19	299.12	13.88	1,786.22	82.
	Canada to LME#63. Hudson Bay		19.89		308.79		109.32		652.8
	Canada to LME#9. Newfoundland-Labrador Shelf		2.52		39.19		13.88		82.8
	Canada to LME#8. Scotian Shelf		7.18		111.40		39.44		235.5
	Canada to LME#64. Arctic Ocean		22.31		346.30		122.60		732.1
Sri Lanka	Sri Lanka to LME#34. Bay of Bengal	430.80		351.64	351.64	124.50	124.50	743.43	743.4
Chile	Chile to LME#13. Humboldt Current	4.50		5.14	5.14	1.82	1.82	10.87	10.8
China, People's Republic of	China, People's Republic of to LME#36. South China Sea	100.84		760.85	385.66	269.37	136.54	1,608.56	815.3
	China, People's Republic of to LME#47. East China Sea		24.51		184.92		65.47	,	390.9
	China, People's Republic of to LME#48. Yellow Sea		25.22		190.27		67.36		402.2
Colombia	Colombia to LME#11. Pacific Central-American	17.73		71.95	39.19	25.47	13.88	152.11	82.8
	Colombia to LME#12. Caribbean Sea		8.07		32.75		11.60		69.2
Congo	Congo to LME#28. Guinea Current	122.64		236.48	236.48	83.72	83.72	499.97	499.9
Democratic Republic of the Congo	Democratic Republic of the Congo to LME#28. Guinea Current	100.30		236.48	236.48	83.72	83.72	499.97	499.9
Costa Rica	Costa Rica to LME#11. Pacific Central-American	25.21		71.95	39.19	25.47	13.88	152.11	82.8
	Costa Rica to LME#12. Caribbean Sea		11.48		32.75		11.60		69.2
Croatia	Croatia to LME#26. Mediterranean	234.07		412.24	412.24	145.95	145.95	871.55	871.5
Cuba	Cuba to LME#12. Caribbean Sea	40.71		32.75	32.75	11.60	11.60	69.25	69.2
Cyprus	Cyprus to LME#26. Mediterranean	327.53		412.24	412.24	145.95	145.95	871.55	871.5
Czech Republic	Czech Republic to LME#22. North Sea	97.47		190.27	190.27	67.36	67.36	402.27	402.2
Benin	Benin to LME#28. Guinea Current	148.76		236.48	236.48	83.72	83.72	499.97	499.9
Denmark	Denmark to LME#22. North Sea	90.47		615.13	190.27	217.78	67.36	1,300.48	402.2
	Denmark to LME#23. Baltic Sea		56.72		385.66		136.54	_,	815.3
	Denmark to LME#60. Faroe Plateau		5.76		39.19		13.88		82.8
Dominican Republic	Dominican Republic to LME#12. Caribbean Sea	43.53		32.75	32.75	11.60	11.60	69.25	69.2
Ecuador	Ecuador to LME#11. Pacific Central-American	28.09		39.19	39.19	13.88	13.88	82.86	82.8
El Salvador	El Salvador to LME#11. Pacific Central-American	38.70		39.19	39.19	13.88	13.88	82.86	82.8
Equatorial Guinea	Equatorial Guinea to LME#28. Guinea Current	159.30		236.48	236.48	83.72	83.72	499.97	499.9
Ethiopia	Ethiopia to LME#32. Arabian Sea	135.64		706.53	307.51	250.14	108.87	1,493.72	650.3
	Ethiopia to LME#33. Red Sea		76.60		399.02		141.27		843.6
Eritrea	Eritrea to LME#33. Red Sea	220.58		399.02	399.02	141.27	141.27	843.60	843.6
Estonia	Estonia to LME#23. Baltic Sea	208.21		385.66	385.66	136.54	136.54	815.35	815.
Falkland Islands (Malvinas)	Falkland Islands (Malvinas) to LME#14. Patagonian Shelf	62.16		39.19	39.19	13.88	13.88	82.86	82.8
Finland	Finland to LME#23. Baltic Sea	208.79		385.66	385.66	136.54	136.54	815.35	815.3
France	France to LME#22. North Sea	108.99		792.79	190.27	280.68	67.36	1,676.10	402.
	France to LME#24. Celtic-Biscay Shelf	100.5	26.16		190.27		67.36	,	402.1
	France to LME#26. Mediterranean		56.67		412.24		145.95		871.5
Djibouti	Djibouti to LME#32. Arabian Sea	187.73		307.51	307.51	108.87	108.87	650.13	650.
Gabon	Gabon to LME#28. Guinea Current	148.37		236.48	236.48	83.72	83.72	499.97	499.9
Georgia	Georgia to LME#22. Black Sea	148.57		412.24	412.24	145.95	145.95	871.55	871.
Gambia	Gambia to LME#28. Guinea Current	223.61		236.48	236.48	83.72	83.72	499.97	499.9
Germany	Germany to LME#22. North Sea	123.98		575.93	190.27	203.90	67.36	1,217.62	402.
contaily	Germany to LME#22. North Sea	123.90	83.02	575.35	385.66	203.30	136.54	1,217.02	815.
Ghana	Gennary to LME#23. Build Sea	166.52		236.48	236.48	83.72	83.72	499.97	499.
Greece	Greece to LME#26. Mediterranean	300.80		412.24	412.24	145.95	145.95	871.55	499. 871.
Guatemala	Guatemala to LME#11. Pacific Central-American	22.06		71.95	39.19	25.47	13.88	152.11	82.
	Guatemala to LME#11. Pacific Central-American Guatemala to LME#12. Caribbean Sea	22.00	10.04	/1.55	39.19	23.47	11.60	136.11	69.
Guinea	Guinea to LME#28. Guinea Current	186.62		236.48	236.48	83.72	83.72	499.97	499.
Guyana	Guinea to LME#28. Guinea Current Guyana to LME#17. North Brazil Shelf	33.87		236.48 39.19	236.48 39.19	13.88	13.88	499.97 82.86	499. 82.
Haiti	Haiti to LME#12. Caribbean Sea	42.74		39.19	39.19	13.88	13.88	69.25	82. 69.
Honduras	Haiti to LME#12. Caribbean Sea Honduras to LME#12. Caribbean Sea	31.92		32.75	32.75	11.60	11.60	69.25	69. 69.
Hungary									
	Hungary to LME#62. Black Sea	201.73		412.24 39.19	412.24 39.19	145.95 13.88	145.95 13.88	871.55	871.
			, 20.39	23.13	23'13	12.00	10.00	82.86	82.
Iceland	Iceland to LME#59. Iceland Shelf			650.15	207 54	222.20	100 07	1 202 50	CEO -
	India to LME#32. Arabian Sea	138.36	64.55	659.15	307.51	233.36	108.87	1,393.56	
Iceland			64.55 73.81	659.15 99.22	307.51 351.64 99.22	233.36 35.13	108.87 124.50 35.13	1,393.56 209.76	650. 743.4 209.1





1	16	
т	10	

Iraq	Iraq to LME#32. Arabian Sea	131.70	131.70	307.51	307.51	108.87	108.87	650.13	650
Ireland	Ireland to LME#24. Celtic-Biscay Shelf	193.70	193.70	190.27	190.27	67.36	67.36	402.27	402
Israel	Israel to LME#26. Mediterranean	227.01	227.01	412.24	412.24	145.95	145.95	871.55	871
Italy	Italy to LME#26. Mediterranean	287.25	287.25	412.24	412.24	145.95	145.95	871.55	871
Kosovo Côto d'Iugiro	Kosovo to LME#26. Mediterranean	222.44 178.22	222.44 178.22	412.24 236.48	412.24	145.95	145.95 83.72	871.55 499.97	871
Côte d'Ivoire Jamaica	Côte d'Ivoire to LME#28. Guinea Current Jamaica to LME#12. Caribbean Sea	44.23	44.23	32.75	236.48 32.75	83.72 11.60	83.72	499.97 69.25	499 69
Japan	Japan to LME#47. East China Sea	91.88	16.90	1,005.04	184.92	355.82	65.47	2,124.82	390
Japan	Japan to LME#49. Kuroshio Current	51.00	18.74	1,005.04	205.00	333.02	72.58	2,124.02	433
	Japan to LME#50. Sea of Japan/East Sea		35.26		385.66		136.54		815
	Japan to LME#51. Oyashio Current		3.58		39.19		13.88		82
	Japan to LME#52. Sea of Okhotsk		17.39		190.27		67.36		402
Jordan	Jordan to LME#33. Red Sea	190.90	190.90	399.02	399.02	141.27	141.27	843.60	843
Kenya	Kenya to LME#31. Somali Coastal Current	20.86	20.86	39.19	39.19	13.88	13.88	82.86	82
Democratic People's Republic of Korea		119.12	28.95	760.85	184.92	269.37	65.47	1,608.56	390
	Democratic People's Republic of Korea to LME#48. Yellow Sea		29.79		190.27		67.36		402
	Democratic People's Republic of Korea to LME#50. Sea of Japan/East Sea		60.38		385.66		136.54		815
Republic of Korea	Republic of Korea to LME#47. East China Sea	130.24	31.65	760.85	184.92	269.37	65.47	1,608.56	390
	Republic of Korea to LME#48. Yellow Sea		32.57		190.27		67.36		402
	Republic of Korea to LME#50. Sea of Japan/East Sea		66.02		385.66		136.54		815
Lao People's Democratic Republic	Lao People's Democratic Republic to LME#36. South China Sea	255.54	255.54	385.66	385.66	136.54	136.54	815.35	815
Lebanon	Lebanon to LME#26. Mediterranean	238.53	238.53	412.24	412.24	145.95	145.95	871.55	871
Latvia	Latvia to LME#23. Baltic Sea	193.58	193.58	385.66	385.66	136.54	136.54	815.35	815
Liberia	Liberia to LME#28. Guinea Current	210.50	210.50	236.48	236.48	83.72	83.72	499.97	499
Libyan Arab Jamahiriya	Libyan Arab Jamahiriya to LME#26. Mediterranean	233.79	233.79	412.24	412.24	145.95	145.95	871.55	871
Lithuania	Lithuania to LME#23. Baltic Sea	181.06	181.06	385.66	385.66	136.54	136.54	815.35	815
Madagascar	Madagascar to LME#30. Agulhas Current	168.72	168.72	190.27	190.27	67.36	67.36	402.27	402
Malaysia	Malaysia to LME#34. Bay of Bengal	132.07	62.44	743.83	351.64	263.34	124.50	1,572.58	743
	Malaysia to LME#35. Gulf of Thailand		1.16		6.52		2.31		13
Mali	Malaysia to LME#36. South China Sea	67 AC	68.48	275.52	385.66	07.00	136.54	502.00	815
Mali	Mali to LME#27. Canary Current	65.89	9.37	275.68	39.19	97.60	13.88	582.83	82
Mauritania	Mali to LME#28. Guinea Current	20.20	56.52	30.40	236.48	13.00	83.72 13.88	02.00	499
	Mauritania to LME#27. Canary Current	30.38	30.38 5.90	39.19 612.20	39.19	13.88	13.88	82.86	82
Mexico	Mexico to LME#3. California Current Mexico to LME#4. Gulf of California	92.16	24.20	012.20	39.19 160.76	216.74	13.88 56.92	1,294.30	82 339
	Mexico to LME#5. Gulf of Mexico		62.06		412.24		145.95		871
Moldova	Moldova to LME#52. Black Sea	195.55	195.55	412.24	412.24	145.95	145.95	871.55	871
Montenegro	Montenegro to LME#26. Mediterranean	222.44	222.44	412.24	412.24	145.95	145.95	871.55	871
Morocco	Morocco to LME#26. Mediterranean	116.32	106.22	451.44	412.24	159.83	145.95	954.41	871
11010220	Morocco to LME#27. Canary Current	110.52	10.10	131.11	39.19	155.05	13.88	55111	82
Mozambique	Morambique to LME#30. Agulhas Current	121.38	121.38	190.27	190.27	67.36	67.36	402.27	402
Oman	Oman to LME#32. Arabian Sea	216.85	216.85	307.51	307.51	108.87	108.87	650.13	650
Namibia	Namibia to LME#29. Benguela Current	26.54	26.54	39.19	39.19	13.88	13.88	82.86	82
Nepal	Nepal to LME#34. Bay of Bengal	152.47	152.47	351.64	351.64	124.50	124.50	743.43	743
Netherlands	Netherlands to LME#22. North Sea	131.20	131.20	190.27	190.27	67.36	67.36	402.27	402
New Caledonia	New Caledonia to LME#40. Northeast Australia	68.65	68.65	39.19	39.19	13.88	13.88	82.86	82
New Zealand	New Zealand to LME#46. New Zealand Shelf	52.74	52.74	39.19	39.19	13.88	13.88	82.86	82
Nicaragua	Nicaragua to LME#11. Pacific Central-American	23.44	12.77	71.95	39.19	25.47	13.88	152.11	82
	Nicaragua to LME#12. Caribbean Sea		10.67		32.75		11.60		69
Niger	Niger to LME#28. Guinea Current	123.69	123.69	236.48	236.48	83.72	83.72	499.97	499
Nigeria	Nigeria to LME#28. Guinea Current	129.39	129.39	236.48	236.48	83.72	83.72	499.97	499
Norway	Norway to LME#21. Norwegian Sea	91.78	45.89	380.55	190.27	134.73	67.36	804.54	402
	Norway to LME#22. North Sea		45.89		190.27		67.36		402
Pakistan	Pakistan to LME#32. Arabian Sea	138.18	138.18	307.51	307.51	108.87	108.87	650.13	650
Panama	Panama to LME#11. Pacific Central-American	24.95	13.59	71.95	39.19	25.47	13.88	152.11	82
	Panama to LME#12. Caribbean Sea		11.36		32.75		11.60		69
Paraguay	Paraguay to LME#14. Patagonian Shelf	22.54	22.54	39.19	39.19	13.88	13.88	82.86	82
Peru	Peru to LME#13. Humboldt Current	3.66	3.66	5.14	5.14	1.82	1.82	10.87	10
Philippines	Philippines to LME#36. South China Sea	287.84	143.92	771.32	385.66	273.08	136.54	1,630.70	815
	Philippines to LME#37. Sulu-Celebes Sea		143.92		385.66		136.54		815
Poland	Poland to LME#23. Baltic Sea	189.69	189.69	385.66	385.66	136.54	136.54	815.35	815
Portugal	Portugal to LME#25. Iberian Coastal	36.50	36.50	39.19	39.19	13.88	13.88	82.86	82
Guinea-Bissau	Guinea-Bissau to LME#28. Guinea Current	210.58	210.58	236.48	236.48	83.72	83.72	499.97	499
Timor-Leste	Timor-Leste to LME#38. Indonesian Sea	145.72	145.72	99.22	99.22	35.13	35.13	209.76	209
Puerto Rico	Puerto Rico to LME#12. Caribbean Sea	45.40	45.40	32.75	32.75	11.60	11.60	69.25	69
Romania Russian Enderation	Romania to LME#62. Black Sea	204.17	204.17	412.24	412.24	145.95	145.95	871.55	871
Russian Federation	Russian Federation to LME#20. Barents Sea	67.42	4.94	2,599.35	190.27	920.27	67.36	5,495.46	402
	Russian Federation to LME#54. Chukchi Sea		6.46		249.05		88.17		526
	Russian Federation to LME#56. East Siberian Sea Russian Federation to LME#57. Laptev Sea		6.46 6.46		249.05 249.05		88.17 88.17		526 526
	Russian Federation to LME#57. Laptev Sea		6.46		249.05		88.17		526
	Russian Federation to LME#62. Black Sea		10.69		412.24		145.95		871
	Russian Federation to LME#64. Arctic Ocean		8.98		346.30		122.60		732
	Russian Federation to LME#50. Sea of Japan/East Sea		10.00		385.66		136.54		815
	Russian Federation to LME#51. Oyashio Current		1.02		39.19		13.88		82
	Russian Federation to LME#52. Sea of Okhotsk		4.94		190.27		67.36		402
	Russian Federation to LME#53. West Bering Sea		1.02		39.19		13.88		82
	Saudi Arabia to LME#32. Arabian Sea	133.11	57.94	706.53	307.51	250.14	108.87	1,493.72	650
Saudi Arabia	Saudi Arabia to Livie#32. Arabian Sea		75.18		399.02		141.27		843
Saudi Arabia	Saudi Arabia to LME#32. Arabian Sea				39.19	13.88	13.88	82.86	82
		34.74	34.74	39.19	35.15	10.00			871
Senegal	Saudi Arabia to LME#33. Red Sea	34.74 167.24	34.74 83.62	39.19 824.49	412.24	291.90	145.95	1,743.11	
Senegal	Saudi Arabia to LME#33. Red Sea Senegal to LNE#27. Canary Current Serbia to LME#E2. Black Sea Serbia to LME#26. Mediterranean								87
Senegal Serbia	Saudi Arabia to LME#33. Red Sea Senegal to LME#27. Canary Current Serbia to LME#62. Black Sea		83.62		412.24 412.24 236.48		145.95	1,743.11 499.97	871
Senegal Serbia Sierra Leone Slovakia	Saudi Arabia to LME#33. Red Sea Senegal to LME#27. Canary Current Serbia to LME#28. Black Sea Serbia to LME#26. Mediterranean Sierra Leone to LME#28. Guinea Current Slovakia to LME#62. Black Sea	167.24 200.64 197.82	83.62 83.62 200.64 197.82	824.49 236.48 412.24	412.24 412.24 236.48 412.24	291.90 83.72 145.95	145.95 145.95 83.72 145.95	499.97 871.55	871 499 871
Saudi Arabia Senegal Serbia Sierra Leone Siovakia Viet Nam	Saudi Arabia to LME#33. Red Sea Senegal to LNE#27. Canary Current Serbia to LME#26. Black Sea Serbia to LME#26. Mediterranean Sierra Leone to LME#28. Guinea Current Slovakia to LME#62. Black Sea Viet Nam to LME#36. South China Sea	167.24 200.64	83.62 83.62 200.64 197.82 308.15	824.49 236.48	412.24 412.24 236.48 412.24 385.66	291.90 83.72 145.95 136.54	145.95 145.95 83.72 145.95 136.54	499.97 871.55 815.35	871 499 871 815
Senegal Serbia Sierra Leone Slovakia Viet Nam Slovenia	Saudi Arabia to LME#33. Red Sea Senegal to LME#27. Canary Current Serbia to LME#262. Black Sea Serbia to LME#26. Mediterranean Sierra Leone to LME#28. Guinea Current Slovakia to LME#28. Black Sea Viet Nam to LME#36. South China Sea Slovenia to LME#26. Mediterranean	167.24 200.64 197.82 308.15 245.10	83.62 83.62 200.64 197.82 308.15 245.10	824.49 236.48 412.24 385.66 412.24	412.24 412.24 236.48 412.24 385.66 412.24	291.90 83.72 145.95 136.54 145.95	145.95 145.95 83.72 145.95 136.54 145.95	499.97 871.55 815.35 871.55	871 499 871 815 871
Senegal Serbia Sierra Leone Slovakia Viet Nam	Saudi Arabia to LME#33. Red Sea Senegal to LME#27. Canary Current Serbia to LME#26. Black Sea Serbia to LME#26. Mediterranean Sierra Leone to LME#28. Guinea Current Slovakia to LME#62. Black Sea Viet Nam to LME#36. South China Sea Slovenia to LME#26. Mediterranean Somalia to LME#31. Somali Coastal Current	167.24 200.64 197.82 308.15	83.62 83.62 200.64 197.82 308.15 245.10 9.66	824.49 236.48 412.24 385.66	412.24 412.24 236.48 412.24 385.66 412.24 39.19	291.90 83.72 145.95 136.54	145.95 145.95 83.72 145.95 136.54 145.95 13.88	499.97 871.55 815.35	871 499 871 815 871 871 871
Senegal Serbia Sierra Leone Slovakia Viet Nam Slovenia	Saudi Arabia to LME#33. Red Sea Senegal to LME#27. Canary Current Serbia to LME#262. Black Sea Serbia to LME#26. Mediterranean Sierra Leone to LME#28. Guinea Current Slovakia to LME#28. Black Sea Viet Nam to LME#36. South China Sea Slovenia to LME#26. Mediterranean	167.24 200.64 197.82 308.15 245.10	83.62 83.62 200.64 197.82 308.15 245.10	824.49 236.48 412.24 385.66 412.24	412.24 412.24 236.48 412.24 385.66 412.24	291.90 83.72 145.95 136.54 145.95	145.95 145.95 83.72 145.95 136.54 145.95	499.97 871.55 815.35 871.55	871 499 871 815 871





716 Zimbabwe	Zimbabwe to LME#30. Agulhas Current	104.20	104.20	190.27	190.27	67.36	67.36	402.27	402.27
724 Spain	Spain to LME#25. Iberian Coastal	120.25	10.44	451.44	39.19	159.83	13.88	954.41	82.86
	Spain to LME#26. Mediterranean		109.81		412.24		145.95		871.55
736 Sudan	Sudan to LME#33. Red Sea	168.17	168.17	399.02	399.02	141.27	141.27	843.60	843.60
748 Swaziland	Swaziland to LME#30. Agulhas Current	132.36	132.36	190.27	190.27	67.36	67.36	402.27	402.27
752 Sweden	Sweden to LME#23. Baltic Sea	131.61	88.13	575.93	385.66	203.90	136.54	1,217.62	815.35
	Sweden to LME#22. North Sea		43.48		190.27		67.36		402.27
756 Switzerland	Switzerland to LME#22. North Sea	129.80	24.34	1,014.76	190.27	359.26	67.36	2,145.38	402.27
	Switzerland to LME#26. Mediterranean		52.73		412.24		145.95		871.55
	Switzerland to LME#62. Black Sea		52.73		412.24		145.95		871.55
760 Syrian Arab Republic	Syrian Arab Republic to LME#26. Mediterranean	192.19	192.19	412.24	412.24	145.95	145.95	871.55	871.55
764 Thailand	Thailand to LME#34. Bay of Bengal	230.69	230.69	351.64	351.64	124.50	124.50	743.43	743.43
768 Togo	Togo to LME#28. Guinea Current	159.90	159.90	236.48	236.48	83.72	83.72	499.97	499.97
784 United Arab Emirates	United Arab Emirates to LME#32. Arabian Sea	211.15	211.15	307.51	307.51	108.87	108.87	650.13	650.13
788 Tunisia	Tunisia to LME#26. Mediterranean	281.59	281.59	412.24	412.24	145.95	145.95	871.55	871.55
792 Turkey	Turkey to LME#26. Mediterranean	221.60	221.60	412.24	412.24	145.95	145.95	871.55	871.55
800 Uganda	Uganda to LME#26. Mediterranean	178.36	178.36	412.24	412.24	145.95	145.95	871.55	871.55
804 Ukraine	Ukraine to LME#62. Black Sea	181.23	181.23	412.24	412.24	145.95	145.95	871.55	871.55
807 The FYR of Macedonia	The FYR of Macedonia to LME#26. Mediterranean	242.07	242.07	412.24	412.24	145.95	145.95	871.55	871.55
818 Egypt	Egypt to LME#26. Mediterranean	205.96	205.96	412.24	412.24	145.95	145.95	871.55	871.55
826 United Kingdom of GB and NI	United Kingdom of GB and NI to LME#22. North Sea	105.48	52.74	380.55	190.27	134.73	67.36	804.54	402.27
	United Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf		52.74		190.27		67.36		402.27
834 United Republic of Tanzania: Mainland	United Republic of Tanzania: Mainland to LME#30. Agulhas Current	98.90	98.90	190.27	190.27	67.36	67.36	402.27	402.27
840 United States	United States to LME#1. East Bering Sea	43.36	5.66	1,457.36	190.27	515.96	67.36	3,081.09	402.27
	United States to LME#2. Gulf of Alaska		1.17		39.19		13.88		82.86
	United States to LME#3. California Current		1.17		39.19		13.88		82.86
	United States to LME#4. Gulf of California		4.78		160.76		56.92		339.88
	United States to LME#5. Gulf of Mexico		12.27		412.24		145.95		871.55
	United States to LME#6. Southeast U.S. Continental Shelf		1.17		39.19		13.88		82.86
	United States to LME#7. Northeast U.S. Continental Shelf		1.17		39.19		13.88		82.86
	United States to LME#10. Insular Pacific-Hawaiian		1.17		39.19		13.88		82.86
	United States to LME#54. Chukchi Sea		7.41		249.05		88.17		526.54
	United States to LME#55. Beaufort Sea		7.41		249.05		88.17		526.54
858 Uruguay	Uruguay to LME#14. Patagonian Shelf	32.38	32.38	39.19	39.19	13.88	13.88	82.86	82.86
862 Venezuela (Bolivarian Republic of)	Venezuela (Bolivarian Republic of) to LME#12. Caribbean Sea	24.64	24.64	32.75	32.75	11.60	11.60	69.25	69.25
887 Yemen	Yemen to LME#32. Arabian Sea	189.09	189.09	307.51	307.51	108.87	108.87	650.13	650.13
894 Zambia	Zambia to LME#30. Agulhas Current	90.11	90.11	190.27	190.27	67.36	67.36	402.27	402.27
n=143	n=214	n=143	n=214	n=143	n=214	n=143	n=214	n=143	n=214





### Appendix 3-X: Exposure

**Table 3.13:** Exposure Factors (XF) at the Country-to-LME scale.

ISO & Country to LME         15.85         0.319         1455         (c)         1800/HgN         1800/HgN           8         Abarnia to LMERZ-Mediterranean         0.627         9.132         0.091           12         Augria to LMERZ-Mediterranean         0.627         9.132         0.091           24         Angola to LMERZ-Mediterranean         0.627         9.132         0.091           24         Angola to LMERZ-Mediterranean         0.627         9.132         0.091           24         Angola to LMERZ-Mediterranean         0.495         7.204         0.021           Australia to LMERAL Sacchertal Australia         0.495         7.204         0.021           Australia to LMERAL Southeast Australia         0.777         11.317         0.113           Australia to LMERAL Southeast Australia         0.771         11.233         0.108           Australia to LMERAL Southeast Australia         0.771         11.233         0.101           40         Australia to LMERAL Southeast Australia         0.772         10.376         0.104           50         Bendited to LMERAL Southeast Australia         0.712         10.376         0.104           50         Bendited to LMERAL Southeast Australia         0.711         1.233         0.223			OM:N	O <sub>2</sub> :OM*(1-BGE)	O <sub>2</sub> :N	NIE	O <sub>2</sub> :N*NIE	*VCC = XF
12         Algeria to MER20. Mediter anean         0.627         9.132         0.091           21         Angeria to MER30. Angueia Current         2.734         39.821         0.398           21         Ageria to MER30. North Australia to MER40. North-Australia to MER40. North-Australia to MER40. North-Australia to MER40. North-Australia to MER40. Australia to ME	ISO #	Country to LME	15.855	0.919	14.565	[-]	1	kgO <sub>2</sub> /kgN
24         Augola to LMEE29. Benguela Current         2,734         39,821         0.398           20         Agentine to LMEE10. Northesst Australia         0.454         2,754         40,111         0.401           5         Australia to LMEE90. Northesst Australia         0.495         7,204         0.072           Australia to LMEE10. Northesst Australia         0.495         9,105         0.0091           Australia to LMEE40. Southeest Australia         0.777         11,317         0.1133           Australia to LMEE40. Southeest Australia         0.771         11,323         0.112           40         Australia to LMEE40. Meet Central Australia         0.771         11,337         0.1134           Australia to LMEE40. Meet Central Australia         0.772         10,376         0.104           50         Belgium to LMEE20. Melterenean         0.772         11,375         0.176           50         Belgium to LMEE20. Melterenean         0.772         11,375         0.176           50         Belgium to LMEE20. Melterenean         0.627         9.132         0.091           50         Belgium to LMEE30. Australia         0.627         9.132         0.091           50         Belgium to LMEE30. Australia         0.627         9.132         0.091 <td>8</td> <td>Albania to LME#26. Mediterranean</td> <td></td> <td></td> <td></td> <td>0.627</td> <td>9.132</td> <td>0.091</td>	8	Albania to LME#26. Mediterranean				0.627	9.132	0.091
32         Argention to UMERIA. Pracyonian thelif         2,754         40.111         0.401           36         Australia to UMERIA. North Australia         1,584         2,3067         0.231           Australia to UMERIA. North Australia         0,425         7,204         0.002           Australia to UMERIA. Southwest Australia         0,777         11.317         0.113           Australia to UMERIA. Southwest Australia         0,771         11.233         0.112           Australia to UMERIA. Southwest Australia         0,771         11.233         0.112           40         Katria to UMERIA. Mest-Central Australia         0,771         11.233         0.112           40         Bahamas to UMERIA. Caribbean Sea         0,712         10.376         0.104           50         Belgium to UMERIA. North Sea         0,712         10.376         0.104           50         Belgium to UMERIA. Bay of Bengal         1,071         71.587         0.176           50         Belgium to UMERIA. Bay of Bengal         1,071         71.587         0.176           51         Belgium to UMERIA. Bay of Bengal         1,011         190.999         0.191           52         Belgium to UMERIA. Bay of Bengal         1,211         10.376         0.104	12	Algeria to LME#26. Mediterranean				0.627	9.132	0.091
36         Australia to LME39. North Australia         1.584         23.067         0.231           Australia to LME40. Northeast Australia         0.495         7.044         0.072           Australia to LME40. Southeast Australia         0.777         11.317         0.113           Australia to LME40. Southeast Australia         0.777         11.317         0.113           Australia to LME40. Southeast Australia         0.779         10.322         0.103           Australia to LME40. Northwest Australia         0.771         11.337         0.112           40         Australia to LME40. Mortheast Australia         0.771         11.337         0.104           50         Bangiadesh to LME52. Mortheranean         0.627         9.132         0.091           50         Bangiadesh to LME52. Mortheranean         0.627         9.132         0.032           65         Belyium to LME52. Mortheranean         0.627         9.132         0.032           70         Bosnia and Herzgovin to LME52. Mortheranean         0.627         9.132         0.091           70         Bosnia and LME53. SouthBread Sheff         1.107         17.587         0.172           70         Bosnia and LME32. Southeranean         0.627         9.132         0.091           717 <td>24</td> <td>Angola to LME#29. Benguela Current</td> <td></td> <td></td> <td></td> <td>2.734</td> <td>39.821</td> <td>0.398</td>	24	Angola to LME#29. Benguela Current				2.734	39.821	0.398
36         Australia to LME39. North Australia         1.584         23.067         0.231           Australia to LME40. Northeast Australia         0.495         7.044         0.072           Australia to LME40. Southeast Australia         0.777         11.317         0.113           Australia to LME40. Southeast Australia         0.777         11.317         0.113           Australia to LME40. Southeast Australia         0.779         10.322         0.103           Australia to LME40. Northwest Australia         0.771         11.337         0.112           40         Australia to LME40. Mortheast Australia         0.771         11.337         0.104           50         Bangiadesh to LME52. Mortheranean         0.627         9.132         0.091           50         Bangiadesh to LME52. Mortheranean         0.627         9.132         0.032           65         Belyium to LME52. Mortheranean         0.627         9.132         0.032           70         Bosnia and Herzgovin to LME52. Mortheranean         0.627         9.132         0.091           70         Bosnia and LME53. SouthBread Sheff         1.107         17.587         0.172           70         Bosnia and LME32. Southeranean         0.627         9.132         0.091           717 <td>32</td> <td>Argentina to LME#14. Patagonian Shelf</td> <td></td> <td></td> <td></td> <td>2.754</td> <td>40.111</td> <td>0.401</td>	32	Argentina to LME#14. Patagonian Shelf				2.754	40.111	0.401
Australia to LME#41. East-Central Australia         0.625         9.105         0.091           Australia to LME#43. Southeest Australia         0.777         11.317         0.113           Australia to LME#43. Southeest Australia         0.709         10.322         0.108           Australia to LME#44. West-Central Australia         0.771         11.233         0.112           Australia to LME#45. Morthwest Australia         0.771         11.233         0.112           Australia to LME#45. Morthwest Australia         0.771         10.376         0.104           Singladesh to LME#12. Caribbean Sea         0.712         10.376         0.104           Singladesh to LME#13. Humbolit Current         1.207         17.587         0.176           Bolivia to LME#13. Humbolit Current         0.527         9.132         0.091           Brazil to LME#13. Humbolit Current         0.527         9.132         0.091           Brazil to LME#13. Sumbfars all Sheff         0.433         7.178         0.072           Brazil to LME#13. Sumbfars all Sheff         0.433         5.22         0.336           Belzie to LME#2. Caribbean Sea         0.712         10.376         0.104           1071         Muntali Sheff         0.430         0.727         10.376         0.104	36	Australia to LME#39. North Australia				1.584	23.067	
Australia to LMEM2. Southeast Australia         0.777         11.317         0.113           Australia to LMEM4. Southeest Australia         0.761         10.824         0.108           Australia to LMEM4. Southeest Australia         0.771         11.23         0.112           Australia to LMEM5. Northwest Australia         0.771         11.23         0.112           40         Australia to LMEM2. Contheest Australia         0.771         11.23         0.112           50         Begladesh to LMEM2. Anotheest Australia         0.771         11.23         0.112           51         Begladesh to LMEM2. Northwest Australia         0.771         11.23         0.112           56         Beglum to LMEM2. Any of Bengal         1.207         17.587         0.176           56         Bolgum to LMEM2. Any of Bengal         1.207         17.587         0.176           57         Borna and Herzegovina to LMEM2. Mediteranean         0.227         9.132         0.091           58         Boliva to LMEM2. Anothes Current         1.31         19.099         10.376         0.104           58         Boliva to LMEM2. Caribbean Sea         0.712         10.376         0.104           59         Brazi to LMEM2. Anothesal Sheff         2.304         3.352         0.332 <td></td> <td>Australia to LME#40. Northeast Australia</td> <td></td> <td></td> <td></td> <td>0.495</td> <td>7.204</td> <td>0.072</td>		Australia to LME#40. Northeast Australia				0.495	7.204	0.072
Australia to LME#43. Southwest Australia         0.745         10.844         0.108           Australia to LME#44. West-Central Australia         0.709         10.322         0.103           Australia to LME#44. West-Central Australia         0.771         11.233         0.112           40         Australia to LME#45. Mediterranean         0.627         9.132         0.0091           44         Bahamas to LME#24. Caribbean Sea         0.712         10.376         0.104           56         Bedglum to LME#32. North Sea         2.075         30.230         0.0322           56         Boligiach to LME#33. Hay of Bengal         1.207         17.587         0.176           58         Boligian to LME#33. Humbolit Current         0.599         13.371         0.0213           70         Bosina and Herzegovina to LME#164. Mediterranean         0.627         9.132         0.0911           712         Botiswana to LME#15. South Brazil Shelf         0.493         3.352         0.336           70         Borali to LME#17. North Frazil Shelf         0.493         7.178         0.104           712         Inde#17. North Frazil Shelf         0.493         7.352         0.014           712         Inde#17. North Frazil Shelf         0.402         7.178         0.104<		Australia to LME#41. East-Central Australia				0.625	9.105	0.091
Australia to LMEEMA, West-Central Australia         0.709         10.322         0.103           Australia to LMEEAS. Northwest Australia         0.771         11.233         0.112           40 Austria to LMEEAS. Mediterranean         0.627         9.132         0.0104           43 Bahamas to LMEEAS. Mediterranean         0.712         10.376         0.104           50 Benjadieh to LMEEAS. Anoth Sea         0.712         10.376         0.020           64 Buhan to LMEEAS. North Sea         0.771         17.587         0.176           75 Benjadieh to LMEEAS. Anoth Sea         0.727         17.587         0.176           76 Brazil to LMEEAS. Anoth Sea         0.627         9.132         0.0201           77 Brazil to LMEEAS. South Brazil Shelf         1.311         19.099         0.191           78 Brazil to LMEEAS. South Brazil Shelf         2.304         33.552         0.336           81 Beize to LMEEAS. South Brazil Shelf         2.304         33.552         0.336           81 Beize to LMEEAS. Additerranean         0.627         9.132         0.091           91 Burgaria to LMEEAS. Additerranean         0.757         34.265         0.144           100 Burgaria to LMEEAS. Calinea Current         0.757         34.265         0.257           112         Cam		Australia to LME#42. Southeast Australia				0.777	11.317	0.113
Australia to LMERAS. Northwest Australia         0.771         11.233         0.0112           40         Austria to LMERAS. Constitueranean         0.627         9.132         0.0091           50         Bangladesh to LMERIAS. Constibean Sea         0.772         17.587         0.176           55         Beljum to LMERIAS. North Sea         2.075         30.230         0.302           68         Bolivia to LMERIAS. All of Bengal         1.077         17.587         0.176           68         Bolivia to LMERIAS. All of Bengal         1.077         17.587         0.023           70         Bosnia and Herzegovina to LMERIAS. Mediterranean         0.627         9.132         0.091           70         Barzil to LMERIS. South Brazil Shelf         1.311         19.099         0.110           70         Brazil to LMERIS. Conth Brazil Shelf         0.433         7.178         0.072           71         Brazil to LMERIS. Conth Brazil Shelf         0.433         7.178         0.014           70         Brazil to LMERIS. Conth Brazil Shelf         0.434         3.552         0.336           8         Beiter to LMERIS. Conth Brazil Shelf         0.434         3.552         0.326           70         Brazil to LMERIS. Conth Brazil Shelf         0.434		Australia to LME#43. Southwest Australia				0.745	10.844	0.108
40         Austria to LMER26. Mediterranean         0.627         9.132         0.091           44         Bahamas to LMER12. Caribbean Sea         0.712         10.376         0.104           55         Belgium to LMER22. North Sea         2.075         30.200         0.302           64         Blutan to LMER34. Bay of Bengal         1.207         17.587         0.176           65         Boliva to LMER34. Bay of Bengal         1.207         17.587         0.176           65         Boliva to LMER34. Bay of Bengal         1.207         17.587         0.176           65         Boliva to LMER34. Bay of Bengal         1.207         17.587         0.176           70         Bosnia and Herzegovina to LMER26. Mediterranean         0.627         9.132         0.091           71         Barali to LMER15. South Brazil Shelf         0.493         7.178         0.072           70.70         Brazil to LMER12. Caribbean Sea         0.712         10.376         0.104           92         Virgin Islands (British) to LME212. Caribbean Sea         0.721         10.376         0.104           93         UMER12. Caribbean Sea         0.721         10.376         0.104           94         Barlari to LMER26. Mediterranean         0.627         9.132<		Australia to LME#44. West-Central Australia				0.709	10.322	0.103
44         Bahamas to LME#12. Caribbean Sea         0.712         10.376         0.104           50         Barglatdesh to LME#34. Bay of Bengal         1.207         17.587         0.176           64         Buttan to LME#34. Bay of Bengal         1.207         17.587         0.176           65         Belgium to LME#34. Bay of Bengal         1.207         17.587         0.176           66         Bolivia to LME#13. Humboldt Current         1.531         22.233         0.232           70         Bosnia and Herzegovina to LME#26. Mediterranean         0.527         9.132         0.091           71         Boral to LME#15. South Brazil Shelf         1.311         19.099         0.191           70         Brazil to LME#15. South Brazil Shelf         2.304         3.3552         0.336           72         Brazil to LME#17. North Brazil Shelf         1.311         19.099         0.191           70         Brazil to LME#17. North Brazil Shelf         0.302         0.336         0.014           73         Brazil to LME#17. North Brazil Shelf         0.302         0.336         0.014           70         Brazil to LME#17. North Brazil Shelf         0.302         0.336         0.567         0.104           70         Brazil to LME#17. North Brazil S		Australia to LME#45. Northwest Australia				0.771	11.233	0.112
50         Bangladesh to LMER34. Bay of Bengal         1.207         17.587         0.176           56         Beljum to LMER22. North Sea         2.075         30.230         0.302           64         Bhutan to LMER34. Bay of Bengal         1.237         17.587         0.176           65         Bolivia to LMER34. Bay of Bengal         1.531         22.233         0.091           70         Bosnia and Herzgovina to LMER36. Mediterranean         0.627         9.132         0.091           72         Botswana to LMER30. Aguihas Current         0.959         1.3 971         0.104           70         Brazil to LMER15. South Brazil Shelf         0.493         7.178         0.072           70         Brazil to LMER15. North Brazil Shelf         0.493         7.178         0.104           70         Brazil to LMER15. South Brazil Shelf         0.493         7.178         0.104           70         Brazil to LMER15. South Brazil Shelf         0.493         7.178         0.104           70         Brazil to LMER15. South Brazil Shelf         0.493         7.178         0.104           70         Brazil to LMER15. South Chrenta         1.637         2.784         0.091           70         Bolizero LMER12. Caribbean Sea         0.712         <	40	Austria to LME#26. Mediterranean				0.627	9.132	0.091
55         Belgium to LME#22. North Sea         2.075         30.230         0.302           64         Butan to LME#34. Bay of Bengal         1.207         17.587         0.176           68         Bolivia to LME#13. Humbolit Current         1.531         2.2293         0.223           70         Bosnia and Herzegovina to IME#26. Mediterranean         0.627         9.132         0.040           76         Brazil to LME#15. South Brazil Sheff         1.311         9.099         0.191           Brazil to LME#15. South Brazil Sheff         2.304         33.552         0.336           84         Belize to LME#12. Caribbean Sea         0.712         10.376         0.104           92         Vrigni Islands (British) to LME#12. Caribbean Sea         0.712         10.376         0.104           100         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           110         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           1104         Myanara to LME#26. Mediterranean         0.627         9.132         0.091           111         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.016           112         Canada to LME#28. Guinea Current         1.763         2.5	44	Bahamas to LME#12. Caribbean Sea				0.712	10.376	0.104
64       Bhutan to LME#34. Bay of Bengal       1.207       17.587       0.176         68       Bolivia to LME#13. Humboldt Current       1.531       22.293       0.0231         70       Bosnia and Herzegovina to LME#26. Mediterranean       0.657       9.1321       0.014         71       Botswana to LME#10. Agulhas Current       0.959       13.371       0.140         76       Brazil to LME#15. South Brazil Sheff       1.311       19.099       0.191         Brazil to LME#12. Caribbean Sea       0.712       10.376       0.104         70       Bulgaria to LME#26. Mediterranean       0.627       9.132       0.091         Bulgaria to LME#26. Mediterranean       0.627       9.132       0.091         Bulgaria to LME#26. Mediterranean       0.627       9.132       0.091         Bulgaria to LME#28. Glack Sea       1.207       17.587       0.176         112       Belarus to LME#28. Black Sea       1.207       17.587       0.176         120       Cameroon to LME#28. Guinea Current       1.763       25.685       0.257         121       Canada to LME#36. Sliffornia Current       0.751       1.208       0.233         122       China, People's Republic of to LME#37. South China Sea       0.711       0.4041	50	Bangladesh to LME#34. Bay of Bengal				1.207	17.587	0.176
68         Bolivia to LME#13. Humboldt Current         1.531         22.293         0.223           70         Bosnia and Herzegovina to LME#26. Mediterranean         0.627         9.132         0.091           72         Botswana to LME#30. Agulhas Current         0.959         13.971         0.140           76         Brazil to LME#15. South Brazil Shelf         0.493         7.178         0.072           Brazil to LME#17. North Brazil Shelf         2.304         33.552         0.336           84         Belize to LME#12. Caribbean Sea         0.712         10.376         0.104           92         Virgin Islands (British) to LME#12. Caribbean Sea         0.712         10.376         0.104           100         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           Bulgaria to LME#28. Guide Gragal         1.007         17.537         0.176           120         Cameron to LME#28. Guinea Current         1.763         25.685         0.257           124	56	Belgium to LME#22. North Sea				2.075	30.230	0.302
70         bosnia and Herzegovina to LME#26. Mediterranean         0.627         9.132         0.091           72         botswana to LME#30. Agulhas Current         0.599         13.971         0.140           76         brazil to LME#15. South Brazil Shelf         1.311         19.099         0.191           Brazil to LME#15. South Brazil Shelf         2.304         33.552         0.336           84         Belize to LME#12. Caribbean Sea         0.712         10.376         0.104           92         virgin Islands (British) to LME#12. Caribbean Sea         0.627         9.132         0.091           80         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           80         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.014           108         Myanmar to LME#26. Mediterranean         0.627         9.132         0.014           112         Belarus to LME#26. Mediterranean         0.627         9.132         0.176           112         Belarus to LME#26. Guifon Auska         1.763         2.568         0.257           114         Ganada to LME#28. Guinae Current         1.763         2.568         0.223           124         Ganada to LME#28. Budon Bay         0.015         0.223 </td <td>64</td> <td>Bhutan to LME#34. Bay of Bengal</td> <td></td> <td></td> <td></td> <td>1.207</td> <td></td> <td>0.176</td>	64	Bhutan to LME#34. Bay of Bengal				1.207		0.176
72         Botswana to LME#30. Agulhas Current         0.959         13.971         0.140           76         Brazil to LME#13. South Brazil Shelf         1.311         19.099         0.191           Brazil to LME#15. South Brazil Shelf         0.493         7.178         0.072           Brazil to LME#12. Caribbean Sea         0.712         10.376         0.104           92         Wrgin Islands (British) to LME#12. Caribbean Sea         0.712         10.376         0.104           100         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           Bulgaria to LME#30. Sulforia Current         0.975         14.205         0.176           112         Belarus to LME#32. Baltic Sea         4.095         59.640         0.596           116         Cambodia to LME#3. Guinea Current         1.763         25.685         0.257           120         Cameroon to LME#28. Guinea Current         1.597         23.261         0.038           1214         Canada to LME#63. Hudson Bay         0.601         8.760         0.008           122         Canada to LME#63. Hudson Bay         0.015         0.225         0.002           123	68	Bolivia to LME#13. Humboldt Current				1.531	22.293	0.223
72         Botswana to LME#30. Agulhas Current         0.959         13.971         0.140           76         Brazil to LME#13. South Brazil Shelf         1.311         19.099         0.191           Brazil to LME#15. South Brazil Shelf         0.493         7.178         0.072           Brazil to LME#12. Caribbean Sea         0.712         10.376         0.104           92         Wrgin Islands (British) to LME#12. Caribbean Sea         0.712         10.376         0.104           100         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           Bulgaria to LME#30. Sulforia Current         0.975         14.205         0.176           112         Belarus to LME#32. Baltic Sea         4.095         59.640         0.596           116         Cambodia to LME#3. Guinea Current         1.763         25.685         0.257           120         Cameroon to LME#28. Guinea Current         1.597         23.261         0.038           1214         Canada to LME#63. Hudson Bay         0.601         8.760         0.008           122         Canada to LME#63. Hudson Bay         0.015         0.225         0.002           123	70	Bosnia and Herzegovina to LME#26. Mediterranean				0.627	9.132	0.091
76         Brazil to LME#15. South Brazil Shelf         1.311         19.099         0.191           Brazil to LME#15. South Brazil Shelf         0.493         7.178         0.072           Brazil to LME#17. North Brazil Shelf         2.304         33.552         0.336           84         Belize to LME#12. Caribbean Sea         0.712         10.376         0.104           92         Virgin Islands (British) to LME#12. Caribbean Sea         0.627         9.132         0.091           Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           Bulgaria to LME#3. Bay of Bengal         1.207         17.587         0.176           112         Belarus to LME#3. Bay of Bengal         1.207         17.587         0.142           1200         Cameroon to LME#3. Galifornia Current         0.975         14.205         0.142           1210         Cameda to LME#3. Guif of Alaska         1.563         2.257         1124           1214         Canada to LME#3. Hudson Bay         0.601         8.760         0.088           1214         Canada to LME#3. Netfoundland-tabrador Shelf         1.384         20.162         0.202           1214         Canada to LME#3. Sotian Shelf         0.711         0.349         0.176         0.176	72	Botswana to LME#30. Agulhas Current				0.959		
Brazil to LME#16. East Brazil Shelf         0.072         0.072           Brazil to LME#17. North Brazil Shelf         2.304         33.552         0.336           84         Belize to LME#12. Caribbean Sea         0.712         10.376         0.104           92         Virgin Islands (British) to LME#12. Caribbean Sea         0.712         0.376         0.104           100         Bulgaria to LME#36. Mediterranean         0.712         0.312         0.091           101         Bulgaria to LME#36. Mediterranean         0.702         7.382         0.071           101         Myanmar to LME#34. Bay of Bengal         1.207         17.587         0.176           112         Belarus to LME#32. Guinea Current         1.763         25.685         0.257           114         Canada to LME#32. Guinea Current         1.763         25.685         0.257           112         Canada to LME#32. Guinea Current         1.738         20.162         0.002           114         Canada to LME#32. Guinea Current         1.738         20.162         0.022           114         Sti Lanka to LME#34. Bay of Bengal         1.597         23.261         0.022           1152         Canada to LME#34. Autoion Bay         0.0104         0.0104         0.0104 <tr< td=""><td>76</td><td>Brazil to LME#15. South Brazil Shelf</td><td></td><td></td><td></td><td></td><td></td><td></td></tr<>	76	Brazil to LME#15. South Brazil Shelf						
Brazil to LMEH17. North Brazil Shelf         2.304         33.552         0.336           84         Belize to LMEH12. Caribbean Sea         0.712         10.376         0.104           92         Virgin Islands (British) to LMEH12. Caribbean Sea         0.712         10.376         0.104           100         Bulgaria to LMEH26. Mediterranean         0.627         9.132         0.091           104         Myanmar to LMEH34. Bay of Bengal         1.207         17.587         0.176           112         Belarus to LMEH23. Baltic Sea         4.095         59.640         0.596           112         Cameoon to LMEH23. Guinea Current         1.763         25.685         0.257           124         Canada to LMEH26. Meditor Alaska         1.597         23.261         0.233           Canada to LMEH28. Guinea Current         1.584         20.162         0.002           124         Canada to LMEH3. Hudson Bay         0.601         8.760         0.0088           Canada to LMEH8. Soctian Shelf         1.384         20.162         0.002           124         Sriada to LMEH3. Humboldt Current         1.531         22.293         0.023           125         Chile to LMEH3. Humboldt South China Sea         0.711         10.349         0.103		Brazil to LME#16. East Brazil Shelf				0.493		0.072
91         Virgin Islands (British) to LME#12. Caribbean Sea         0.712         10.376         0.104           100         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           Bulgaria to LME#26. Mediterranean         0.627         9.132         0.021           104         Myanmar to LME#34. Bay of Bengal         1.207         17.587         0.176           112         Belarus to LME#33. Baltic Sea         4.095         59.640         0.596           116         Cambodia to LME#3. California Current         0.975         14.205         0.142           120         Cameon to LME#3. Gulifor Alaska         1.597         23.261         0.233           121         Canada to LME#63. Hudson Bay         0.601         8.760         0.008           122         Canada to LME#63. Hudson Bay         0.601         8.760         0.0202           123         Canada to LME#63. Hudson Bay         0.601         8.760         0.0202           124         Canada to LME#63. Hudson Bay         0.601         8.760         0.0202           124         Striaka to LME#3. Sotian Shelf         2.754         40.111         0.4011           124         Stri Lanka to LME#3. Humboldt Current         1.531         2.2.93         0.		Brazil to LME#17. North Brazil Shelf				2.304		0.336
91         Virgin Islands (British) to LME#12. Caribbean Sea         0.712         10.376         0.104           100         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           Bulgaria to LME#26. Mediterranean         0.627         9.132         0.021           104         Myanmar to LME#34. Bay of Bengal         1.207         17.587         0.176           112         Belarus to LME#33. Baltic Sea         4.095         59.640         0.596           116         Cambodia to LME#3. California Current         0.975         14.205         0.142           120         Cameon to LME#3. Gulifor Alaska         1.597         23.261         0.233           121         Canada to LME#63. Hudson Bay         0.601         8.760         0.008           122         Canada to LME#63. Hudson Bay         0.601         8.760         0.0202           123         Canada to LME#63. Hudson Bay         0.601         8.760         0.0202           124         Canada to LME#63. Hudson Bay         0.601         8.760         0.0202           124         Striaka to LME#3. Sotian Shelf         2.754         40.111         0.4011           124         Stri Lanka to LME#3. Humboldt Current         1.531         2.2.93         0.	84	Belize to LME#12. Caribbean Sea						
100         Bulgaria to LME#26. Mediterranean         0.627         9.132         0.091           Bulgaria to LME#26. Mediterranean         1.880         27.384         0.274           104         Myanmar to LME#34. Bay of Bengal         1.207         17.587         0.176           112         Belarus to LME#23. Baltic Sea         4.095         59.640         0.596           116         Cambodia to LME#32. Galifornia Current         0.975         14.205         0.142           120         Cameroon to LME#28. Guinea Current         1.763         25.685         0.257           124         Canada to LME#63. Hudson Bay         0.601         8.760         0.088           Canada to LME#64. Scotian Shelf         1.384         20.162         0.202           Canada to LME#64. Arctic Ocean         0.015         0.225         0.002           144         Sri Lanka to LME#64. Arctic Ocean         0.015         0.225         0.002           143         Sri Lanka to LME#64. Arctic Ocean         0.112         0.331         0.223           156         China, People's Republic of to LME#36. South China Sea         0.711         0.349         0.103           157         China, People's Republic of to LME#47. East China Sea         0.712         10.376         0.104 <td>92</td> <td>Virgin Islands (British) to LME#12. Caribbean Sea</td> <td></td> <td></td> <td></td> <td>0.712</td> <td></td> <td></td>	92	Virgin Islands (British) to LME#12. Caribbean Sea				0.712		
Bulgaria to LME#62. Black Sea         1.880         27.384         0.274           104         Myanmar to LME#34. Bay of Bengal         1.207         17.587         0.176           112         Belarus to LME#32. Baltic Sea         4.095         59.640         0.596           116         Cambdia to LME#3. California Current         0.975         14.205         0.142           120         Cameroon to LME#28. Guinea Current         1.763         25.685         0.233           124         Canada to LME#3. Hudson Bay         0.601         8.760         0.088           Canada to LME#83. Hudson Bay         0.601         8.760         0.088           Canada to LME#84. Scotian Shelf         2.754         40.111         0.401           Canada to LME#64. Arctic Ocean         0.015         0.225         0.002           144         Sri Lanka to LME#34. Bay of Bengal         1.207         17.587         0.176           152         China, People's Republic of to LME#36. South China Sea         0.711         1.034         0.223           156         China, People's Republic of to LME#47. East China Sea         1.564         22.776         0.228           157         Colombia to LME#11. Pacific Central-American         1.087         15.83         0.158	100	Bulgaria to LME#26. Mediterranean				0.627		
112       Belarus to LME#23. Baltic Sea       4.095       59.640       0.596         116       Cambodia to LME#3. California Current       0.975       14.205       0.142         120       Cameroon to LME#28. Guinea Current       1.763       25.685       0.257         124       Canada to LME#28. Guinea Current       1.763       25.685       0.233         Canada to LME#3. Hudson Bay       0.601       8.760       0.088         Canada to LME#8. Scotian Shelf       1.384       20.162       0.202         Canada to LME#8. Scotian Shelf       2.754       40.111       0.401         Canada to LME#34. Bay of Bengal       1.207       17.587       0.176         125       Chile to LME#34. Bay of Bengal       1.207       17.587       0.176         126       Chile to LME#34. Bay of Bengal       1.207       17.587       0.176         127       Chile to LME#34. Bay of Bengal       1.207       17.587       0.176         128       Chile to LME#34. Bay of Bengal       1.207       17.587       0.176         129       Chila, People's Republic of to LME#36. South China Sea       0.711       10.349       0.103         120       China, People's Republic of to LME#47. East China Sea       1.564       22.776       0.2		Bulgaria to LME#62. Black Sea				1.880	27.384	0.274
116         Cambodia to LME#3. California Current         0.975         14.205         0.142           120         Cameroon to LME#28. Guinea Current         1.763         25.685         0.257           124         Canada to LME#2. Guif of Alaska         1.597         23.261         0.233           Canada to LME#63. Hudson Bay         0.601         8.760         0.008           Canada to LME#9. Newfoundland-Labrador Shelf         1.384         20.162         0.202           Canada to LME#8. Scotian Shelf         2.754         40.111         0.401           Canada to LME#84. Arctic Ocean         0.015         0.225         0.002           144         Sri Lanka to LME#34. Bay of Bengal         1.207         17.587         0.176           155         Chila, People's Republic of to LME#46. South China Sea         0.711         10.349         0.103           China, People's Republic of to LME#47. East China Sea         0.712         10.376         0.228           Colombia to LME#11. Pacific Central-American         1.087         15.832         0.158           Colombia to LME#12. Caribbean Sea         0.712         10.376         0.204           178         Congo to LME#28. Guinea Current         1.763         25.685         0.257           180         Demo	104	Myanmar to LME#34. Bay of Bengal				1.207		0.176
120       Cameroon to LME#28. Guinea Current       1.763       25.685       0.257         124       Canada to LME#2. Gulf of Alaska       1.597       23.261       0.233         Canada to LME#63. Hudson Bay       0.601       8.760       0.088         Canada to LME#9. Newfoundland-Labrador Shelf       1.384       20.162       0.202         Canada to LME#9. Newfoundland-Labrador Shelf       2.754       40.111       0.401         Canada to LME#34. Sotian Shelf       2.754       40.111       0.401         Canada to LME#34. Bay of Bengal       1.207       17.587       0.176         152       Chile to LME#13. Humboldt Current       1.531       22.293       0.223         156       China, People's Republic of to LME#36. South China Sea       0.711       10.349       0.103         China, People's Republic of to LME#48. Yellow Sea       3.308       48.181       0.482         Colombia to LME#12. Caribbean Sea       0.712       10.376       0.104         178       Congo to LME#28. Guinea Current       1.763       25.685       0.257         189       Costa Rica to LME#11. Pacific Central-American       0.712       10.376       0.104         191       Conda to LME#12. Caribbean Sea       0.712       10.376       0.104 <td>112</td> <td>Belarus to LME#23. Baltic Sea</td> <td></td> <td></td> <td></td> <td>4.095</td> <td>59.640</td> <td>0.596</td>	112	Belarus to LME#23. Baltic Sea				4.095	59.640	0.596
124       Canada to LME#2. Gulf of Alaska       1.597       23.261       0.233         Canada to LME#63. Hudson Bay       0.601       8.760       0.088         Canada to LME#63. Hudson Bay       0.601       8.760       0.202         Canada to LME#9. Newfoundland-Labrador Shelf       1.384       20.162       0.202         Canada to LME#8. Scotian Shelf       2.754       40.111       0.401         Canada to LME#44. Arctic Ocean       0.015       0.225       0.002         144       Sri Lanka to LME#34. Bay of Bengal       1.207       17.587       0.176         152       Chile to LME#13. Humboldt Current       1.531       22.293       0.223         156       China, People's Republic of to LME#36. South China Sea       0.711       10.349       0.103         China, People's Republic of to LME#47. East China Sea       1.564       22.776       0.228         China, People's Republic of to LME#48. Yellow Sea       3.308       48.181       0.482         170       Colombia to LME#11. Pacific Central-American       1.087       15.832       0.158         Colombia to LME#11. Pacific Central-American       1.763       25.685       0.257         180       Democratic Republic of the Congo to LME#28. Guinea Current       1.763       25.685 <t< td=""><td>116</td><td>Cambodia to LME#3. California Current</td><td></td><td></td><td></td><td>0.975</td><td>14.205</td><td>0.142</td></t<>	116	Cambodia to LME#3. California Current				0.975	14.205	0.142
Canada to LME#63. Hudson Bay         0.601         8.760         0.088           Canada to LME#9. Newfoundland-Labrador Shelf         1.384         20.162         0.202           Canada to LME#8. Scotian Shelf         2.754         40.111         0.401           Canada to LME#64. Arctic Ocean         0.015         0.225         0.002           144         Sri Lanka to LME#34. Bay of Bengal         1.207         17.587         0.176           152         Chile to LME#13. Humboldt Current         1.531         22.293         0.223           156         China, People's Republic of to LME#36. South China Sea         0.711         10.349         0.103           China, People's Republic of to LME#47. East China Sea         1.564         22.776         0.228           China, People's Republic of to LME#48. Yellow Sea         3.308         48.181         0.482           Colombia to LME#11. Pacific Central-American         1.087         15.832         0.158           Colombia to LME#12. Caribbean Sea         0.712         10.376         0.257           188         Costa Rica to LME#11. Pacific Central-American         1.087         15.832         0.158           Costa Rica to LME#11. Pacific Central-American         1.087         15.832         0.158           Costa Rica to LME#11. Paci	120	Cameroon to LME#28. Guinea Current				1.763	25.685	0.257
Canada to LME#9. Newfoundlad-Labrador Shelf         1.384         20.162         0.202           Canada to LME#8. Scotian Shelf         2.754         40.111         0.401           Canada to LME#64. Arctic Ocean         0.015         0.225         0.002           144         Sri Lanka to LME#34. Bay of Bengal         1.207         17.587         0.176           152         Chile to LME#13. Humboldt Current         1.531         22.293         0.223           156         China, People's Republic of to LME#36. South China Sea         0.711         10.349         0.103           China, People's Republic of to LME#47. East China Sea         1.564         22.776         0.228           China, People's Republic of to LME#48. Yellow Sea         3.308         48.181         0.482           170         Colombia to LME#11. Pacific Central-American         1.087         15.832         0.158           Colombia to LME#12. Caribbean Sea         0.712         10.376         0.104           178         Congo to LME#28. Guinea Current         1.763         25.685         0.257           180         Democratic Republic of the Congo to LME#28. Guinea Current         1.763         25.685         0.257           180         Costa Rica to LME#11. Pacific Central-American         1.087         15.832	124	Canada to LME#2. Gulf of Alaska				1.597	23.261	0.233
Canada to LME#8. Scotian Shelf2.75440.1110.401Canada to LME#64. Arctic Ocean0.0150.2250.002144Sri Lanka to LME#34. Bay of Bengal1.20717.5870.176152Chile to LME#13. Humboldt Current1.53122.2930.223156China, People's Republic of to LME#36. South China Sea0.71110.3490.103157Colombia to LME#11. Pacific Central-American1.08715.8320.228158Colombia to LME#12. Caribbean Sea0.71210.3760.104178Congo to LME#28. Guinea Current1.76325.6850.257188Costa Rica to LME#11. Pacific Central-American1.08715.8320.158199Costa Rica to LME#11. Pacific Central-American1.08715.8320.158190Democratic Republic of the Congo to LME#28. Guinea Current1.76325.6850.257191Costa Rica to LME#11. Pacific Central-American0.6279.1320.004192Cuba to LME#26. Mediterranean0.6279.1320.091192Cuba to LME#21. Caribbean Sea0.71210.3760.104		Canada to LME#63. Hudson Bay				0.601	8.760	0.088
Canada to LME#64. Arctic Ocean         0.015         0.225         0.002           144         Sri Lanka to LME#34. Bay of Bengal         1.207         17.587         0.176           152         Chile to LME#13. Humboldt Current         1.531         22.293         0.223           156         China, People's Republic of to LME#36. South China Sea         0.711         10.349         0.103           157         China, People's Republic of to LME#47. East China Sea         1.564         22.776         0.228           170         Colombia to LME#11. Pacific Central-American         1.087         15.832         0.158           170         Colombia to LME#11. Pacific Central-American         1.763         25.685         0.257           178         Congo to LME#28. Guinea Current         1.763         25.685         0.257           180         Democratic Republic of the Congo to LME#28. Guinea Current         1.087         15.832         0.158           180         Costa Rica to LME#11. Pacific Central-American         1.087         15.832         0.158           180         Democratic Republic of the Congo to LME#28. Guinea Current         1.763         25.685         0.257           181         Costa Rica to LME#11. Pacific Central-American         0.712         10.376         0.104		Canada to LME#9. Newfoundland-Labrador Shelf				1.384	20.162	0.202
144       Sri Lanka to LME#34. Bay of Bengal       1.207       17.587       0.176         152       Chile to LME#13. Humboldt Current       1.531       22.293       0.223         156       China, People's Republic of to LME#36. South China Sea       0.711       10.349       0.103         China, People's Republic of to LME#47. East China Sea       1.564       22.776       0.228         China, People's Republic of to LME#47. East China Sea       1.687       15.832       0.158         China, People's Republic of to LME#48. Yellow Sea       3.308       48.181       0.482         170       Colombia to LME#11. Pacific Central-American       1.087       15.832       0.158         Colombia to LME#12. Caribbean Sea       0.712       10.376       0.104         178       Congo to LME#28. Guinea Current       1.763       25.685       0.257         180       Democratic Republic of the Congo to LME#28. Guinea Current       1.763       25.685       0.257         188       Costa Rica to LME#11. Pacific Central-American       1.087       15.832       0.158         Costa Rica to LME#12. Caribbean Sea       0.712       10.376       0.104         191       Croatia to LME#12. Caribbean Sea       0.712       10.376       0.104         192       Cu		Canada to LME#8. Scotian Shelf				2.754	40.111	0.401
144       Sri Lanka to LME#34. Bay of Bengal       1.207       17.587       0.176         152       Chile to LME#13. Humboldt Current       1.531       22.293       0.223         156       China, People's Republic of to LME#36. South China Sea       0.711       10.349       0.103         China, People's Republic of to LME#47. East China Sea       1.564       22.776       0.228         China, People's Republic of to LME#48. Yellow Sea       3.308       48.181       0.482         170       Colombia to LME#11. Pacific Central-American       1.087       15.832       0.158         Colombia to LME#12. Caribbean Sea       0.712       10.376       0.104         178       Congo to LME#28. Guinea Current       1.763       25.685       0.257         180       Democratic Republic of the Congo to LME#28. Guinea Current       1.087       15.832       0.158         188       Costa Rica to LME#11. Pacific Central-American       1.087       15.832       0.158         188       Costa Rica to LME#11. Pacific Central-American       1.087       15.832       0.158         194       Croatia to LME#12. Caribbean Sea       0.712       10.376       0.104         194       Cotata to LME#26. Mediterranean       0.627       9.132       0.091		Canada to LME#64. Arctic Ocean				0.015	0.225	0.002
156       China, People's Republic of to LME#36. South China Sea       0.711       10.349       0.103         China, People's Republic of to LME#47. East China Sea       1.564       22.776       0.228         China, People's Republic of to LME#48. Yellow Sea       3.308       48.181       0.482         170       Colombia to LME#11. Pacific Central-American       1.087       15.832       0.158         Colombia to LME#12. Caribbean Sea       0.712       10.376       0.104         178       Congo to LME#28. Guinea Current       1.763       25.685       0.257         180       Democratic Republic of the Congo to LME#28. Guinea Current       1.087       15.832       0.158         180       Costa Rica to LME#11. Pacific Central-American       1.087       15.832       0.158         180       Costa Rica to LME#11. Pacific Central-American       1.087       15.832       0.158         180       Costa Rica to LME#11. Pacific Central-American       1.087       15.832       0.158         191       Croatia to LME#26. Mediterranean       0.627       9.132       0.091         192       Cuba to LME#12. Caribbean Sea       0.712       10.376       0.104	144	Sri Lanka to LME#34. Bay of Bengal						
China, People's Republic of to LME#47. East China Sea1.56422.7760.228China, People's Republic of to LME#48. Yellow Sea3.30848.1810.482170Colombia to LME#11. Pacific Central-American1.08715.8320.158Colombia to LME#12. Caribbean Sea0.71210.3760.104178Congo to LME#28. Guinea Current1.76325.6850.257180Democratic Republic of the Congo to LME#28. Guinea Current1.76325.6850.257188Costa Rica to LME#11. Pacific Central-American1.08715.8320.158199Costa Rica to LME#12. Caribbean Sea0.71210.3760.104191Croatia to LME#26. Mediterranean0.6279.1320.091192Cuba to LME#12. Caribbean Sea0.71210.3760.104	152	Chile to LME#13. Humboldt Current				1.531	22.293	0.223
China, People's Republic of to LME#48. Yellow Sea3.30848.1810.482170Colombia to LME#11. Pacific Central-American1.08715.8320.158Colombia to LME#12. Caribbean Sea0.71210.3760.104178Congo to LME#28. Guinea Current1.76325.6850.257180Democratic Republic of the Congo to LME#28. Guinea Current1.76325.6850.257188Costa Rica to LME#11. Pacific Central-American1.08715.8320.158198Costa Rica to LME#12. Caribbean Sea0.71210.3760.104191Croatia to LME#26. Mediterranean0.6279.1320.091192Cuba to LME#12. Caribbean Sea0.71210.3760.104	156	China, People's Republic of to LME#36. South China S	Sea			0.711	10.349	0.103
170       Colombia to LME#11. Pacific Central-American       1.087       15.832       0.158         Colombia to LME#12. Caribbean Sea       0.712       10.376       0.104         178       Congo to LME#28. Guinea Current       1.763       25.685       0.257         180       Democratic Republic of the Congo to LME#28. Guinea Current       1.763       25.685       0.257         188       Costa Rica to LME#11. Pacific Central-American       1.087       15.832       0.158         Costa Rica to LME#12. Caribbean Sea       0.712       10.376       0.104         191       Croatia to LME#26. Mediterranean       0.627       9.132       0.091         192       Cuba to LME#12. Caribbean Sea       0.712       10.376       0.104		China, People's Republic of to LME#47. East China Se	a			1.564	22.776	0.228
Colombia to LME#12. Caribbean Sea         0.712         10.376         0.104           178         Congo to LME#28. Guinea Current         1.763         25.685         0.257           180         Democratic Republic of the Congo to LME#28. Guinea Current         1.763         25.685         0.257           188         Costa Rica to LME#11. Pacific Central-American         1.087         15.832         0.158           Costa Rica to LME#12. Caribbean Sea         0.712         10.376         0.104           191         Croatia to LME#26. Mediterranean         0.627         9.132         0.091           192         Cuba to LME#12. Caribbean Sea         0.712         10.376         0.104		China, People's Republic of to LME#48. Yellow Sea				3.308	48.181	0.482
Colombia to LME#12. Caribbean Sea         0.712         10.376         0.104           178         Congo to LME#28. Guinea Current         1.763         25.685         0.257           180         Democratic Republic of the Congo to LME#28. Guinea Current         1.763         25.685         0.257           188         Costa Rica to LME#11. Pacific Central-American         1.087         15.832         0.158           Costa Rica to LME#12. Caribbean Sea         0.712         10.376         0.104           191         Croatia to LME#26. Mediterranean         0.627         9.132         0.091           192         Cuba to LME#12. Caribbean Sea         0.712         10.376         0.104	170	Colombia to LME#11. Pacific Central-American				1.087	15.832	0.158
180         Democratic Republic of the Congo to LME#28. Guinea Current         1.763         25.685         0.257           188         Costa Rica to LME#11. Pacific Central-American         1.087         15.832         0.158           Costa Rica to LME#12. Caribbean Sea         0.712         10.376         0.104           191         Croatia to LME#26. Mediterranean         0.627         9.132         0.091           192         Cuba to LME#12. Caribbean Sea         0.712         10.376         0.104		Colombia to LME#12. Caribbean Sea				0.712		0.104
188         Costa Rica to LME#11. Pacific Central-American         1.087         15.832         0.158           Costa Rica to LME#12. Caribbean Sea         0.712         10.376         0.104           191         Croatia to LME#26. Mediterranean         0.627         9.132         0.091           192         Cuba to LME#12. Caribbean Sea         0.712         10.376         0.104	178	Congo to LME#28. Guinea Current				1.763	25.685	0.257
Costa Rica to LME#12. Caribbean Sea         0.712         10.376         0.104           191         Croatia to LME#26. Mediterranean         0.627         9.132         0.091           192         Cuba to LME#12. Caribbean Sea         0.712         10.376         0.104	180	Democratic Republic of the Congo to LME#28. Guinea	a Current			1.763	25.685	0.257
Costa Rica to LME#12. Caribbean Sea         0.712         10.376         0.104           191         Croatia to LME#26. Mediterranean         0.627         9.132         0.091           192         Cuba to LME#12. Caribbean Sea         0.712         10.376         0.104	188	Costa Rica to LME#11. Pacific Central-American				1.087	15.832	0.158
191       Croatia to LME#26. Mediterranean       0.627       9.132       0.091         192       Cuba to LME#12. Caribbean Sea       0.712       10.376       0.104		Costa Rica to LME#12. Caribbean Sea				0.712	10.376	
	191	Croatia to LME#26. Mediterranean				0.627		0.091
	192	Cuba to LME#12. Caribbean Sea				0.712		
	196	Cyprus to LME#26. Mediterranean				0.627	9.132	0.091





				. I
203	Czech Republic to LME#22. North Sea	2.075	30.230	0.302
204	Benin to LME#28. Guinea Current	1.763	25.685	0.257
208	Denmark to LME#22. North Sea	2.075	30.230	0.302
	Denmark to LME#23. Baltic Sea	4.095	59.640	0.596
	Denmark to LME#60. Faroe Plateau	0.609	8.866	0.089
214	Dominican Republic to LME#12. Caribbean Sea	0.712	10.376	0.104
218	Ecuador to LME#11. Pacific Central-American	1.087	15.832	0.158
222	El Salvador to LME#11. Pacific Central-American	1.087	15.832	0.158
226	Equatorial Guinea to LME#28. Guinea Current	1.763	25.685	0.257
231	Ethiopia to LME#32. Arabian Sea	1.968	28.664	0.287
	Ethiopia to LME#33. Red Sea	1.402	20.414	0.204
232	Eritrea to LME#33. Red Sea	1.402	20.414	0.204
233	Estonia to LME#23. Baltic Sea	4.095	59.640	0.596
238	Falkland Islands (Malvinas) to LME#14. Patagonian Shelf	2.754	40.111	0.401
246	Finland to LME#23. Baltic Sea	4.095	59.640	0.596
250	France to LME#22. North Sea	2.075	30.230	0.302
	France to LME#24. Celtic-Biscay Shelf	1.709	24.893	0.249
	France to LME#26. Mediterranean	0.627	9.132	0.091
262	Djibouti to LME#32. Arabian Sea	1.968	28.664	0.287
266	Gabon to LME#28. Guinea Current	1.763	25.685	0.257
268	Georgia to LME#62. Black Sea	1.880	27.384	0.274
270	Gambia to LME#28. Guinea Current	1.763	25.685	0.257
276	Germany to LME#22. North Sea	2.075	30.230	0.302
	Germany to LME#23. Baltic Sea	4.095	59.640	0.596
288	Ghana to LME#28. Guinea Current	1.763	25.685	0.257
300	Greece to LME#26. Mediterranean	0.627	9.132	0.091
320	Guatemala to LME#11. Pacific Central-American	1.087	15.832	0.158
	Guatemala to LME#12. Caribbean Sea	0.712	10.376	0.104
324	Guinea to LME#28. Guinea Current	1.763	25.685	0.257
328	Guyana to LME#17. North Brazil Shelf	2.304	33.552	0.336
332	Haiti to LME#12. Caribbean Sea	0.712	10.376	0.104
	Honduras to LME#12. Caribbean Sea	0.712	10.376	0.104
	Hungary to LME#62. Black Sea	1.880	27.384	0.274
	Iceland to LME#59. Iceland Shelf	0.852	12.416	0.124
	India to LME#32. Arabian Sea	1.968	28.664	0.287
	India to LME#34. Bay of Bengal	1.207	17.587	0.176
	Indonesia to LME#38. Indonesian Sea	1.199	17.465	0.175
	Iran, Islamic Republic of to LME#32. Arabian Sea	1.968	28.664	0.287
	Iraq to LME#32. Arabian Sea	1.968	28.664	0.287
	Ireland to LME#24. Celtic-Biscay Shelf	1.709	24.893	0.249
	Israel to LME#26. Mediterranean	0.627	9.132	0.091
	Italy to LME#26. Mediterranean	0.627	9.132	0.091
	Kosovo to LME#26. Mediterranean	0.627	9.132	0.091
	Côte d'Ivoire to LME#28. Guinea Current	1.763	25.685	0.257
	Jamaica to LME#12. Caribbean Sea	0.712	10.376	0.104
	Japan to LME#47. East China Sea	1.564	22.776	0.228
	Japan to LME#49. Kuroshio Current	0.609	8.866	0.089
	Japan to LME#50. Sea of Japan/East Sea	0.957	13.942	0.139
	Japan to LME#51. Oyashio Current	1.186	17.282	0.133
	Japan to LME#52. Sea of Okhotsk	1.397	20.351	0.204
	Jordan to LME#33. Red Sea	1.402	20.331	0.204
	Kenya to LME#31. Somali Coastal Current	1.402	20.414 16.282	0.163
-	Democratic People's Republic of Korea to LME#47. East China Sea	1.564	22.776	0.228
408	Democratic People's Republic of Korea to LME#48. Yellow Sea	3.308	48.181	0.482
	Democratic People's Republic of Korea to LME#40. Sea of Japan/East Sea	0.957	48.181 13.942	0.482
		0.957	13.342	0.135





410	Republic of Korea to LME#47. East China Sea	1.564	22.776	0.228
	Republic of Korea to LME#48. Yellow Sea	3.308	48.181	0.482
	Republic of Korea to LME#50. Sea of Japan/East Sea	0.957	13.942	0.139
418	Lao People's Democratic Republic to LME#36. South China Sea	0.711	10.349	0.103
422	Lebanon to LME#26. Mediterranean	0.627	9.132	0.091
428	Latvia to LME#23. Baltic Sea	4.095	59.640	0.596
430	Liberia to LME#28. Guinea Current	1.763	25.685	0.257
434	Libyan Arab Jamahiriya to LME#26. Mediterranean	0.627	9.132	0.091
440	Lithuania to LME#23. Baltic Sea	4.095	59.640	0.596
450	Madagascar to LME#30. Agulhas Current	0.959	13.971	0.140
458	Malaysia to LME#34. Bay of Bengal	1.207	17.587	0.176
	Malaysia to LME#35. Gulf of Thailand	1.322	19.254	0.193
	Malaysia to LME#36. South China Sea	0.711	10.349	0.103
466	Mali to LME#27. Canary Current	2.268	33.028	0.330
	Mali to LME#28. Guinea Current	1.763	25.685	0.257
478	Mauritania to LME#27. Canary Current	2.268	33.028	0.330
484	Mexico to LME#3. California Current	0.975	14.205	0.142
	Mexico to LME#4. Gulf of California	2.275	33.133	0.331
	Mexico to LME#5. Gulf of Mexico	0.890	12.959	0.130
498	Moldova to LME#62. Black Sea	1.880	27.384	0.274
499	Montenegro to LME#26. Mediterranean	0.627	9.132	0.091
504	Morocco to LME#26. Mediterranean	0.627	9.132	0.091
	Morocco to LME#27. Canary Current	2.268	33.028	0.330
508	Mozambique to LME#30. Agulhas Current	0.959	13.971	0.140
512	Oman to LME#32. Arabian Sea	1.968	28.664	0.287
516	Namibia to LME#29. Benguela Current	2.734	39.821	0.398
524	Nepal to LME#34. Bay of Bengal	1.207	17.587	0.176
528	Netherlands to LME#22. North Sea	2.075	30.230	0.302
540	New Caledonia to LME#40. Northeast Australia	0.495	7.204	0.072
554	New Zealand to LME#46. New Zealand Shelf	0.890	12.959	0.130
558	Nicaragua to LME#11. Pacific Central-American	1.087	15.832	0.158
	Nicaragua to LME#12. Caribbean Sea	0.712	10.376	0.104
562	Niger to LME#28. Guinea Current	1.763	25.685	0.257
566	Nigeria to LME#28. Guinea Current	1.763	25.685	0.257
578	Norway to LME#21. Norwegian Sea	0.737	10.734	0.107
	Norway to LME#22. North Sea	2.075	30.230	0.302
586	Pakistan to LME#32. Arabian Sea	1.968	28.664	0.287
591	Panama to LME#11. Pacific Central-American	1.087	15.832	0.158
	Panama to LME#12. Caribbean Sea	0.712	10.376	0.104
600	Paraguay to LME#14. Patagonian Shelf	2.754	40.111	0.401
604	Peru to LME#13. Humboldt Current	1.531	22.293	0.223
608	Philippines to LME#36. South China Sea	0.711	10.349	0.103
000	Philippines to LME#37. Sulu-Celebes Sea	0.896	13.045	0.130
616	Poland to LME#23. Baltic Sea	4.095	59.640	0.596
	Portugal to LME#25. Iberian Coastal	1.275	18.571	0.186
	Guinea-Bissau to LME#28. Guinea Current	1.763	25.685	0.257
	Timor-Leste to LME#28. Indonesian Sea	1.199	17.465	0.175
	Puerto Rico to LME#12. Caribbean Sea	0.712	10.376	0.104
	Romania to LME#62. Black Sea	1.880	27.384	0.104
-	Russian Federation to LME#20. Barents Sea			
o43		0.594	8.654	0.087
	Russian Federation to LME#54. Chukchi Sea	0.313	4.555	0.046
	Russian Federation to LME#56. East Siberian Sea	0.164	2.382	0.024
	Russian Federation to LME#57. Laptev Sea	0.621	9.052 6.025	0.091
	Russian Federation to LME#58. Kara Sea	0.475	6.925	0.069
	Russian Federation to LME#62. Black Sea	1.880	27.384	0.274





	Russian Federation to LME#64. Arctic Ocean	0.015	0.225	0.002
	Russian Federation to LME#50. Sea of Japan/East Sea	0.957	13.942	0.139
	Russian Federation to LME#51. Oyashio Current	1.186	17.282	0.173
	Russian Federation to LME#52. Sea of Okhotsk	1.397	20.351	0.204
	Russian Federation to LME#53. West Bering Sea	0.921	13.419	0.134
682	Saudi Arabia to LME#32. Arabian Sea	1.968	28.664	0.287
	Saudi Arabia to LME#33. Red Sea	1.402	20.414	0.204
606	Senegal to LME#27. Canary Current	2.268	33.028	0.330
		2.200	001020	0.000
688	Serbia to LME#62. Black Sea	1.880	27.384	0.274
	Serbia to LME#26. Mediterranean	0.627	9.132	0.091
694	Sierra Leone to LME#28. Guinea Current	1.763	25.685	0.257
703	Slovakia to LME#62. Black Sea	1.880	27.384	0.274
704	Viet Nam to LME#36. South China Sea	0.711	10.349	0.103
705	Slovenia to LME#26. Mediterranean	0.627	9.132	0.091
706	Somalia to LME#31. Somali Coastal Current	1.118	16.282	0.163
	Somalia to LME#32. Arabian Sea	1.968	28.664	0.287
710	South Africa to LME#29. Benguela Current	2.734	39.821	0.398
	South Africa to LME#30. Agulhas Current	0.959	13.971	0.140
716	Zimbabwe to LME#30. Agulhas Current	0.959	13.971	0.140
724	Spain to LME#25. Iberian Coastal	1.275	18.571	0.186
	Spain to LME#26. Mediterranean	0.627	9.132	0.091
736	Sudan to LME#33. Red Sea	1.402	20.414	0.204
748	Swaziland to LME#30. Agulhas Current	0.959	13.971	0.140
752	Sweden to LME#23. Baltic Sea	4.095	59.640	0.596
	Sweden to LME#22. North Sea	2.075	30.230	0.302
756	Switzerland to LME#22. North Sea	2.075	30.230	0.302
	Switzerland to LME#26. Mediterranean	0.627	9.132	0.091
	Switzerland to LME#62. Black Sea	1.880	27.384	0.274
760	Syrian Arab Republic to LME#26. Mediterranean	0.627	9.132	0.091
	Thailand to LME#34. Bay of Bengal	1.207	17.587	0.176
	Togo to LME#28. Guinea Current	1.763	25.685	0.257
	United Arab Emirates to LME#32. Arabian Sea	1.968	28.664	0.287
	Tunisia to LME#26. Mediterranean	0.627	9.132	0.091
	Turkey to LME#26. Mediterranean	0.627	9.132	0.091
	Uganda to LME#26. Mediterranean	0.627	9.132	0.091
	Ukraine to LME#62. Black Sea	1.880	27.384	0.274
	The FYR of Macedonia to LME#26. Mediterranean	0.627	9.132	0.091
	Egypt to LME#26. Mediterranean	0.627	9.132	0.091
	United Kingdom of GB and NI to LME#22. North Sea	2.075	30.230	0.302
020	United Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf	1.709	24.893	0.249
834	United Republic of Tanzania: Mainland to LME#30. Agulhas Current	0.959	13.971	0.140
	United States to LME#1. East Bering Sea	1.326	19.317	0.193
840	United States to LME#2. Gulf of Alaska	1.520	23.261	0.233
	United States to LME#3. California Current	0.975	14.205	0.142
	United States to LME#4. Gulf of California	2.275	33.133	0.331
	United States to LME#5. Gulf of Mexico	0.890	12.959	0.130
	United States to LME#6. Southeast U.S. Continental Shelf	1.197	17.434	0.130
	United States to LME#7. Northeast U.S. Continental Shelf	3.110	45.296	0.174
	United States to LME#10. Insular Pacific-Hawaiian	0.286	43.290	0.433
	United States to LME#10. Insular Pacific-Hawanan United States to LME#54. Chukchi Sea	0.280	4.100	0.042
	United States to LME#55. Beaufort Sea			0.046
000	Uruguay to LME#14. Patagonian Shelf	0.439	6.401	0.064
	Venezuela (Bolivarian Republic of) to LME#12. Caribbean Sea	2.754	40.111	
		0.712	10.376	0.104
	Yemen to LME#32. Arabian Sea	1.968	28.664	0.287
894	Zambia to LME#30. Agulhas Current	0.959	13.971	0.140





#### Appendix 3-XI: Effect

 Table 3.14: Effect Factors (EF) per LME based on the results per climate zone.

LME		EF	LME		EF
#. name	#	PAF.m <sup>3</sup> /kgO <sub>2</sub>	#. name	#	PAF.m <sup>3</sup> /kgO <sub>2</sub>
1. East Bering Sea	1	3.10E+02	33. Red Sea	33	3.42E+02
2. Gulf of Alaska	2	3.68E+02	34. Bay of Bengal	34	3.42E+02
3. California Current	3	2.96E+02	35. Gulf of Thailand	35	3.42E+02
4. Gulf of California	4	2.96E+02	36. South China Sea	36	3.42E+02
5. Gulf of Mexico	5	2.96E+02	37. Sulu-Celebes Sea	37	3.42E+02
6. Southeast U.S. Continental Shelf	6	2.96E+02	38. Indonesian Sea	38	3.42E+02
7. Northeast U.S. Continental Shelf	7	3.68E+02	39. North Australia	39	3.42E+02
8. Scotian Shelf	8	3.68E+02	40. Northeast Australia	40	3.42E+02
9. Newfoundland-Labrador Shelf	9	3.10E+02	41. East-Central Australia	41	2.96E+02
10. Insular Pacific-Hawaiian	10	3.42E+02	42. Southeast Australia	42	3.68E+02
11. Pacific Central-American	11	3.42E+02	43. Southwest Australia	43	3.68E+02
12. Caribbean Sea	12	3.42E+02	44. West-Central Australia	44	2.96E+02
13. Humboldt Current	13	3.68E+02	45. Northwest Australia	45	3.42E+02
14. Patagonian Shelf	14	3.68E+02	46. New Zealand Shelf	46	3.68E+02
15. South Brazil Shelf	15	2.96E+02	47. East China Sea	47	2.96E+02
16. East Brazil Shelf	16	3.42E+02	48. Yellow Sea	48	3.68E+02
17. North Brazil Shelf	17	3.42E+02	49. Kuroshio Current	49	2.96E+02
18. West Greenland Shelf	18	3.01E+02	50. Sea of Japan/East Sea	50	3.68E+02
19. East Greenland Shelf	19	3.01E+02	51. Oyashio Current	51	3.68E+02
20. Barents Sea	20	3.01E+02	52. Sea of Okhotsk	52	3.10E+02
21. Norwegian Sea	21	3.10E+02	53. West Bering Sea	53	3.10E+02
22. North Sea	22	3.68E+02	54. Chukchi Sea	54	3.01E+02
23. Baltic Sea	23	3.10E+02	55. Beaufort Sea	55	3.01E+02
24. Celtic-Biscay Shelf	24	3.68E+02	56. East Siberian Sea	56	3.01E+02
25. Iberian Coastal	25	3.68E+02	57. Laptev Sea	57	3.01E+02
26. Mediterranean	26	2.96E+02	58. Kara Sea	58	3.01E+02
27. Canary Current	27	2.96E+02	59. Iceland Shelf	59	3.10E+02
28. Guinea Current	28	3.42E+02	60. Faroe Plateau	60	3.68E+02
29. Benguela Current	29	2.96E+02	61. Antarctic	61	3.01E+02
30. Agulhas Current	30	2.96E+02	62. Black Sea	62	3.68E+02
31. Somali Coastal Current	31	3.42E+02	63. Hudson Bay	63	3.01E+02
32. Arabian Sea	32	3.42E+02	64. Arctic Ocean	64	3.01E+02





#### **Appendix 3-XII: Characterisation Factors**

**Table 3.15:** Characterisation Factors (CF) per emission route at the Country-to-LME and Country scales.

		emission route:	N to	Air	N to	sfw	N to gw		N to mw	
		spatial scale:	Country	Country-to-LME	Country	Country-to-LME	Country	Country-to-LME		Country-to-
Country	Country-to-LME Albania to LME#26. Mediterranean	unit:		PAF.m <sup>3</sup> .d/kgN	PAF.m <sup>3</sup> .d/kgN	PAF.m <sup>3</sup> .d/kgN 11.128.87	PAF.m <sup>3</sup> .d/kgN	PAF.m <sup>3</sup> .d/kgN		PAF.m <sup>3</sup> .d/l
Albania Algeria	Albania to LME#26. Mediterranean Algeria to LME#26. Mediterranean		7,606.07 7,211.38	7,606.07 7,211.38	11,128.87 11,128.87	11,128.87 11,128.87	3,940.04 3,940.04	3,940.04 3,940.04	23,528.27 23,528.27	23,521 23,521
Angola	Angola to LME#20. Mediterranean Angola to LME#29. Benguela Current		2,490.13	2,490.13	4,613.74	4,613.74	1,633.44	1,633.44	9,754.22	9,75
Argentina	Argentina to LME#14. Patagonian Shelf		4,416.45	4,416.45	5,793.14	5,793.14	2,050.99	2,050.99	12,247.66	12,24
Australia	Australia to LME#39. North Australia		550.68	154.64	11,019.20	3,094.40	3,901.21	1,095.53	23,296.40	6,54
7	Australia to LME#40. Northeast Australia			48.29	,	966.37	-,	342.13		2,04
	Australia to LME#41. East-Central Australia			52.72		1,054.97		373.50		2,23
	Australia to LME#42. Southeast Australia			81.68		1,634.43		578.65		3,45
	Australia to LME#43. Southwest Australia			78.27		1,566.22		554.50		3,31
	Australia to LME#44. West-Central Australia			59.76		1,195.88		423.39		2,52
	Australia to LME#45. Northwest Australia			75.31		1,506.92		533.51		3,18
Austria	Austria to LME#26. Mediterranean		5,986.51	5,986.51	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,52
Bahamas	Bahamas to LME#12. Caribbean Sea		1,490.85	1,490.85	1,163.28	1,163.28	411.84	411.84	2,459.37	2,45
Bangladesh	Bangladesh to LME#34. Bay of Bengal		11,107.20	11,107.20	21,167.69	21,167.69	7,494.15	7,494.15	44,752.00	44,75
Belgium	Belgium to LME#22. North Sea		14,146.99	14,146.99	21,195.67	21,195.67	7,504.06	7,504.06	44,811.14	44,8
Bhutan	Bhutan to LME#34. Bay of Bengal		9,743.61	9,743.61	21,167.69	21,167.69	7,494,15	7,494.15	44,752.00	44,75
Bolivia	Bolivia to LME#13. Humboldt Current		214.72	214.72	422.52	422.52	149.59	149.59	893.27	8
Bosnia and Herzegovina	Bosnia and Herzegovina to LME#26. Mediterranean		6,433.01	6,433.01	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,5
Botswana	Botswana to LME#30. Agulhas Current		4,689.03	4,689.03	7,858.44	7,858.44	2,782.18	2,782.18	16,614.04	16,6
Brazil	Brazil to LME#15. South Brazil Shelf		974.66	280.94	7,676.74	2,212.79	2,717.85	783.41	16,229.90	4,6
3	Brazil to LME#16. East Brazil Shelf			122.26	.,	962.97	_,	340.93		2,0
	Brazil to LME#17. North Brazil Shelf			571.46		4,500.99		1,593.52		9,5
Belize	Belize to LME#12. Caribbean Sea		1,097.00	1,097.00	1.163.28	1,163.28	411.84	411.84	2,459.37	2,4
Virgin Islands (British)	Virgin Islands (British) to LME#12. Caribbean Sea		1,692.38	1,692.38	1,163.28	1,163.28	411.84	411.84	2,459.37	2,4
Bulgaria	Bulgaria to LME#26. Mediterranean		11,041.33	2,330.43	52,727.40	11,128.87	18,667.47	3,940.04	111,474.42	23,5
	Bulgaria to LME#62. Black Sea		11,041.33	8,710.90	52,727.40	41,598.53	10,007.47	14,727.43	111,474.42	87,9
y Viyanmar	Myanmar to LME#34. Bay of Bengal		12,033.02	12,033.02	21,167.69	21,167.69	7,494.15	7,494.15	44,752.00	44,7
Belarus	Belarus to LME#23. Baltic Sea		29,863.38	29,863.38	71,378.35	71,378.35	25,270.60	25,270.60	150,905.61	
Cambodia	Cambodia to LME#3. California Current		1,187.57	1,187.57	1,645.78	1,645.78	582.67	582.67	3,479.44	3,4
Cameroon Canada	Cameroon to LME#28. Guinea Current Canada to LME#2. Gulf of Alaska		10,509.35 1,974.47	10,509.35 216.39	20,790.05 30,654.26	20,790.05 3,359.50	7,360.45	7,360.45	43,953.59 64,808.16	43,9
			1,574.47	524.41	30,034.20	8,141.68	10,832.75	2,882.46	04,808.10	
>	Canada to LME#63. Hudson Bay Canada to LME#9. Newfoundland-Labrador Shelf			157.96		2,452.32		868.21		17,2 5,1
	Canada to LME#8. Scotian Shelf									
				1,060.60		16,466.06		5,829.60		34,8
Cri La alva	Canada to LME#64. Arctic Ocean Sri Lanka to LME#34. Bay of Bengal		25 022 46	15.12 25,932.46	21 167 60	234.71 21,167.69	7 404 15	83.09	44 752 00	4
Sri Lanka Chile	, ,		25,932.46		21,167.69		7,494.15 149.59	7,494.15	44,752.00	44,7
	Chile to LME#13. Humboldt Current		369.57	369.57	422.52	422.52	21.204.56	149.59	893.27	8
China, People's Republic of	China, People's Republic of to LME#36. South China Sea		7,937.94	1,810.54	59,893.59	13,660.98	21,204.50	4,836.50	126,624.94	28,8
3	China, People's Republic of to LME#47. East China Sea			1,650.06		12,450.11		4,407.80		26,3
Calambia	China, People's Republic of to LME#48. Yellow Sea Colombia to LME#11. Pacific Central-American		800.08	4,477.33	2 207 10	33,782.51	1 1 ( ) 70	11,960.27	6.040.62	71,4
Colombia			809.98	523.34	3,287.18	2,123.90	1,163.78	751.94	6,949.63	4,4
2	Colombia to LME#12. Caribbean Sea		40 704 75	286.64	20 700 05	1,163.28	7 260 45	411.84	12 052 50	2,4
Congo	Congo to LME#28. Guinea Current		10,781.75	10,781.75	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,9
Democratic Republic of the Congo	Democratic Republic of the Congo to LME#28. Guinea Current		8,817.57	8,817.57	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,9
Costa Rica	Costa Rica to LME#11. Pacific Central-American Costa Rica to LME#12. Caribbean Sea		1,152.00	744.33 407.68	3,287.18	2,123.90	1,163.78	751.94 411.84	6,949.63	4,4
2			6 340 00		11 120 07	1,163.28	200000		22 520 27	2,4
Croatia	Croatia to LME#26. Mediterranean		6,318.80	6,318.80	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,5
Cuba	Cuba to LME#12. Caribbean Sea		1,445.79	1,445.79	1,163.28	1,163.28	411.84	411.84	2,459.37	2,4
Cyprus	Cyprus to LME#26. Mediterranean		8,841.96	8,841.96	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,5
Czech Republic	Czech Republic to LME#22. North Sea		10,857.65	10,857.65	21,195.67	21,195.67	7,504.06	7,504.06	44,811.14	44,8
Benin	Benin to LME#28. Guinea Current		13,077.95	13,077.95	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,9
Denmark	Denmark to LME#22. North Sea		13,803.73	3,117.37	93,854.51	21,195.67	33,227.99	7,504.06	198,423.91	44,8
3	Denmark to LME#23. Baltic Sea			10,498.03		71,378.35		25,270.60		150,9
	Denmark to LME#60. Faroe Plateau			188.33		1,280.49		453.34		2,7
Dominican Republic	Dominican Republic to LME#12. Caribbean Sea		1,545.87	1,545.87	1,163.28	1,163.28	411.84	411.84	2,459.37	2,4
Ecuador	Ecuador to LME#11. Pacific Central-American		1,521.96	1,521.96	2,123.90	2,123.90	751.94	751.94	4,490.26	4,4
El Salvador	El Salvador to LME#11. Pacific Central-American		2,097.28	2,097.28	2,123.90	2,123.90	751.94	751.94	4,490.26	4,4
Equatorial Guinea	Equatorial Guinea to LME#28. Guinea Current		14,004.93	14,004.93	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,9
Ethiopia	Ethiopia to LME#32. Arabian Sea		11,144.71	5,792.04	58,050.86	30,169.71	20,552.17	10,681.20	122,729.09	63,7
1	Ethiopia to LME#33. Red Sea			5,352.68		27,881.15		9,870.96	1	58,9
Eritrea	Eritrea to LME#33. Red Sea		15,412.99	15,412.99	27,881.15	27,881.15	9,870.96	9,870.96	58,945.34	58,9
Estonia	Estonia to LME#23. Baltic Sea		38,535.67	38,535.67	71,378.35	71,378.35	25,270.60	25,270.60	150,905.61	150,9
Falkland Islands (Malvinas)	Falkland Islands (Malvinas) to LME#14. Patagonian Shelf		9,187.22	9,187.22	5,793.14	5,793.14	2,050.99	2,050.99	12,247.66	12,2
Finland	Finland to LME#23. Baltic Sea		38,643.28	38,643.28	71,378.35	71,378.35	25,270.60	25,270.60	150,905.61	150,9
France	France to LME#22. North Sea		6,843.27	2,913.86	49,778.52	21,195.67	17,623.45	7,504.06	105,240.00	44,8
3	France to LME#24. Celtic-Biscay Shelf			2,399.47		17,453.98		6,179.36	1	36,9
	France to LME#26. Mediterranean			1,529.93		11,128.87		3,940.04		23,5
Djibouti	Djibouti to LME#32. Arabian Sea		18,417.86	18,417.86	30,169.71	30,169.71	10,681.20	10,681.20	63,783.75	63,7
Gabon	Gabon to LME#28. Guinea Current		13,043.97	13,043.97	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,9
Georgia	Georgia to LME#62. Black Sea		17,264.22	17,264.22	41,598.53	41,598.53	14,727.43	14,727.43	87,946.16	87,9
Gambia	Gambia to LME#28. Guinea Current		19,658.43	19,658.43	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,9
Sermany	Germany to LME#22. North Sea		19,927.80	4,562.65	92,574.02	21,195.67	32,774.65	7,504.06	195,716.75	44,8
2	Germany to LME#23. Baltic Sea			15,365.15		71,378.35		25,270.60		150,9
Ghana	Ghana to LME#28. Guinea Current		14,639.52	14,639.52	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,9
Greece	Greece to LME#26. Mediterranean		8,120.22	8,120.22	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,5
Guatemala	Guatemala to LME#11. Pacific Central-American		1,007.93	651.24	3,287.18	2,123.90	1,163.78	751.94	6,949.63	4,4
2	Guatemala to LME#12. Caribbean Sea			356.69		1,163.28		411.84		2,4
Guinea	Guinea to LME#28. Guinea Current		16,406.40	16,406.40	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,9
Guyana	Guyana to LME#17. North Brazil Shelf		3,889.58	3,889.58	4,500.99	4,500.99	1,593.52	1,593.52	9,515.83	9,5
Haiti	Haiti to LME#12. Caribbean Sea		1,517.80	1,517.80	1,163.28	1,163.28	411.84	411.84	2,459.37	2,4
Honduras	Honduras to LME#12. Caribbean Sea		1,133.63	1,133.63	1,163.28	1,163.28	411.84	411.84	2,459.37	2,4
	Hungary to LME#12. Black Sea		20,356.52	20,356.52	41,598.53	41,598.53	14,727.43	14,727.43	87,946.16	87,9
Hungany			1,402.27	1,402.27	1,510.10	41,598.55	534.63	534.63	3,192.60	87,5 3,1
Hungary				1,702.2/	1,010.10	1,010.10	334.03	J34.03	3,132.00	2,1
celand	Iceland to LME#39. Iceland Shelf				51 227 /1	30 160 71	18 175 20	10 691 20	108 525 75	62 7
	India to LME#32. Arabian Sea		10,776.02	6,332.80	51,337.41	30,169.71	18,175.36	10,681.20	108,535.75	63,7
celand					51,337.41	30,169.71 21,167.69 5,930.87	2,099.75	10,681.20 7,494.15 2,099.75	108,535.75 12,538.84	63,7 44,7 12,5





1			1	i.		1			
	Iraq to LME#32. Arabian Sea	12,920.81	12,920.81	30,169.71	30,169.71	10,681.20 6,179.36	10,681.20	63,783.75	63,783.75
	Ireland to LME#24. Celtic-Biscay Shelf Israel to LME#26. Mediterranean	17,768.49 6,128.33	17,768.49 6,128.33	17,453.98 11,128.87	17,453.98 11,128.87	3,940.04	6,179.36 3,940.04	36,900.59 23,528.27	36,900.59 23,528.27
	Italy to LME#26. Mediterranean	7,754.52	7,754.52	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,528.27
	Kosovo to LME#26. Mediterranean	6,004.91	6,004.91	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,528.27
	Côte d'Ivoire to LME#28. Guinea Current	15,667.52	15,667.52	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,953.59
	Jamaica to LME#12. Caribbean Sea	1,571.02	1,571.02	1,163.28	1,163.28	411.84	411.84	2,459.37	2,459.37
	Japan to LME#47. East China Sea	4,767.33	1,138.15	52,149.38	12,450.11	18,462.82	4,407.80	110,252.38	26,321.58
	Japan to LME#49. Kuroshio Current		491.17		5,372.88		1,902.20		11,359.16
	Japan to LME#50. Sea of Japan/East Sea		1,811.28		19,813.46		7,014.70		41,888.91
	Japan to LME#51. Oyashio Current		228.17		2,495.94		883.65		5,276.82
	Japan to LME#52. Sea of Okhotsk		1,098.56		12,016.99		4,254.46		25,405.91
o Jordan	Jordan to LME#33. Red Sea	13,339.20	13,339.20	27,881.15	27,881.15	9,870.96	9,870.96	58,945.34	58,945.34
4 Kenya	Kenya to LME#31. Somali Coastal Current	1,162.60	1,162.60	2,184.28	2,184.28	773.32	773.32	4,617.93	4,617.93
8 Democratic People's Republic of Korea	Democratic People's Republic of Korea to LME#47. East China Sea	10,340.12	1,949.18	66,046.07	12,450.11	23,382.77	4,407.80	139,632.29	26,321.58
	Democratic People's Republic of Korea to LME#48. Yellow Sea		5,288.96		33,782.51		11,960.27		71,421.80
	Democratic People's Republic of Korea to LME#50. Sea of Japan/East Sea		3,101.98		19,813.46		7,014.70		41,888.91
Republic of Korea	Republic of Korea to LME#47. East China Sea	11,305.84	2,131.22	66,046.07	12,450.11	23,382.77	4,407.80	139,632.29	26,321.58
	Republic of Korea to LME#48. Yellow Sea		5,782.93		33,782.51		11,960.27		71,421.80
	Republic of Korea to LME#50. Sea of Japan/East Sea	0.054.74	3,391.69	42.000.00	19,813.46	1 0 3 5 5 0	7,014.70	20.004.55	41,888.91
	Lao People's Democratic Republic to LME#36. South China Sea	9,051.71	9,051.71	13,660.98	13,660.98	4,836.50	4,836.50	28,881.56	28,881.56
	Lebanon to LME#26. Mediterranean	6,439.34	6,439.34	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,528.27
	Latvia to LME#23. Baltic Sea	35,828.36	35,828.36 18,505.35	71,378.35	71,378.35 20,790.05	25,270.60 7,360.45	25,270.60 7,360.45	150,905.61	150,905.61
	Liberia to LME#28. Guinea Current	18,505.35		20,790.05				43,953.59	43,953.59
	Libyan Arab Jamahiriya to LME#26. Mediterranean Lithuania to LME#23. Baltic Sea	6,311.36 33,510.99	6,311.36 33,510.99	11,128.87 71,378.35	11,128.87 71,378.35	3,940.04 25,270.60	3,940.04 25,270.60	23,528.27 150,905.61	23,528.27 150,905.61
	Lithuania to LME#23. Baltic Sea Madagascar to LME#30. Agulhas Current	33,510.99 6,968.10	33,510.99 6,968.10	7,858.44	/1,3/8.35 7,858.44	25,270.60 2,782.18	25,270.60 2,782.18		150,905.61 16,614.04
	Madagascar to LME#30. Aguinas Current Malaysia to LME#34. Bay of Bengal	6,968.10	3,758.44	35,258.65	21,167.69	12,482.88	7,494.15	16,614.04 74,542.60	44,752.00
	Malaysia to LME#34. Bay of Bengal Malaysia to LME#35. Gulf of Thailand	0,200.37	76.35	33,238.05	429.98	12,402.08	152.23	74,542.00	44,752.00 909.05
	Malaysia to LME#35. Guil of maland Malaysia to LME#36. South China Sea		2,425.58		13,660.98		4,836.50		28,881.56
	Mali to LME#27. Canary Current	5,883.41	914.58	24,616.72	3,826.67	8,715.24	1,354.78	52,043.81	8,090.22
	Mali to LME#28. Guinea Current	5,005.41	4,968.83	24,010.72	20,790.05	0,715.24	7,360.45	52,045.01	43,953.59
	Mauritania to LME#27. Canary Current	2,965.74	2,965.74	3,826.67	3,826.67	1,354.78	1,354.78	8,090.22	8,090.22
	Mexico to LME#3. California Current	4,995.20	247.74	33,183.89	1,645.78	11,748.33	582.67	70,156.21	3,479.44
	Mexico to LME#4. Gulf of California		2,370.27		15,746.08		5,574.70		33,289.80
	Mexico to LME#5. Gulf of Mexico		2,377.19		15,792.03		5,590.97		33,386.96
s Moldova	Moldova to LME#62. Black Sea	19,732.66	19,732.66	41,598.53	41,598.53	14,727.43	14,727.43	87,946.16	87,946.16
9 Montenegro	Montenegro to LME#26. Mediterranean	6,004.91	6,004.91	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,528.27
	Morocco to LME#26. Mediterranean	3,853.37	2,867.41	14,955.54	11,128.87	5,294.82	3,940.04	31,618.48	23,528.27
	Morocco to LME#27. Canary Current		985.96		3,826.67		1,354.78		8,090.22
8 Mozambique	Mozambique to LME#30. Agulhas Current	5,012.94	5,012.94	7,858.44	7,858.44	2,782.18	2,782.18	16,614.04	16,614.04
2 Oman	Oman to LME#32. Arabian Sea	21,274.65	21,274.65	30,169.71	30,169.71	10,681.20	10,681.20	63,783.75	63,783.75
	Namibia to LME#29. Benguela Current	3,124.29	3,124.29	4,613.74	4,613.74	1,633.44	1,633.44	9,754.22	9,754.22
	Nepal to LME#34. Bay of Bengal	9,178.18	9,178.18	21,167.69	21,167.69	7,494.15	7,494.15	44,752.00	44,752.00
	Netherlands to LME#22. North Sea	14,615.34	14,615.34	21,195.67	21,195.67	7,504.06	7,504.06	44,811.14	44,811.14
	New Caledonia to LME#40. Northeast Australia	1,692.66	1,692.66	966.37	966.37	342.13	342.13	2,043.07	2,043.07
	New Zealand to LME#46. New Zealand Shelf	2,518.46	2,518.46	1,871.56	1,871.56	662.60	662.60	3,956.78	3,956.78
	Nicaragua to LME#11. Pacific Central-American	1,070.72	691.81	3,287.18	2,123.90	1,163.78	751.94	6,949.63	4,490.26
	Nicaragua to LME#12. Caribbean Sea		378.91		1,163.28		411.84		2,459.37
	Niger to LME#28. Guinea Current	10,873.93	10,873.93	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,953.59
	Nigeria to LME#28. Guinea Current	11,375.19	11,375.19	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,953.59
	Norway to LME#21. Norwegian Sea	6,640.38	1,528.58 5,111.80	27,533.82	6,338.15 21,195.67	9,748.00	2,243.94 7,504.06	58,211.03	13,399.88 44,811.14
	Norway to LME#22. North Sea Pakistan to LME#32. Arabian Sea	13,556.88	13,556.88	30,169.71	30,169.71	10,681.20	10,681.20	63,783.75	63,783.75
	Panama to LME#11. Pacific Central-American	1,140.17	736.68	3,287.18	2,123.90	1,163.78	751.94	6,949.63	4,490.26
	Panama to LME#11. Pacific Central-American Panama to LME#12. Caribbean Sea	1,140.17	403.49	3,207.18	1,163.28	1,105.78	411.84	0,545.03	2,459.37
	Paraguay to LME#14. Patagonian Shelf	3,331.12	3,331.12	5,793.14	5,793.14	2,050.99	2,050.99	12,247.66	12,247.66
	Peru to LME#13. Humboldt Current	301.05	301.05	422.52	422.52	149.59	149.59	893.27	893.27
	Philippines to LME#36. South China Sea	11,523.83	5,097.96	30,880.38	13,660.98	10,932.80	4,836.50	65,286.21	28,881.56
	Philippines to LME#37. Sulu-Celebes Sea	,,	6,425.88	.,	17,219.40	.,	6,096.31		36,404.65
	Poland to LME#23. Baltic Sea	35,107.62	35,107.62	71,378.35	71,378.35	25,270.60	25,270.60	150,905.61	150,905.61
	Portugal to LME#25. Iberian Coastal	2,497.74	2,497.74	2,682.17	2,682.17	949.59	949.59	5,670.55	5,670.55
•	Guinea-Bissau to LME#28. Guinea Current	18,512.85	18,512.85	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,953.59
	Timor-Leste to LME#38. Indonesian Sea	8,710.92	8,710.92	5,930.87	5,930.87	2,099.75	2,099.75	12,538.84	12,538.84
	Puerto Rico to LME#12. Caribbean Sea	1,612.49	1,612.49	1,163.28	1,163.28	411.84	411.84	2,459.37	2,459.37
	Romania to LME#62. Black Sea	20,602.61	20,602.61	41,598.53	41,598.53	14,727.43	14,727.43	87,946.16	87,946.16
	Russian Federation to LME#20. Barents Sea	2,591.69	128.55	99,924.93	4,956.31	35,377.15	1,754.72	211,257.79	10,478.46
	Russian Federation to LME#54. Chukchi Sea		88.56		3,414.44		1,208.84		7,218.69
1	Russian Federation to LME#56. East Siberian Sea		46.31		1,785.58		632.16	1	3,775.00
	Russian Federation to LME#57. Laptev Sea		175.99		6,785.50		2,402.32		14,345.67
1	Russian Federation to LME#58. Kara Sea		134.64		5,191.29		1,837.91		10,975.25
	Russian Federation to LME#62. Black Sea		1,078.91		41,598.53		14,727.43		87,946.16
	Russian Federation to LME#64. Arctic Ocean		6.09		234.71		83.09		496.21
			513.89		19,813.46		7,014.70		41,888.91
	Russian Federation to LME#50. Sea of Japan/East Sea				2,495.94	1	883.65	1	5,276.82
	Russian Federation to LME#50. Sea of Japan/East Sea Russian Federation to LME#51. Oyashio Current		64.74						
	Russian Federation to LME#50. Sea of Japan/East Sea Russian Federation to LME#51. Oyashio Current Russian Federation to LME#52. Sea of Okhotsk		311.68		12,016.99		4,254.46		25,405.91
	Russian Federation to LME#50. Sea of Japan/East Sea Russian Federation to LME#51. Oyashio Current Russian Federation to LME#52. Sea of Okhotsk Russian Federation to LME#53. West Bering Sea	10 000 00	311.68 42.33	50.050.00	12,016.99 1,632.19	20 552 15	577.86	422 720 77	3,450.72
2 Saudi Arabia	Russian Federation to LME#50. Sea of Japan/East Sea Russian Federation to LME#51. Oyashio Current Russian Federation to LME#52. Sea of Okhotsk Russian Federation to LME#53. West Bering Sea Saudi Arabia to LME#32. Arabian Sea	10,936.85	311.68 42.33 5,684.01	58,050.86	12,016.99 1,632.19 30,169.71	20,552.17	577.86 10,681.20	122,729.09	3,450.72 63,783.75
2 Saudi Arabia 2	Russian Federation to LME#50. Sea of Japan/East Sea Russian Federation to LME#51. Oyashio Current Russian Federation to LME#52. Sea of Okhotsk Russian Federation to LME#53. West Bering Sea Saudi Arabia to LME#32 Arabian Sea Saudi Arabia to LME#33. Red Sea		311.68 42.33 5,684.01 5,252.84		12,016.99 1,632.19 30,169.71 27,881.15		577.86 10,681.20 9,870.96		3,450.72 63,783.75 58,945.34
2 Saudi Arabia 2	Russian Federation to LME#50. Sea of Japan/East Sea Russian Federation to LME#51. Oyashio Current Russian Federation to LME#52. Sea of Okhotsk Russian Federation to LME#53. West Bering Sea Saudi Arabia to LME#32. Arabian Sea	10,936.85 3,391.52	311.68 42.33 5,684.01	58,050.86 3,826.67	12,016.99 1,632.19 30,169.71	20,552.17 1,354.78	577.86 10,681.20	122,729.09 8,090.22	3,450.72 63,783.75
2 <mark>Saudi Arabia</mark> 2 6 Senegal	Russian Federation to LME#50. Sea of Japan/East Sea Russian Federation to LME#51. Oyashio Current Russian Federation to LME#52. Sea of Okhotsk Russian Federation to LME#53. West Bering Sea Saudi Arabia to LME#32 Arabian Sea Saudi Arabia to LME#33. Red Sea		311.68 42.33 5,684.01 5,252.84		12,016.99 1,632.19 30,169.71 27,881.15		577.86 10,681.20 9,870.96		3,450.72 63,783.75 58,945.34



Lee .		1		1		1		1	
694 Sierra Leone	Sierra Leone to LME#28. Guinea Current	17,638.63	17,638.63	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,953.59
703 Slovakia	Slovakia to LME#62. Black Sea	19,961.73	19,961.73	41,598.53	41,598.53	14,727.43	14,727.43	87,946.16	87,946.16
704 Viet Nam	Viet Nam to LME#36. South China Sea	10,915.28	10,915.28	13,660.98	13,660.98	4,836.50	4,836.50	28,881.56	28,881.56
705 Slovenia	Slovenia to LME#26. Mediterranean	6,616.68	6,616.68	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,528.27
706 Somalia	Somalia to LME#31. Somali Coastal Current	7,975.11	538.42	32,354.00	2,184.28	11,454.52	773.32	68,401.68	4,617.93
2	Somalia to LME#32. Arabian Sea		7,436.70		30,169.71		10,681.20		63,783.75
710 South Africa	South Africa to LME#29. Benguela Current	3,247.27	1,201.24	12,472.19	4,613.74	4,415.62	1,633.44	26,368.26	9,754.22
2	South Africa to LME#30. Agulhas Current		2,046.03		7,858.44		2,782.18		16,614.04
716 Zimbabwe	Zimbabwe to LME#30. Agulhas Current	4,303.58	4,303.58	7,858.44	7,858.44	2,782.18	2,782.18	16,614.04	16,614.04
724 Spain	Spain to LME#25. Iberian Coastal	3,678.77	714.43	13,811.04	2,682.17	4,889.62	949.59	29,198.82	5,670.55
2	Spain to LME#26. Mediterranean		2,964.33		11,128.87		3,940.04		23,528.27
736 Sudan	Sudan to LME#33. Red Sea	11,750.93	11,750.93	27,881.15	27,881.15	9,870.96	9,870.96	58,945.34	58,945.34
748 Swaziland	Swaziland to LME#30. Agulhas Current	5,466.38	5,466.38	7,858.44	7,858.44	2,782.18	2,782.18	16,614.04	16,614.04
752 Sweden	Sweden to LME#23. Baltic Sea	21,154.72	16,311.16	92,574.02	71,378.35	32,774.65	25,270.60	195,716.75	150,905.61
2	Sweden to LME#22. North Sea		4,843.57		21,195.67		7,504.06		44,811.14
756 Switzerland	Switzerland to LME#22. North Sea	9,455.26	2,711.07	73,923.07	21,195.67	26,171.52	7,504.06	156,285.57	44,811.14
3	Switzerland to LME#26. Mediterranean		1,423.46		11,128.87		3,940.04		23,528.27
	Switzerland to LME#62. Black Sea		5,320.73		41,598.53		14,727.43		87,946.16
760 Syrian Arab Republic	Syrian Arab Republic to LME#26. Mediterranean	5,188.23	5,188.23	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,528.27
764 Thailand	Thailand to LME#34. Bay of Bengal	13,886.51	13,886.51	21,167.69	21,167.69	7,494.15	7,494.15	44,752.00	44,752.00
768 Togo	Togo to LME#28. Guinea Current	14,057.36	14,057.36	20,790.05	20,790.05	7,360.45	7,360.45	43,953.59	43,953.59
784 United Arab Emirates	United Arab Emirates to LME#32. Arabian Sea	20,715.44	20,715.44	30,169.71	30,169.71	10,681.20	10,681.20	63,783.75	63,783.75
788 Tunisia	Tunisia to LME#26. Mediterranean	7,601.66	7,601.66	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,528.27
792 Turkey	Turkey to LME#26. Mediterranean	5,982,32	5,982,32	11.128.87	11.128.87	3,940,04	3,940,04	23.528.27	23.528.27
800 Uganda	Uganda to LME#26. Mediterranean	4.814.88	4,814,88	11.128.87	11,128.87	3,940,04	3,940,04	23.528.27	23.528.27
804 Ukraine	Ukraine to LME#62. Black Sea	18,287,34	18,287.34	41,598.53	41,598,53	14,727.43	14,727.43	87.946.16	87,946.16
807 The FYR of Macedonia	The FYR of Macedonia to LME#26. Mediterranean	6,534.89	6,534.89	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,528.27
818 Egypt	Egypt to LME#26. Mediterranean	5,560.13	5,560.13	11,128.87	11,128.87	3,940.04	3,940.04	23,528.27	23,528.27
826 United Kingdom of GB and NI	United Kingdom of GB and NI to LME#22. North Sea	10,712.59	5,874.84	38,649.65	21,195.67	13,683.42	7,504.06	81,711.73	44,811.14
2	United Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf		4,837.75		17,453.98		6,179.36		36,900.59
834 United Republic of Tanzania: Mainland		4,084.75	4,084.75	7,858.44	7,858.44	2,782.18	2,782.18	16,614.04	16,614.04
840 United States	United States to LME#1. East Bering Sea	1,942,30	339,36	65,282,46	11,406,01	23,112,42	4.038.15	138.017.88	24,114.20
10	United States to LME#2. Gulf of Alaska	-/	99,95		3,359,50		1,189,39		7,102.53
	United States to LME#3. California Current		48,97		1,645.78		582.67		3,479.44
	United States to LME#4. Gulf of California		468.48		15,746.08		5,574.70		33,289.80
	United States to LME#5. Gulf of Mexico		469.85		15,792.03		5,590.97		33,386.96
	United States to LME#6. Southeast U.S. Continental Shelf		60.10		2.019.95		715.14		4,270.51
	United States to LME#7. Northeast U.S. Continental Shelf		194.64		6,541,93		2.316.09		13,830.72
	United States to LME#10. Insular Pacific-Hawaiian		16.63		558.87		197.86		1,181.53
	United States to LME#10. Insular Pacific-Hawalian		101.59		3,414.44		1,208.84		7,218.69
			101.59						
	United States to LME#55. Beaufort Sea	1 700 50		5 702 44	4,797.87	2.050.00	1,698.62	12 247 66	10,143.49
858 Uruguay	Uruguay to LME#14. Patagonian Shelf	4,786.56	4,786.56	5,793.14	5,793.14	2,050.99	2,050.99	12,247.66	12,247.66
862 Venezuela (Bolivarian Republic of)	Venezuela (Bolivarian Republic of) to LME#12. Caribbean Sea	874.99	874.99	1,163.28	1,163.28	411.84	411.84	2,459.37	2,459.37
887 Yemen	Yemen to LME#32. Arabian Sea	18,551.47	18,551.47	30,169.71	30,169.71	10,681.20	10,681.20	63,783.75	63,783.75
894 Zambia	Zambia to LME#30. Agulhas Current	3,721.39	3,721.39	7,858.44	7,858.44	2,782.18	2,782.18	16,614.04	16,614.04
	n=214	n=143	n=214	n=143	n=214	n=143	n=214	n=143	n=214





Table 3.16: Characterisation Factors (CF) and total N emission to air at Country-to-LME scale.

Description         Control         Perspective           1         Apprint to UMR25. Mediterranean         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.00         7,200.0		E	mission:	N to air	
Disp All Data Data Data Data Data Data Data Da		Resolutio	on scale:	· · · · · · · · · · · · · · · · · · ·	
a National to LME265. Mediterranean         7,266.07         2,211.38         1.7567-08           a Angela to LME29. Benguela Current         2,490.13         3.247-08         3.247-08           a Angela to LME29. Benguela Current         2,490.13         3.247-08         3.247-08           a Australia to LME20. Anothesis Australia         4.82.9         2.2287-08           Australia to LME30. North-est Australia         4.82.9         2.2287-08           Australia to LME30. Southesis Australia         7.87.7         2.2287-08           Australia to LME30. Southesis Australia         7.87.7         2.2287-08           Australia to LME30. Southesis Australia         7.87.7         2.2287-08           Australia to LME32. Southesis Australia         7.97.7         2.2287-08           Australia to LME32. Southesis Australia         7.97.7         3.2287-08           Australia to LME32.					Emission to air
1         Apple to LMER26. Mether areasen         7.211.33         7.211.33           2         Apple to LMER26. Decuyed Current         7.241.34         7.247.03           2         Apple to LMER26. Decuyed Current         7.247.03         7.225.03           4         Marcial ao LMER20. Northe Astralia         7.225.03         7.225.03           4         Marcial ao LMER20. Southext Astralia         7.225.03         7.225.03           4         Marcial ao LMER20. Southext Astralia         7.37         7.225.03           4         Marcial ao LMER20. Southext Astralia         7.33         7.225.03           5         Marcial ao LMER20. Southext Astralia         7.33         7.245.03           6         Marcial ao LMER20. Mether Astralia         7.33         7.245.03           6         Marcial ao LMER20. Mether Astralia         7.34         3.316.07           7         Barkina to LMER20. Mether Astralia         7.34         3.316.07           8         Marcial ao LMER20. Mether Astralia         7.34         3.316.07           9         Marcial ao LMER20. Mether Astralia         7.360.03         3.316.07           9         Marcial ao LMER20. Mether Astralia         7.360.03         3.316.07           9         Marcian LMER20. Mether Astralia					
2Appendix to LMR2P. Requesion Streft42,480.3332,245.03A kastralia to LMR3P. North Astralia134.6422,245.03A kastralia to LMR3P. North Mastralia135.6422,245.03A kastralia to LMR3P. Southeast Astralia32.8222,245.03A kastralia to LMR3P. Southeast Astralia32.8222,245.03A kastralia to LMR3P. Southeast Astralia32.9222,245.03A kastralia to LMR3P. Southeast Astralia35.9522,245.03A kastralia to LMR3P. Southeast Astralia1,107.024,945.03A kastralia to LMR3P. Molecular1,107.024,945.03A kastralia to LMR3P. Apped Bengal1,107.024,945.03B kabita to LMR3P. Apped Bengal1,107.024,315.06B kabita to LMR3P. Apped Bengal1,107.034,315.06B kabita to LMR3P. Apped Bengal1,216.031,764.09B kabita to LMR3P. Apped Bengal1,216.032,764.00B kabita to LMR3P. Apped Bengal1,216.032,764.00B kabita to LMR3P. Apped Bengal1,216.032,764.00B kabita to LMR3P. Apped Bengal <td></td> <td></td> <td></td> <td></td> <td></td>					
31         Apartan is to LMB1A, Straigonian Sheff         44.61.6.4         10.94-09           31         Asstrail as to LMB0A, North Australia         154.64         22.824-08           Austrail as to LMB2A, Dorth Australia         22.22         22.824-08           Austrail as to LMB2A, Southwest Australia         72.22         22.84-08           Australia to LMB2A, Southwest Australia         73.31         22.824-08           Australia to LMB2A, Buy of Bengal         11,107.20         4.924-07           Australia to LMB2A, Buy of Bengal         11,224-07         4.934-07           Australia to LMB2A, South Strail Sheft         12,226         11,224-07           Australia to LMB2A, South Strail Sheft         12,226         4.832-00 <tr< td=""><td></td><td>0</td><td></td><td></td><td></td></tr<>		0			
in         Material is to MH293. North Australia         154.64         22.284-08           Australia is to MH21. East-Central Australia         61.02         22.284-08           Australia is to MH23. Southest Australia         61.02         22.284-08           Australia is to MH23. Southest Australia         7.02         22.284-08           Australia is to MH23. Southest Australia         7.03         22.284-08           Australia to MH23. Southest Australia         7.03         22.284-08           Australia to MH23. Nothest Australia         7.03         22.284-08           Australia to MH23. Nothest Australia         7.03         22.284-08           Australia to MH23. Nothest Australia         7.03         22.284-08           Banglades to MH23. Authoba See         1.490.65         3.314-07           Banglades to MH23. Authoba See         1.490.65         3.314-07           Bandia to MH23. Authoba Cengla         1.44-08         3.314-07           Bandia to MH23. Authoba Current         2.432-03         1.144-08           Bandia to MH23. Cantraban Sea         1.022.03         1.764-09           Brait to MH27. North Pauli Sheff         7.314.222.03         7.584-07           Bandia to MH23. Authoba Current         1.030.23         4.614-08          10.842. Authoa to MH23. Authoba Sea					
Image: Program Science         42250           Australia to LME41. Sust-Central Australia         52.72           Australia to LME42. Southwest Australia         73.23           Australia to LME42. Southwest Australia         73.33           Australia to LME42. Southwest Australia         73.34           Australia to LME42. Australia         73.34           Australia to LME42. Month Sa         11.072.00           Bolivia to LME42. Month Sa         3.364-07           Bolivia to LME43. Augtralia Current         4.363.01           Bolivia to LME43. Augtralia Sheff         22.062.02           Bradia to LME43. Carrent         1.366-07           Bradia to LME43. Augtralia Sheff         7.266-07           Bradia to LME42. Souther Sa         1.976-03           Bradia to LME43. Augtralia Sheff         7.266-07           Bradia to LME43. Augtralia Sheff         7.266-07           Bradia to LME43. Augt					
Image: Program Science         9.272         2.226-08           Australia to LMEA12. Southest Australia         81.6         2.226-08           Australia to LMEA13. Southest Australia         59.70         2.226-08           Australia to LMEA14. New E-Central Australia         59.70         2.226-08           Australia to LMEA15. New E-Central Australia         59.70         2.226-08           Australia to LMEA14. New E-Central Australia         59.70         2.226-08           Banamo E-MER12. Carthbean Sea         1.1107.20         4.995-08           Banding Montella, Bany of Bengal         1.11107.20         4.995-08           Banding Montella, Bany of Bengal         1.11107.20         4.995-08           Banding Montella, Bany of Bengal         2.1110.00         3.995-07           Bosnia and Kerregovina to LME20. Auglines Current         4.893.00         3.114-06           Barali to LMEB12. Carthbean Sea         1.923.30         2.787-04           Brazito to LMEB2. Monteranean         3.990.00         2.996.30         2.476-04           Barali to LMEB2. Monteranean         3.903.00         7.586-07           Barali to LMEB2. Monteranean         3.903.00         7.586-07           Barali to LMEB2. Monteranean         3.904.00         7.586-07           Barali to LMEB2. Monte Current	50				
Australia to LMEMA. Southwest Australia         7827         2285-08           Australia to LMEMA. Mericentral Australia         7331         2285-08           Australia to LMEMA. Mericentral Australia         7331         2285-08           4         Bahamas to LMEMA. Mericentral Australia         7331         2285-08           4         Bahamas to LMEMA. Mericentral Australia         7331         2285-08           5         Bergiunto LMERA. Bay of Bengal         1110-70         4995-08           6         Bohita to LMERA. Bay of Bengal         1241-06         305-07           7         Boshita and Merzgowina to LMERA. Augusta Eurert         264303         1116-07           7         Boshita and Mirella S. Muttraliz R. Metterranean         1056-07         207-07           9         Barali to LMERA C. Angulhas Current         46830         1166-07           9         Barali to LMERA C. Angulhas Current         109700         1066-07           9         Barali to LMERA C. Angulhas Current         109700         1066-07           10         Barali to LMERA C. Angulhas Current         109700         1066-07           11         Barali to LMERA C. Angulhas Current         109700         1066-07           12         Barali to LMERA Mangulhas Current         109703					
Australia to LMEMA WestCentral Australia         59.75         2.228-03           Australia to LMEMA S. Morthwest Australia         73.81         2.228-03           Australia to LMEAD. Morthwest Australia         73.81         2.228-03           Australia to LMEAD. Morthwest Australia         73.81         1.746-08           Bangladeh UNEED. Australia to LMERD. Caribben Sea         1.406.05         1.991.05           Bangladeh UNEED. Australia to LMERD. Caribben Sea         1.406.05         2.226-07           Bolivia to LMERD. Australia to LMERD. Caribben Sea         1.406.05         2.226-07           Bolivia to LMERD. Australia Sheff         2.200.05         2.226-07         2.226-07           Brazil to LMERD. Caribben Sea         1.076-09         2.276-07         2.226-07           Brazil to LMERD. Australia Sheff         2.200.05         2.276-07         2.226-07           Brazil to LMERD. Caribben Sea         1.076-09         2.276-07         2.276-07           Brazil to LMERD. Caribben Sea         1.076-09         2.276-07         2.276-07           Brazil to LMERD. Caribben Sea         1.076-09         2.276-07           Brazil to LMERD. Caribben Sea         1.076-09         2.276-07           Brazil to LMERD. Caribben Sea         1.076-09         2.276-07           Brazil to LMERD. Austral				81.68	
Number7382226-0040Australia to LMERS. Northwest Australia5,966.31,747-0041Bahams to LMERJ2. Carlbean Sea1,107.004,995-0052Berglumo LMERZ2. North Sea1,11,07.002,924-0754Bhuttan to LMERZ3. North Sea2,144,146.999,244-0755Berglumo LMERZ3. North Sea1,11,07.003,356-0756Bosinia and Kerzgovin to LMERZ6. Mediterranean6,433.013,556-0757Bosinia and Kerzgovin to LMERZ6. Mediterranean6,433.013,556-0758Brail to LMERZ5. South Brail Sheff1,222.601,766-09Brail to LMERZ6. Carlbean Sea1,766-091,766-09Brail to LMERZ6. Carlbean Sea1,623.032,478-0458Belliz to LMERZ6. Mediterranean2,330.047,558-0759Bulgaria to LMERZ6. Mediterranean2,330.047,558-0750Bulgaria to LMERZ6. Mediterranean1,826.751,158-0650Bulgaria to LMERZ8. Bulit Sea2,116-082,248-0450Canadato LMERZ8. Bulit Sea2,116-082,248-0451Balagria to LMERZ8. Mediter anean2,330.047,558-0752Bulgaria to LMERZ8. Bulit Sea2,116-082,330.0452Canadato LMERZ8. Bulit Sea1,1262,396.0852Canadato LMERZ8. Bulit Sea2,116-082,396.0853Canadato LMERZ8. Bulit Sea1,1562,396.0854Canadato LMERZ8. Bulit Sea1,1562,396.0854Canadato LMERZ8.		Australia to LME#43. Southwest Australia		78.27	2.28E+08
40         Justria to LMEB22. Caribbean Sea         1.490.08         3.9312-06           41         Bahamas to LMEB22. Caribbean Sea         1.4,140.08         3.9312-06           52         Belgium to LMEB23. Avorth Sea         1.4,146.99         9.242-07           63         Bolard Stack to LMEB33. Avorth Sea         1.4,146.99         9.242-07           64         Bolaria to LMEB23. Avorth Sea         1.4,146.99         9.242-07           70         Bostina to LMEB33. Avorth Sea         1.247-02         4.312-08           70         Bostina to LMEB33. Avorth Sea         1.147-09         1.147-09           87         Brazil to LMEB32. Caroth Brazil Shelf         2.200         1.757-09           87         Brazil to LMEB2. Carobbean Sea         1.0797.00         1.656-07           94         Belize to LMEB2. Mediterranean         2.330.43         7.558-07           104         Myanmar to LMEB2. Back Sea         2.710-00         2.457-04           115         Cameroon to LMEB2. Guinea Current         10,599.35         3.075-08           116         Camado to LMEB3. Hubrio Surton         10,509.35         3.075-08           116         Canada to LMEB3. Avorton Bay         2.481-04         2.981-08           117         Canada to LMEB3. Sunton Bay		Australia to LME#44. West-Central Australia		59.76	2.28E+08
44Bahamas to IMEBI2. Caribbean Sea1,4008.83,931-0650Beiguino UMEBI2. Caribbean Sea11,1107204991-0861Beilvino ILMEBI2. Nethola Current11,416.99,248-1072Bostina and Herzegovina to IMEBI2. Mediterranean6,433.013,591-0773Bostina to IMEBI3. South Parial Silvif20.0911,761-0974Brazit to IMEBI3. South Parial Silvif20.0911,761-0975Brazit to IMEBI2. Caribbean Sea1,972-001,761-0976Brazit to IMEBI2. Caribbean Sea1,972-001,661-0777Buigaria to IMEBI2. Caribbean Sea1,972-001,661-0778Buigaria to IMEBI2. Caribbean Sea1,972-001,661-0779Buigaria to IMEBI2. Meltranean2,303.437,581-0770Buigaria to IMEBI2. Black Sea3,710-907,581-0771Buigaria to IMEBI2. Black Sea3,710-903,591-0672Graneron IMEBI2. Built Geurent1,167.51,581-0873Graneron IMEBI2. Built Geurent1,500.53,591-0674Granda to IMEBI3. Hundon Bay2,581-082,581-0875Granda to IMEBI3. Hundon Current1,500.53,591-0874Granda to IMEBI3. Hundon Current1,500.54,591-0875Canada to IMEBI3. Hundon Current3,501-032,591-0876Canada to IMEBI3. Hundon Current1,500.54,591-0976Canada to IMEBI3. Hundon Current3,501-074,591-0976Canada to IMEBI3. Hundo		Australia to LME#45. Northwest Australia		75.31	2.28E+08
50         Barjadesh to LMER2. Bay of Bengal         11,10720         4.995-08           6         Bayta to LMER3. Bay of Bengal         7.878.61         3.364-07           6         Boita to LMER3. Bay of Bengal         7.878.61         3.364-07           7         Boita to LMER3. Humboldt Current         4.893.03         1.144-08           7         Boita to LMER3. Aguita S Current         4.893.03         1.144-08           7         Brazit to LMER5. South Brazil Sheff         2.020.44         1.764-09           7         Brazit to LMER5. South Brazil Sheff         2.020.44         1.764-09           8         Parizit to LMER5. Bast Brazil Sheff         2.020.44         1.764-09           9         Brazit to LMER5. Bast Brazil Sheff         2.020.44         1.764-09           9         Brazit to LMER5. Bast Bast Sheff         2.020.44         1.764-09           9         Brazit to LMER5. Bast Bast Sheff         2.020.44         2.0214-04           12         Belars to LMER3. Bay of Bengal         1.033.02         4.634-04           12         Belars to LMER3. Bay of Bengal         2.026.04         2.026.04           12         Belars to LMER3. Bay of Bengal         2.026.04         2.026.04           12         Canada to LMER3. Cuinen Current	40	Austria to LME#26. Mediterranean		5,986.51	1.74E+08
selgum to LMER2. North Sea         14,146.99         9.246-07           sellvian to LMER3. Namobial Current         21,472         4.316-03           sellvian to LMER3. Namobial Current         24,832.01         3.305-047           selswan to LMER3. Namobial Current         4,880.03         1.146-08           selswan to LMER3. Aguihas Current         4,880.03         1.146-08           selswan to LMER3. South Brail Sheff         2202         1.756-09           selize to LMER3. Caribbean Sea         1,097.00         1.666-07           selize to LMER3. Caribbean Sea         1,097.00         1.666-07           selize to LMER3. Black Sea         3,710.90         7.586-07           seligaria to LMER3. Black Sea         3,710.90         7.586-07           seligaria to LMER3. California Current         1,187.57         1.586-08           canada to LMER3. California Current         1,187.57         1.586-08           canada to LMER3. California Current         1,000.03         2.986-08           canada to LMER3. Califori Aska         2.096-08         2.	44	Bahamas to LME#12. Caribbean Sea		1,490.85	3.91E+06
aButan to UME3A say of Bengal9,743.619,33.64-07bBoshia and Herzgovina to UME4C5. Mediteranean2,14224,31.44-08bBoshia and Herzgovina to UME4C5. Mediteranean6,33.031,14-08brazil to UME1C5. South Brazil Shelf2,20.021,764-09brazil to UME1C5. South Brazil Shelf2,20.021,764-09brazil to UME1C5. Cast Brazil Shelf2,20.021,764-09brazil to UME1C2. Caribbean Sea1,692.032,476-04bulgaria to UME62. Nack Sea1,692.032,476-04bulgaria to UME62. Nack Sea2,300.037,584-07bulgaria to UME62. Nack Sea2,010.032,476-04bulgaria to UME62. Nack Sea2,010.032,476-04bulgaria to UME62. Nack Sea2,010.032,476-04bulgaria to UME62. Nack Sea2,010.032,476-04bulgaria to UME62. Nack Sea2,010.032,586-08canada to UME62. Solita Current1,875.71,586-08canada to UME82. Solita Sea2,582-082,586-08canada to UME82. Solita Sea2,582-082,586-08canada to UME82. Solita Sea1,610.032,586-08canada to UME82. Solita Sea1,610.042,586-08colombia to UME72. Solita Chrina Sea1,610.042,586-08canada to UME72. Solita Chrina Sea1,610.042,586-08canada to UME72. Solita Chrina Sea1,610.043,566-07canada to UME72. Solita Chrina Sea1,610.043,566-07canada to UME73. Solita Chrina Sea1,610.043,566-07	50	Bangladesh to LME#34. Bay of Bengal		11,107.20	4.99E+08
solivi a to LMEF13. Humboldt Current214.724.31F-0870Boxana and Herzegovina to LMER26. Mediterranean6.433.01339F-0772Botxana to LMER30. Aguita Surrent4.683.011.74E-098Brazil to LMEF15. South Brazil Sheff220.041.76E-098Belize to LMEF12. Caribbean Sea1.097.001.76E-0981Belize to LMEF12. Caribbean Sea1.097.001.75E-079Wiggrin to LMEF12. Caribbean Sea1.097.001.75E-0710Buiggrin to LMEF26. Mediterranean2.330.437.58E-07116Cambodia to LMEF26. Seatific Sea29.863.382.11F-08117Belarus to LMEF26. Seatific Sea29.863.382.11F-08118Cambodia to LMEF26. Seatific Sea29.863.382.21F-08119Canada to LMEF26. Seatific Sea29.863.382.21F-08110Canada to LMEF26. Seatific Agaita2.02.872.32F-081116Canada to LMEF26. Seatific Agaita2.23F-082.32F-081116Canada to LMEF26. Calif of Alaska2.15.92.32F-08112Canada to LMEF26. Seatific Agaita South China Sea1.650.064.33F-09113Canada to LMEF36. Actific Corean3.13E-073.32F-08114Sri Lanka to LMEF36. South China Sea1.650.064.33F-09113Canada to LMEF36. Actific Cortral-Agaita3.43F-093.36F-08114Sri Lanka to LMEF34. South China Sea1.650.064.33F-09115China, People's Republic of to LMEF46. South China Sea1.6	56	Belgium to LME#22. North Sea		14,146.99	9.24E+07
20         Bosnia and Herzegovina to LMER2.6. Mediterranean         6.433.01         3.59F-07           20         Bosain to LMER5. South Braail Sheff         122.26         1.76F-09           Brazil to LMER5. South Brazil Sheff         122.26         1.76F-09           Brazil to LMER12. Caribbean Sea         1.907.00         1.66F-07           20         Wign Islands (Britsh) to LMER12. Caribbean Sea         1.902.38         2.47F-04           100         Buigaria to LMER2. Mediterranean         2.330.43         7.58F-07           121         Belaze to LMER2. Bailto Sea         7.978-03         7.58F-07           122         Belarus to LMER2. Bailto Sea         7.978-03         7.58F-07           123         Belaze to LMER2. Bailto Sea         7.978-03         7.58F-07           124         Belaze to LMER2. Bailto Sea         7.978-03         7.58F-07           125         Canada to LMER2. Bailto Alasia         2.98F-08         2.98F-08           126         Canada to LMER2. Guinea Current         1.957.93         2.98F-08           126         Canada to LMER2. Merdounland-Labrador Shelf         1.050.93         2.98F-08           126         Canada to LMER3. Shelf Actric Cocean         1.512         2.98F-08           126         Chinto LMER3. Shelf Actric Lorental <td>64</td> <td>Bhutan to LME#34. Bay of Bengal</td> <td></td> <td>9,743.61</td> <td>3.36E+07</td>	64	Bhutan to LME#34. Bay of Bengal		9,743.61	3.36E+07
12 2 3 5South Brazil to LMER3. Aguihas Current4.689.031.14f-0816 17 5Brazil to LMER5. Esst Brazil Sheff22.0341.76f-0917 18 18 10LER56. Esst Brazil Sheff1.76f-091.76f-0918 18 18 10Belize to LMER12. Caribbean Sea1.097.001.75f-0710 10 10 10 10 10 10 10 10 11LMER12. Caribbean Sea1.097.001.75f-0711 10 11 10 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 11 <br< td=""><td></td><td></td><td></td><td></td><td></td></br<>					
76         Brazil to LMEH5. South Brazil Sheff         280.94         1.76E-09           Brazil to LMEH5. South Stat Brazil Sheff         122.26         1.776E-09           Brazil to LMEH2. North Brazil Sheff         71.40         1.76E-09           Belize to LMEH2. North Brazil Sheff         1.970.00         1.66E-07           20         Virgin Islands (British) to LMEH2. Caribbean Sea         1.097.00         1.66E-07           21         Bulgaria to LMEE2. Mitterranean         2.330.2         4.48E-08           21         Belarus to LMEE2. Black Sea         8.710.90         7.58E-07           120         Bulgaria to LMEE2. Black Sea         2.986.08         2.21E-06           121         Belarus to LMEE3. Call fornia Current         1.187.57         1.58E-08           120         Canada to LMEE3. Call fornia Current         1.0509.35         2.98E-08           121         Canada to LMEE3. Call fornia Surrent         1.0509.37         2.93E-08           122         Canada to LMEE3. Call fornia Surrent         1.0509.37         2.93E-08           122         Canada to LMEE3. Surth China Sea         1.810.54         4.93E-09           123         Canada to LMEE3. Surth China Sea         1.810.54         4.93E-09           124         Siri Lanka to LMEE3. Surth China Sea					
Brazil to LMEH1. Cast Brazil Shelf         122.26         1.76E-09           Brazil to LMEH2. North Brazil Shelf         77.46         1.76E-09           Belize to LMEH2. Caribbean Sea         1.692.38         2.47E-04           100         Bulgaria to LMEH2. Caribbean Sea         1.692.38         2.47E-04           101         Bulgaria to LMEH2. Mediterranean         2.330.43         7.58E+07           102         Bulgaria to LMEH26. Mediterranean         2.030.21         4.63E+08           112         Belarus to LMEH26. Balto Sea         2.936.33         2.11E+08           112         Belarus to LMEH26. Jabto Sea         2.93E+08         2.30F+08           124         Canada to LMEH63. Hudson Bay         2.238E+08         2.33E+08           124         Canada to LMEH63. Hudson Bay         2.238E+08         2.33E+08           125         Chile to LMEH63. Hudson Bay         2.238E+08         2.33E+08           126         Canada to LMEH63. Hudson Bay         2.532.46         4.68E+07           125         Chile to LMEH63. Hudson South China Sea         1.810.54         4.93E+09           126         China, People's Republic of to LMEH3. South China Sea         1.650.06         4.93E+09           126         China, People's Republic of to LMEH3. South China Sea         1					
Brazil to LMEH17. North Brazil Shelf         571.46         1.76E-09           Bileize to LMEH12. Caribbean Sea         1.097.00         1.66E-07           Virgin Istands (British) to LMEH12. Caribbean Sea         2,330.43         7.55E-07           Bulgaria to LMEH26. Mediterranean         2,330.43         7.55E-07           Didgaria to LMEH26. Mediterranean         2,330.43         7.55E-07           Ond Wyanmar to LMEH28. Agn of Bengal         2,110.03         4.663E-08           Didgaria to LMEH28. Salitic Sea         2,986.33         2,11E-08           Canado to LMEH28. California Current         10.509.35         3.07E-08           Canada to LMEE9. Netwondland-Labrador Shelf         2,08E-08         2.98E-08           Canada to LMEE9. Netwondland-Labrador Shelf         1,060.00         2.98E-08           Canada to LMEE9. Netwondland-Labrador Shelf         1,060.00         2.98E-08           Canada to LMEH2. South Shelf         1,060.00         2.98E-08           Canada to LMEH2. Numbold Current         369.57         9.13E-07           Diable Sheublic of to LMEH38. South China Sea         1,810.94         4.93E-09           China, People's Republic of to LMEH38. South China Sea         1,810.94         4.93E-09           China, People's Republic of to LMEH38. Guinea Current         1,816.45         3.06E+08     <	76				
34         belize to LMEH12. Caribbean Sea         1,097.00         1.66E407           20         Virgin Islands (British) to LMEH12. Caribbean Sea         1,692.30         2,74Fe04           100         Bulgaria to LMEH26. Mediterranean         2,330.43         7,55E407           101         Myanmar to LMEH32. Mediterranean         2,330.43         7,55E407           102         Myanmar to LMEH32. Baltic Sea         2,986.33         2,11Fe08           103         Balgaria to LMEH23. California Current         10,509.35         1,35E408           104         Canada to LMEH2. California Current         10,509.35         3,07Fe08           104         Canada to LMEH2. Guif of Alaska         2,98Fe08         2,98Fe08         Canada to LMEH63. Hudson Bay         2,98Fe08           105         Canada to LMEH64. Attic Ocean         1,512         2,98Fe08         2,98Fe08           104         Canada to LMEH64. Attic Ocean         1,512         2,98Fe08         2,98Fe08           105         China, People's Republic of to LMEH36. South China Sea         1,650.06         2,98Fe08           105         China, People's Republic of to LMEH36. South China Sea         1,650.06         4,93Fe09           106         China, People's Republic of to LMEH36. South China Sea         1,650.06         4,93Fe09 <td></td> <td></td> <td></td> <td></td> <td></td>					
112         Virgin Islands (British) to LME#12. Caribbean Sea         1.692.38         2.47E+04           100         Bulgaria to LME#62. Mediterranean         2.330.43         7.58E+07           104         Myanmar to LME#64. Black Sea         8.710.90         7.58E+07           105         Myanmar to LME#64. Bay of Bengal         2.936.33         2.4654+06           106         Myanmar to LME#24. Bay of Bengal         2.946-03.35         3.07E+08           107         Myanmar to LME#24. Bay of Bengal         2.11E+08         3.07E+08           108         Canada to LME#8. California Current         1.050-93.5         3.07E+08           104         Canada to LME#8. Sculian Current         1.057-96         2.98E+08           105         Canada to LME#8. Sculian Shelf         1.060.60         2.98E+08           104         Sri Lanka to LME#8. Arctic Ocean         1.512         2.98E+08           105         China, People's Republic of to LME#65. South China Sea         1.810.94         4.93E+09           107         Colombia to LME#11. Pacific Central-American         252.34         4.93E+09           107         Colombia to LME#12. Caribbean Sea         1.660.66         4.93E+09           107         Colombia to LME#12. Caribbean Sea         1.661.607         1.99E+09	0.4				
100         Bulgaria to LME#26. Mediterranean         2,330.43         7.58E+07           Bulgaria to LME#26. Biack Sea         8,710.00         7.58E+07           112         Belarus to LME#23. Baltic Sea         2,9,83.38         2.11E+08           112         Belarus to LME#23. Baltic Sea         2,9,83.38         2.11E+08           115         Cambodia to LME#2. Guif of Alaska         216.33         2.38E+08           Canada to LME#2. Guif of Alaska         216.33         2.98E+08           Canada to LME#3. Hudson Bay         524.41         2.98E+08           Canada to LME#3. Newfoundland-Labrador Shelf         15.02         2.98E+08           Canada to LME#3. Newfoundland-Labrador Shelf         15.12         2.98E+08           Canada to LME#3. Arctic Ocean         15.12         2.98E+08           Canada to LME#3. Asy of Bengal         25.932.46         4.68E+07           25         Chi Lo LME#13. Humbold Current         369.55         3.31E+07           156         China, People's Republic of to LME#A. Seat China Sea         1,810.54         4.93E+09           16100         Colombia to LME#12. Caribbean Sea         1,650.05         4.31E+09           170         Colombia to LME#12. Caribbean Sea         1,650.05         4.31E+07           180         Compto	÷.				
Bulgaria to LME#62. Black Sea         8,710.90         7.58E-07           104         Myanmar to LME#34. Bay of Bengal         12,033.02         4.6314-08           112         Belarus to LME#32. Baltic Sea         29,863.38         2.111-08           112         Belarus to LME#32. Guinora Current         1.053.05         3.071-08           120         Camado to LME#32. Guinora Current         1.058.05         3.071-08           121         Canada to LME#32. Guinora Current         1.058.05         3.071-08           122         Canada to LME#32. Guinora Current         1.050.05         3.071-08           123         Canada to LME#63. Audoon Bay         52.44.41         3.2981-08           124         Canada to LME#64. Audoon Bay         52.981-08         2.3981-08           124         Canada to LME#64. Scotian Shelf         1.050.05         3.9381-09           125         China, People's Republic of to LME#64. Scotth China Sea         1.810.54         4.9381-09           125         China, People's Republic of to LME#64. Scotth China Sea         1.610.07         6.01071 at LME#12. Acaribean Sea         1.610.07           126         Colombia to LME#12. Caribbean Sea         1.610.07         1.111-08         1.011-07           127         Colombia to LME#12. Caribbean Sea         1.610					
104         Myanmar to LMEH34. Bay of Bengal         12,033.02         4.63E+08           112         Belarus to LMEH23. Baltic Sea         29,863.38         2.111+08           116         Cambodia to LMEH3. California Current         1,187.77         1.58E+08           116         Camcon to LMEH28. Guinea Current         10,509.35         3.07E+08           112         Canada to LMEH3. Guinon Current         10,509.35         3.07E+08           113         Canada to LMEH3. Scotian Shelf         10,60.60         2.98E+08           Canada to LMEH3. Actic Ocean         15.12         2.98E+08           Canada to LMEH3. Actic Ocean         15.12         2.98E+08           Canada to LMEH3. Alwohod facurent         369.57         9.31E+07           114         Sri Lanka to LMEH3. Alwohod facurent         369.57         9.31E+07           115         China, People's Republic of to LMEH36. South China Sea         1,810.54         4.93E+09           115         China, People's Republic of to LMEH37. Bartofica Sea         4,677.33         4.93E+09           116         Colombia to LMEH1. Pacific Central-American         22.34         3.06E+08           1170         Colombia to LMEH2. Caribbean Sea         10,67.57         5.17E+08           118         Colombia to LMEH2. Caribbean Sea <td>100</td> <td>-</td> <td></td> <td></td> <td></td>	100	-			
116         Cameoon to LME#3. California Current         11,87.57         1.158E+08           120         Cameoon to LME#28. Guinea Current         10,009.35         3.07E+08           121         Canada to LME#28. Guinea Current         10,009.35         2.38E+08           121         Canada to LME#63. Hudson Bay         224.41         2.98E+08           121         Canada to LME#63. Hudson Bay         2.2481         2.98E+08           122         Canada to LME#64. Arctic Ocean         15.12         2.98E+08           123         China ka to LME#64. Arctic Ocean         15.12         2.98E+08           124         Sri Lanka to LME#64. Arctic Ocean         15.12         2.98E+08           125         China kopels's Republic of to LME#74. South China Sea         1.810.54         4.93E+09           126         China, People's Republic of to LME#74. East China Sea         1.650.06         4.93E+09           126         Colombia to LME#11. Pacific Central-American         23.34         3.06E+08           127         Colombia to LME#12. Caribbean Sea         3.06E+08         3.06E+08           128         Colombia to LME#12. Caribbean Sea         4.935.97         1.91E+08           129         Cubata to LME#12. Caribbean Sea         1.0781.75         1.11E+08	104				
120 121 122Cameroon to LME#28. Guinea Current10,509.353.07E+08124 123 124Canada to LME#28. Guinea Current216.392.98E+08124 125 126Canada to LME#3. Hudson Bay2.24.412.98E+08125 126Canada to LME#3. Scotian Shelf1.060.602.98E+08124 125Chile to LME#34. Bay of Bengal25.932.644.68E+07125 126 126Chile to LME#34. Bay of Bengal3.937E+084.93E+09124 125 126Chile to LME#34. Bay of Bengal3.937E+094.93E+09125 126 126 127 126 127 127 126Chile to LME#13. Humboldt Current3.93579.13E+07126 127 127 128 128 129 129 129 129 129Colombia to LME#42. Caribbean Sea1.61E+074.33E+09128 129 129 129 120 120 120 120 120 120 120 120 120 120 120 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 121 	112	Belarus to LME#23. Baltic Sea		29,863.38	2.11E+08
124 Canada to LME#2. Guif of Alaska216.392.98E+08Canada to LME#3. Hudson Bay524.412.98E+08Canada to LME#9. Newfoundland-Labrador Shelf1.506.602.98E+08Canada to LME#8. Scotian Shelf1.060.602.98E+08Canada to LME#3. Bay of Bengal2.5,932.464.68E+07152Chile to LME#3. Humbold Current369.579.13E+07155China, People's Republic of to LME#46. South China Sea1.810.544.93E+09China, People's Republic of to LME#47. East China Sea1.650.064.93E+09China, People's Republic of to LME#48. Yellow Sea4.477.334.93E+09Colombia to LME#11. Pacific Central-American226.643.06E+08170Colombia to LME#12. Caribbean Sea1.0781.751.11E+08180Democratic Republic of the Congo to LME#28. Guinea Current8.81.751.59E+09188Costa Rica to LME#11. Pacific Central-American6.318.806.39E+07191Croatia to LME#12. Caribbean Sea1.045.798.10E+07192Cuba to LME#12. Caribbean Sea1.045.798.10E+07193Costa Rica to LME#12. Caribbean Sea1.045.798.10E+07194Coratia to LME#12. Caribbean Sea1.045.798.30E+06195Cyrus to LME#26. Mediterranean6.318.806.39E+07196Cyrus to LME#27. North Sea3.17.772.38E+07197Coratia to LME#12. North Sea3.17.772.38E+07198Demmark to LME#22. North Sea3.17.772.38E+07199C	116	Cambodia to LME#3. California Current		1,187.57	1.58E+08
Canada to LME#63. Hudson Bay524.412.98E+08Canada to LME#64. Arctic Ocean157.962.98E+08Canada to LME#64. Arctic Ocean15.122.98E+08144Sri Lanka to LME#64. Arctic Ocean15.122.98E+08152Chile to LME#13. Humboldt Current369.579.13E+07156China, People's Republic of to LME#36. South China Sea1,810.544.493E+09157Colombia to LME#11. Pacific Central-American223.343.06E+08158Colombia to LME#12. Caribbean Sea2.86.643.06E+08159Colombia to LME#12. Caribbean Sea2.86.643.06E+08159Costa Rica to LME#12. Caribbean Sea4.077.571.59E+09159Costa Rica to LME#12. Caribbean Sea4.077.581.51E+07159Costa Rica to LME#12. Caribbean Sea4.047.581.61E+07159Costa Rica to LME#12. Caribbean Sea4.047.581.61E+07159Costa Rica to LME#12. Caribbean Sea4.047.581.61E+07159Cubato LME#12. Caribbean Sea1.445.778.10E+07150Cubato LME#12. Caribbean Sea1.445.751.51E+08159Cubato LME#12. Caribbean Sea1.445.751.51E+07159Cubato LME#12. Caribbean Sea1.445.751.51E+07150Cubato LME#12. Caribbean Sea1.445.751.51E+07150Cubato LME#12. Caribbean Sea1.445.751.51E+07150Demark to LME#25. Mediterranean3.81E+071.54E+08151Demark to LME#25. Mediterranean </td <td>120</td> <td>Cameroon to LME#28. Guinea Current</td> <td></td> <td>10,509.35</td> <td>3.07E+08</td>	120	Cameroon to LME#28. Guinea Current		10,509.35	3.07E+08
Canada to LME#9. Newfoundland-labrador Shelf157.962.98E+08Canada to LME#8. Scotian Shelf1,060.602.98E+08Canada to LME#64. Arctic Ocean15.122.98E+08144Sri Lanka to LME#34. Bay of Bengal25,932.464.68E+07155China, People's Republic of to LME#36. South China Sea1,810.544.93E+09China, People's Republic of to LME#47. East China Sea1,805.064.93E+09China, People's Republic of to LME#48. Yellow Sea4,477.334.30E+08Colombia to LME#11. Pacific Central-American523.343.06E+08Colombia to LME#12. Caribbean Sea286.643.06E+08100Democratic Republic of the LM#48. Yellow Sea447.734.11E+08101Colombia to LME#12. Caribbean Sea286.643.06E+08102Colombia to LME#12. Caribbean Sea407.681.61E+07103Costa Rica to LME#11. Pacific Central-American7.43.31.01E+07104Costa Rica to LME#12. Caribbean Sea1,445.798.10E+07105Cyprus to LME#26. Mediterranean6,318.806.39E+07106Cyprus to LME#26. Mediterranean13,077.959.12E+07107Costa Rica to LME#12. Caribbean Sea1,445.798.10E+07108Demorark to LME#28. Suinea Current13,077.959.12E+07109Demark to LME#28. Suinea Current13,077.959.12E+07120Denmark to LME#28. Guinea Current1,545.873.20E+07121Demark to LME#28. Saltic Sea5,355.873.20E+07<	124	Canada to LME#2. Gulf of Alaska		216.39	2.98E+08
Canada to LME#6. Scotian Shelf1,060.002.98E+08Canada to LME#64. Arctic Ocean15.122.98E+08144Sri Lanka to LME#34. Bay of Bengal25,932.464.68E+07152Chile to LME#13. Humbold Current369.579.13E+07153China, People's Republic of to LME#36. South China Sea1,810.544.93E+09154China, People's Republic of to LME#37. East China Sea1,650.064.93E+09155China, People's Republic of to LME#48. Yellow Sea4,477.334.93E+09156Colombia to LME#11. Pacific Central-American28.643.06E+08157Colombia to LME#12. Caribbean Sea28.6643.06E+08158Costa Rica to LME#12. Caribbean Sea10,781.751.11E+08159Costa Rica to LME#12. Caribbean Sea407.688.10E+07159Costa Rica to LME#12. Caribbean Sea407.688.10E+07159Costa Rica to LME#12. Caribbean Sea1,445.798.10E+07159Costa Rica to LME#12. Caribbean Sea1,445.798.10E+07159Coptrus to LME#26. Mediterranean8,841.963.92E+06150Coptrus to LME#22. North Sea13.077.959.12E+07150Denmark to LME#22. North Sea13.077.959.12E+07150Denmark to LME#23. Baltic Sea10.498.032.38E+07151Denmark to LME#23. Baltic Sea15.61-071.545.87152Eudor to LME#11. Pacific Central-American1,521.61.28E+07152Eudor to LME#12. Caribbean Sea1,545.87 <td></td> <td>Canada to LME#63. Hudson Bay</td> <td></td> <td>524.41</td> <td>2.98E+08</td>		Canada to LME#63. Hudson Bay		524.41	2.98E+08
Canada to LME#64. Arctic Ocean         15.12         2.98E+08           144         Sri Lanka to LME#34. Bay of Bengal         25.932.46         4.668E+07           152         Chile to LME#13. Humboldt Current         369.57         9.13E+09           156         China, People's Republic of to LME#36. South China Sea         1.810.54         4.93E+09           156         China, People's Republic of to LME#47. East China Sea         1.650.06         4.93E+09           170         Colombia to LME#11. Pacific Central-American         523.34         3.06E+08           Colombia to LME#12. Caribbean Sea         286.64         3.06E+08           Colombia to LME#12. Caribbean Sea         286.64         3.06E+08           170         Colombia to LME#12. Caribbean Sea         286.64         3.06E+08           1710         Congo to LME#28. Guinea Current         8.817.57         1.11E+08           1720         Coratia Ric to LME#11. Pacific Central-American         6.318.80         6.39E+07           1721         Croatia to LME#26. Mediterranean         6.318.80         6.39E+07           1722         Cuba to LME#26. Mediterranean         8.841-95         3.92E+06           1723         Cubat to LME#26. Mediterranean         3.82E+07         3.92E+06           1734         Casta Rica to		Canada to LME#9. Newfoundland-Labrador Shelf		157.96	2.98E+08
144         Sri Lanka to LME#34. Bay of Bengal         25,932.46         4.68E+07           152         Chile to LME#13. Humbold Current         369.57         9.13E+07           156         China, People's Republic of to LME#45. South China Sea         1,810.54         4.93E+09           157         China, People's Republic of to LME#45. Vellow Sea         4,477.33         4.93E+09           157         Colombia to LME#11. Pacific Central-American         523.34         3.06E+08           157         Colombia to LME#12. Caribbean Sea         286.64         3.06E+08           158         Colombia to LME#12. Caribbean Sea         286.64         3.06E+08           159         Democratic Republic of the Congo to LME#28. Guinea Current         8.817.57         1.159E+09           158         Costa Rica to LME#12. Caribbean Sea         407.68         1.61E+07           159         Costa Rica to LME#12. Caribbean Sea         1.457.97         8.10E+07           159         Costa Rica to LME#12. Caribbean Sea         1.457.97         8.10E+07           150         Czeck Republic to LME#22. North Sea         3.117.37         2.38E+07           150         Czeck Republic to LME#22. North Sea         3.117.37         2.38E+07           150         Demmark to LME#23. Baltic Sea         3.117.37				1,060.60	2.98E+08
152Chile to LME#13. Humboldt Current369.579.13E+07156China, People's Republic of to LME#36. South China Sea1,810.544.93E+09China, People's Republic of to LME#47. East China Sea1,650.064.93E+09170Colombia to LME#11. Pacific Central-American523.344.93E+09170Colombia to LME#12. Caribbean Sea286.643.06E+08178Congo to LME#28. Guinea Current10,781.751.11E+08180Democratic Republic of the Congo to LME#28. Guinea Current8.817.571.59E+09181Costa Rica to LME#12. Caribbean Sea407.686.61E+07192Costa Rica to LME#12. Caribbean Sea407.686.63E+07193Costa Rica to LME#12. Caribbean Sea407.686.39E+07194Costa Rica to LME#12. Caribbean Sea40.857.651.76E+08195Cyprus to LME#26. Mediterranean6.318.806.39E+07196Cyprus to LME#26. Mediterranean8,841.963.92E+06207Cech Republic to LME#22. North Sea10,857.651.76E+08208Benin to LME#28. Guinea Current13,077.959.12E+07209Denmark to LME#28. Guinea Current1,948.332.38E+07214Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07214Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07214Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07215Ecuador to LME#11. Pacific Central-American1,521.961.27F+08					
156China, People's Republic of to LME#36. South China Sea1,810.544,93E+09China, People's Republic of to LME#47. East China Sea1,650.064,93E+09China, People's Republic of to LME#48. Yellow Sea4,477.334,93E+09170Colombia to LME#11. Pacific Central-American523.343,06E+08178Congo to LME#28. Guinea Current8,817.571,11E+08180Democratic Republic of the Congo to LME#28. Guinea Current8,817.571,59E+09181Costa Rica to LME#11. Pacific Central-American744.331,61E+07192Croatia to LME#12. Caribbean Sea407.681,61E+07193Costa Rica to LME#12. Caribbean Sea407.686,39E+07194Costa Rica to LME#12. Caribbean Sea1,445.798,10E+07195Cyprus to LME#26. Mediterranean6,318.806,39E+07196Cyprus to LME#26. Mediterranean8,841.963,92E+06193Cach Republic to LME#22. North Sea3,107.759,12E+07204Denmark to LME#22. North Sea3,117.372,38E+07214Dominican Republic to LME#12. Caribbean Sea1,545.873,20E+07215Ecuador to LME#11. Pacific Central-American1,521.962,32E+07216Denmark to LME#23. Baltic Sea1,545.873,20E+07217Dominican Republic to LME#12. Caribbean Sea5,352.684,56E+08218Eduatrial Guinea to LME#32. Rothea Current14,004.935,00E+06219Equatorial Guinea to LME#32. Rothea Current14,004.935,					
China, People's Republic of to LME#47. East China Sea1,650.064,93E+09China, People's Republic of to LME#48. Yellow Sea4,477.334,93E+09170Colombia to LME#11. Pacific Central-American523.343,06E+08178Congo to LME#12. Caribbean Sea286.643,06E+08180Democratic Republic of the Congo to LME#28. Guinea Current8,817.571,59E+09181Costa Rica to LME#11. Pacific Central-American744.331,61E+07191Croatia to LME#12. Caribbean Sea407.681,61E+07192Costa Rica to LME#26. Mediterranean6,318.806,39E+07193Cuba to LME#26. Mediterranean6,318.806,39E+07194Cuba to LME#26. Mediterranean8,841.953,22E+06195Cyprus to LME#26. Mediterranean8,841.953,22E+07196Cyprus to LME#26. Mediterranean8,841.953,02E+07197Cuba to LME#26. Mediterranean1,087.051,76E+08108Cacerh Republic to LME#22. North Sea3,117.372,38E+07109Denmark to LME#22. North Sea3,117.372,38E+071218Dominican Republic to LME#12. Caribbean Sea1,545.873,20E+071218Cuadorial Guinea to LME#12. Caribbean Sea1,545.873,20E+071218Cuadorial Guinea to LME#28. Guinea Current1,904.935,00E+061219Dominican Republic to LME#12. Caribbean Sea5,792.044,56E+081222El Salvador to LME#11. Pacific Central-American2,997.843,20E+071					
China, People's Republic of to LME#48. Yellow Sea4,477.334,493E+09170Colombia to LME#11. Pacific Central-American523.343.06E+08178Congo to LME#12. Caribbean Sea286.643.06E+08178Congo to LME#28. Guinea Current10,781.751.11E+08180Democratic Republic of the Congo to LME#28. Guinea Current8,817.571.59E+09188Costa Rica to LME#11. Pacific Central-American744.331.61E+07191Croatia to LME#12. Caribbean Sea407.681.61E+07192Cuba to LME#12. Caribbean Sea447.686.39E+07193Costa Rica to LME#26. Mediterranean6.318.806.39E+07194Coratia to LME#26. Mediterranean8,841.963.92E+06195Cyprus to LME#28. Guinea Current13,077.959.12E+07196Denmark to LME#28. Guinea Current13,077.959.12E+07108Denmark to LME#28. Guinea Current13,077.959.12E+07109Denmark to LME#28. Guinea Current13,079.551.76E+08114Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07115Ecuador to LME#11. Pacific Central-American1,545.873.20E+07116Ecuador to LME#11. Pacific Central-American2,097.282.60E+07117Ecuador to LME#11. Pacific Central-American2,097.282.60E+07118Ecuador to LME#11. Pacific Central-American3,532.684.56E+08114Ecuador to LME#33. Red Sea5,572.044.56E+08115	156				
170Colombia to LME#11. Pacific Central-American523.343.06E+08178Colombia to LME#12. Caribbean Sea286.643.06E+08178Congo to LME#28. Guinea Current10,781.751.11E+08180Democratic Republic of the Congo to LME#28. Guinea Current8.817.571.59E+09181Costa Rica to LME#11. Pacific Central-American744.331.61E+07191Croatia to LME#12. Caribbean Sea407.681.61E+07192Cuba to LME#12. Caribbean Sea1.445.798.10E+07193Croatia to LME#12. Caribbean Sea1.045.708.10E+07194Cypus to LME#26. Mediterranean8.841.963.92E+06195Cypus to LME#28. Guinea Current1.0,857.651.76E+08196Cypus to LME#28. Guinea Current1.0,857.651.76E+08197Denmark to LME#23. Baltic Sea1.0,498.032.38E+07198Denmark to LME#23. Baltic Sea1.545.873.20E+07199Cudor to LME#11. Pacific Central-American1.521.961.27E+08191Croatia to LME#23. Arabian Sea1.545.873.20E+07192Equatorial Guinea to LME#28. Guinea Current14,004.935.00E+06193Equatorial Guinea to LME#28. Guinea Current14,004.935.00E+06194Deminican Republic to LME#14. Partigican Current1.541.961.27E+08193Equatorial Guinea to LME#28. Guinea Current1.541.961.27E+08194Equatorial Guinea to LME#33. Red Sea5.52.684.56E+08194 <td< td=""><td></td><td></td><td></td><td></td><td></td></td<>					
Colombia to LME#12. Caribbean Sea286.643.06E+08178Congo to LME#28. Guinea Current10,781.751.11E+08180Democratic Republic of the Congo to LME#28. Guinea Current8,817.571.59E+09188Costa Rica to LME#11. Pacific Central-American744.331.61E+07191Croatia to LME#12. Caribbean Sea407.686.39E+07192Cuba to LME#12. Caribbean Sea1,445.798.10E+07193Croatia to LME#26. Mediterranean6,318.806.39E+07194Cypus to LME#26. Mediterranean8.841.963.92E+06195Cypus to LME#26. Mediterranean10,857.651.76E+08196Cypus to LME#28. Guinea Current13,077.959.12E+07208Denmark to LME#22. North Sea3.117.372.38E+07209Denmark to LME#28. Baltic Sea10,498.032.23E+07214Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07215Ecuador to LME#11. Pacific Central-American1,521.961.27E+08216Equatorial Guinea to LME#12. Caribbean Sea1,545.873.20E+07226Equatorial Guinea to LME#12. Caribbean Sea5,792.044.56E+08217Dominican Republic to LME#12. Caribbean Sea5,792.044.56E+08218Eudor to LME#11. Pacific Central-American2.097.282.60E+07226Equatorial Guinea to LME#28. Guinea Current14,004.935.00E+06223Ethiopia to LME#33. Red Sea5,522.684.56E+08224Ethiopia to LME#33	170				
178Congo to LME#28. Guinea Current10,781.751.11E+08180Democratic Republic of the Congo to LME#28. Guinea Current8,817.571.59E+09188Costa Rica to LME#11. Pacific Central-American744.331.61E+07191Croatia to LME#22. Caribbean Sea407.681.61E+07192Cuba to LME#12. Caribbean Sea1,445.798.10E+07193Croatia to LME#12. Caribbean Sea1,445.798.10E+07194Cuba to LME#12. Caribbean Sea1,445.798.10E+07195Cyprus to LME#26. Mediterranean8,841.963.92E+06196Cyprus to LME#28. Guinea Current13,077.959.12E+07208Denmark to LME#28. Guinea Current13,077.959.12E+07208Denmark to LME#28. Guinea Current1,0498.032.38E+07214Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07215Ecuador to LME#11. Pacific Central-American1,521.961.27E+08216Balvador to LME#11. Pacific Central-American2.097.282.60E+07226Equatorial Guinea to LME#12. Guinea Current14,004.935.00E+06213Ethiopia to LME#33. Red Sea5,792.044.56E+08214Ethiopia to LME#33. Red Sea3.535.672.16E+07223Estonia to LME#33. Red Sea3.545.684.56E+08214Ethiopia to LME#33. Red Sea3.535.672.16E+07223Estonia to LME#33. Red Sea3.545.681.17E+08234Fritrea to LME#33. Red Sea3.8,643.28	170				
180Democratic Republic of the Congo to LME#28. Guinea Current8,817.571.59E+09188Costa Rica to LME#11. Pacific Central-American744.331.61E+07191Croatia to LME#12. Caribbean Sea407.681.61E+07192Cuba to LME#12. Caribbean Sea1,445.798.10E+07193Croatia to LME#12. Caribbean Sea1,445.798.10E+07194Cuba to LME#12. Caribbean Sea1,445.798.10E+07195Cyprus to LME#26. Mediterranean8,841.963.92E+06196Cyprus to LME#28. Guinea Current13,077.959.12E+07208Denmark to LME#28. Guinea Current13,077.959.12E+07209Denmark to LME#28. Baltic Sea1,049.80.32.38E+07214Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07215Ecuador to LME#11. Pacific Central-American1,521.961.27E+08216Balvador to LME#11. Pacific Central-American2,097.282.60E+07226Equatorial Guinea to LME#28. Guinea Current14,004.935.00E+06217Ethiopia to LME#32. Arabian Sea5,792.044.56E+08218Ethiopia to LME#33. Red Sea5,352.684.56E+08229Estonia to LME#33. Red Sea3.8543.752.10E+07238Estonia to LME#33. Red Sea3.55.672.16E+07238Firtera to LME#33. Red Sea3.8543.281.17E+08239Firtera to LME#33. Red Sea3.8543.281.12E+07238Firtera to LME#33. Baltic Sea3.8543.56 </td <td>178</td> <td></td> <td></td> <td></td> <td></td>	178				
188Costa Rica to LME#11. Pacific Central-American744.331.61E+07Costa Rica to LME#12. Caribbean Sea407.681.61E+07191Croatia to LME#26. Mediterranean6,318.806.39E+07192Cuba to LME#12. Caribbean Sea1,445.798.10E+07193Cuprus to LME#26. Mediterranean8,841.963.92E+06194Cyprus to LME#26. Mediterranean8,841.963.92E+07195Cyprus to LME#26. Mediterranean8,841.963.92E+07203Czech Republic to LME#22. North Sea13,077.959.12E+07204Benin to LME#28. Guinea Current13,077.959.12E+07205Denmark to LME#22. North Sea3,117.372.38E+07206Denmark to LME#23. Baltic Sea10,498.032.38E+07207Denmark to LME#20. Farce Plateau188.332.30E+07218Ecuador to LME#11. Pacific Central-American1,521.961.27E+08222El Salvador to LME#11. Pacific Central-American2,997.282.60E+07233Ethiopia to LME#32. Arabian Sea5,792.044.56E+08234Ethiopia to LME#33. Red Sea5,352.684.56E+08235Fritrea to LME#33. Red Sea15,412.995.24E+07238Falkland Islands (Malvinas) to LME#14. Patagonian Shelf9,187.224.05E+05236France to LME#23. Baltic Sea38,643.281.17E+08236Frinand to LME#23. Baltic Sea38,643.281.17E+08236France to LME#23. Baltic Sea38,643.281.17E+08<		-			
191 192 193 194 194 194 194 195 195 195 195 196 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 196 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 197 198 198 197 198 198 198 198 198 198 198 199 198 199 198 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 199 <br< td=""><td></td><td></td><td></td><td></td><td></td></br<>					
192 193Cuba to LME#12. Caribbean Sea1,445.798.10E+07196 197Cyprus to LME#26. Mediterranean8,841.963.92E+06203 203Czech Republic to LME#22. North Sea10,857.651.76E+08204 205Benin to LME#28. Guinea Current13,077.959.12E+07205 206Denmark to LME#22. North Sea3,117.372.38E+07206 207 208Denmark to LME#23. Baltic Sea10,498.032.38E+07208 208 208Denmark to LME#12. Caribbean Sea1,545.873.20E+07214 209 209Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07215 208 209 209Ecuador to LME#11. Pacific Central-American2,097.282.60E+07216 209 209 209 200Ethiopia to LME#23. Arabian Sea5,792.044.56E+08217 208 209 209 209 209 200Ethiopia to LME#33. Red Sea5,352.684.56E+08218 219 210 210 210 210 210 210 210 210 210 2110 2110 2110 2120 2120 2120 2130 2130 2130 2130 21405.00E+062.52E+07219 210 210 210 2110 2110 2120 2120 2130 2130 2130 2130 2130 21402.52E+072.405E+05213 2140 2140 2130 2140 2140 21402.913.863.20E+062.405E+052140 2150 21402.913.802.913.802.02E+062150 2160 21602.913.802.02E+072.405E+052161 2170 2180 21802.913.802					
196Cyprus to LME#26. Mediterranean8,841.963.92E+06203Czech Republic to LME#22. North Sea10,857.651.76E+08204Benin to LME#28. Guinea Current13,077.959.12E+07208Denmark to LME#22. North Sea3,117.372.38E+07209Denmark to LME#23. Baltic Sea10,498.032.23E+07214Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07215Ecuador to LME#11. Pacific Central-American1,521.961.27E+08216Equador to LME#32. Arabian Sea2,097.282.60E+07217Equatorial Guinea to LME#28. Guinea Current14,004.935.00E+06218Ethiopia to LME#33. Red Sea5,792.044.56E+08219Ethiopia to LME#33. Red Sea5,54E+072.24E+07219Estonia to LME#33. Red Sea15,6412.995.24E+07210Estonia to LME#33. Baltic Sea38,643.281.17E+08211Baltic Sea3.864.032.45E+05212France to LME#33. Baltic Sea3.864.51.294.05E+05213Estonia to LME#33. Baltic Sea3.864.51.294.05E+05214France to LME#33. Baltic Sea3.864.51.24.05E+05215France to LME#23. Baltic Sea3.864.51.24.05E+05216France to LME#23. Baltic Sea3.864.51.24.05E+05216France to LME#24. Celtic-Biscay Shelf2.913.863.20E+05217Experimention2.913.863.20E+05218France to LME#24. Celtic-Biscay	191	Croatia to LME#26. Mediterranean		6,318.80	6.39E+07
200         Cach Republic to LME#22. North Sea         10,857.65         1.76E+08           204         Benin to LME#28. Guinea Current         13,077.95         9.12E+07           208         Denmark to LME#22. North Sea         3,117.37         2.38E+07           209         Denmark to LME#23. Baltic Sea         10,498.03         2.38E+07           214         Dominican Republic to LME#12. Caribbean Sea         1,545.87         3.20E+07           218         Ecuador to LME#11. Pacific Central-American         1,521.96         1.27E+08           226         Equatorial Guinea to LME#28. Guinea Current         14,004.93         5.00E+06           213         Ecuador to LME#32. Arabian Sea         5,792.04         4.56E+08           214         Dominican CuLME#32. Arabian Sea         5,352.68         4.56E+08           215         Ecuador to LME#33. Red Sea         5,352.68         4.56E+08           216         Entiopia to LME#33. Red Sea         15,412.99         5.24E+07           213         Estonia to LME#33. Red Sea         38,535.67         2.16E+07           214         Deminican Subitic Sea         38,643.28         1.17E+08           215         Estonia to LME#33. Red Sea         15,412.99         5.24E+07           216         Entiopia to LME#	192	Cuba to LME#12. Caribbean Sea		1,445.79	8.10E+07
204Benin to LME#28. Guinea Current13,077.959.12E+07208Denmark to LME#22. North Sea3,117.372.38E+07Denmark to LME#23. Baltic Sea10,498.032.38E+07Denmark to LME#60. Farce Plateau188.332.38E+07Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07218Ecuador to LME#11. Pacific Central-American1,521.961.27E+08221Eslavador to LME#11. Pacific Central-American2.097.282.60E+07223Ethiopia to LME#32. Arabian Sea5,792.044.56E+08214Ethiopia to LME#33. Red Sea5,352.684.56E+08215Estonia to LME#33. Red Sea15,412.995.24E+07218Estonia to LME#23. Baltic Sea38,653.672.10E+07219Faithand to LME#23. Baltic Sea38,643.281.17E+08210France to LME#23. Baltic Sea2,913.863.20E+05211Faind to LME#23. North Sea2,913.863.20E+07212Estonia to LME#23. Baltic Sea38,643.281.17E+08213Faind to LME#23. Baltic Sea38,643.281.17E+08214France to LME#24. Celtic-Biscay Shelf2,913.863.20E+08215France to LME#24. Celtic-Biscay Shelf2,399.473.20E+08				8,841.96	3.92E+06
208Denmark to LME#22. North Sea3,117.372.38E+07Denmark to LME#23. Baltic Sea10,498.032.38E+07Denmark to LME#60. Farce Plateau188.332.38E+07Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07218Ecuador to LME#11. Pacific Central-American1,521.961.27E+08222El Salvador to LME#11. Pacific Central-American2.097.282.60E+07233Ethiopia to LME#32. Arabian Sea5,792.044.56E+08234Ethiopia to LME#33. Red Sea5,352.684.56E+08235Ethiopia to LME#33. Red Sea38,535.672.16E+07236Estoniato LME#23. Baltic Sea38,643.281.17E+08237Frikland Islands (Malvinas) to LME#14. Patagonian Shelf9,187.224.05E+05246Friance to LME#22. North Sea2.913.863.20E+07250France to LME#22. North Sea2.913.863.20E+07250France to LME#24. Celtic-Biscay Shelf2.939.473.20E+08				10,857.65	1.76E+08
Denmark to LME#23. Baltic Sea10,498.032.38E+07Denmark to LME#60. Farce Plateau188.332.38E+07214Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07218Ecuador to LME#11. Pacific Central-American1,521.961.27E+08222El Salvador to LME#11. Pacific Central-American2,097.282.60E+07223Ethiopia to LME#32. Guinea Current14,004.935.00E+06224Ethiopia to LME#33. Red Sea5,352.684.56E+08233Ethiopia to LME#33. Red Sea3,352.684.56E+08234Ethia to LME#33. Red Sea3.643.282.16E+07233Estonia to LME#23. Baltic Sea38,535.672.16E+07234Filtand to LME#23. Baltic Sea3.86,643.281.17E+08246Finland to LME#23. Baltic Sea3.86,43.281.17E+08250France to LME#24. Celtic-Biscay Shelf2,913.863.20E+08					9.12E+07
Denmark to LME#60. Faroe Plateau188.332.38E+07214Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07218Ecuador to LME#11. Pacific Central-American1,521.961.27E+08222El Salvador to LME#11. Pacific Central-American2,097.282.60E+07223Equatorial Guinea to LME#28. Guinea Current14,004.935.00E+06234Ethiopia to LME#33. Red Sea5,352.684.56E+08235Etrirea to LME#33. Red Sea3,535.672.16E+07238Faltkand Islands (Malvinas) to LME#14. Patagonian Shelf9,187.224.05E+05246Finland to LME#23. Baltic Sea38,643.281.17E+08250France to LME#24. Celtic-Biscay Shelf2,913.663.20E+05	208				
214Dominican Republic to LME#12. Caribbean Sea1,545.873.20E+07218Ecuador to LME#11. Pacific Central-American1,521.961.27E+08222El Salvador to LME#11. Pacific Central-American2,097.282.60E+07226Equatorial Guinea to LME#28. Guinea Current14,004.935.00E+06231Ethiopia to LME#32. Arabian Sea5,792.044.56E+08232Eritrea to LME#33. Red Sea5,352.684.56E+08233Estonia to LME#23. Baltic Sea38,535.672.16E+07234Falkland Islands (Malvinas) to LME#14. Patagonian Shelf9,187.224.05E+05246Finland to LME#23. Baltic Sea38,643.281.17E+08250France to LME#24. Celtic-Biscay Shelf2,913.863.20E+05					
218Ecuador to LME#11. Pacific Central-American1,521.961.27E+08222El Salvador to LME#11. Pacific Central-American2,097.282,60E+07226Equatorial Guinea to LME#28. Guinea Current14,004.935.00E+06231Ethiopia to LME#32. Arabian Sea5,792.044,56E+08232Eritrea to LME#33. Red Sea5,352.684,56E+08233Estonia to LME#23. Baltic Sea38,536.752,16E+07238Falkand Islands (Malvinas) to LME#14. Patagonian Shelf9,187.224,05E+08246Finland to LME#23. Baltic Sea38,643.281,17E+08256France to LME#22. North Sea2,913.663,20E+08256France to LME#24. Celtic-Biscay Shelf2,399.473,20E+08					
222         El Salvador to LME#11. Pacific Central-American         2,097.28         2,097.28         2,007.28           226         Equatorial Guinea to LME#28. Guinea Current         14,004.93         5,00E+06           231         Ethiopia to LME#32. Arabian Sea         5,792.04         4,56E+08           232         Eritrea to LME#33. Red Sea         15,412.99         5,24E+07           233         Estonia to LME#23. Baltic Sea         38,535.67         2,16E+07           238         Falkland Islands (Malvinas) to LME#14. Patagonian Shelf         9,187.22         4,05E+05           246         Finland to LME#23. Baltic Sea         38,643.28         1,17E+08           250         France to LME#24. Celtic-Biscay Shelf         2,913.86         3,20E+08					
228Equatorial Guinea to LME#28. Guinea Current14,004.935.00E+06231Ethiopia to LME#32. Arabian Sea5,792.044.56E+08232Ethiopia to LME#33. Red Sea5,352.684.56E+08233Estonia to LME#33. Red Sea15,412.995.24E+07233Estonia to LME#23. Baltic Sea38,535.672.16E+07234Fihland to LME#23. Baltic Sea38,643.281.17E+08246Finland to LME#23. Baltic Sea38,643.281.17E+08250France to LME#22. North Sea2,913.863.20E+08250France to LME#24. Celtic-Biscay Shelf2,399.473.20E+08					
213         Ethiopia to LME#32. Arabian Sea         5,792.04         4.56E+08           214         Ethiopia to LME#33. Red Sea         5,352.68         4.56E+08           213         Eritrea to LME#33. Red Sea         15,412.99         5.24E+07           213         Estonia to LME#23. Baltic Sea         38,535.67         2.16E+07           218         Falkland Islands (Malvinas) to LME#14. Patagonian Shelf         9,187.22         4.05E+05           216         Finland to LME#23. Baltic Sea         38,643.28         1.17E+08           216         France to LME#24. North Sea         2,913.86         3.20E+08           216         France to LME#24. Celtic-Biscay Shelf         2,399.47         3.20E+08					
Ethiopia to LME#33. Red Sea         5,352.68         4.56E+08           232         Fritrea to LME#33. Red Sea         15,412.99         5.24E+07           233         Estonia to LME#23. Baltic Sea         38,535.67         2.16E+07           238         Falkland Islands (Malvinas) to LME#14. Patagonian Shelf         9,187.22         4.05E+05           246         Finland to LME#23. Baltic Sea         38,643.28         1.17E+08           250         France to LME#24. North Sea         2,913.86         3.20E+08           250         France to LME#24. Celtic-Biscay Shelf         2,399.47         3.20E+08					
232         Eritrea to LME#33. Red Sea         15,412.99         5.24E+07           233         Estonia to LME#23. Baltic Sea         38,535.67         2.16E+07           238         Falkland Islands (Malvinas) to LME#14. Patagonian Shelf         9,187.22         4.05E+05           246         Finland to LME#23. Baltic Sea         38,643.28         1.17E+08           250         France to LME#22. North Sea         2,913.86         3.20E+08           France to LME#24. Celtic-Biscay Shelf         2,399.47         3.20E+08	231				
233         Estonia to LME#23. Baltic Sea         38,535.67         2.16E+07           238         Falkland Islands (Malvinas) to LME#14. Patagonian Shelf         9,187.22         4.05E+05           246         Finland to LME#23. Baltic Sea         38,643.28         1.17E+08           250         France to LME#22. North Sea         2,913.86         3.20E+08           France to LME#24. Celtic-Biscay Shelf         2,399.47         3.20E+08	222				
238         Falkland Islands (Malvinas) to LME#14. Patagonian Shelf         9,187.22         4.05E+05           246         Finland to LME#23. Baltic Sea         38,643.28         1.17E+08           250         France to LME#22. North Sea         2,913.86         3.20E+08           France to LME#24. Celtic-Biscay Shelf         2,399.47         3.20E+08					
246         Finland to LME#23. Baltic Sea         38,643.28         1.17E+08           250         France to LME#22. North Sea         2,913.86         3.20E+08           France to LME#24. Celtic-Biscay Shelf         2,399.47         3.20E+08					
250         France to LME#22. North Sea         2,913.86         3.20E+08           France to LME#24. Celtic-Biscay Shelf         2,399.47         3.20E+08					
France to LME#24. Celtic-Biscay Shelf 2,399.47 3.20E+08					
France to LME#26. Mediterranean 1,529.93 3.20E+08					
		France to LME#26. Mediterranean		1,529.93	3.20E+08



	Djibouti to LME#32. Arabian Sea	18,417.86	8.30E+06
	Gabon to LME#28. Guinea Current Georgia to LME#62. Black Sea	13,043.97 17,264.22	5.03E+07 4.72E+07
	Gambia to LME#28. Guinea Current	19,658.43	3.96E+06
	Germany to LME#22. North Sea	4,562.65	4.97E+08
	Germany to LME#23. Baltic Sea	15,365.15	4.97E+08
288	Ghana to LME#28. Guinea Current	14,639.52	1.85E+08
300	Greece to LME#26. Mediterranean	8,120.22	8.86E+07
320	Guatemala to LME#11. Pacific Central-American	651.24	3.56E+07
	Guatemala to LME#12. Caribbean Sea	356.69	3.56E+07
	Guinea to LME#28. Guinea Current	16,406.40	1.57E+08
	Guyana to LME#17. North Brazil Shelf Haiti to LME#12. Caribbean Sea	3,889.58 1,517.80	1.05E+07 1.15E+07
	Honduras to LME#12. Caribbean Sea	1,133.63	9.10E+07
	Hungary to LME#62. Black Sea	20,356.52	1.55E+08
	Iceland to LME#59. Iceland Shelf	1,402.27	4.32E+06
356	India to LME#32. Arabian Sea	6,332.80	3.18E+09
	India to LME#34. Bay of Bengal	4,443.22	3.18E+09
	Indonesia to LME#38. Indonesian Sea	6,011.18	1.04E+09
	Iran, Islamic Republic of to LME#32. Arabian Sea	13,376.15	7.71E+08
	Iraq to LME#32. Arabian Sea	12,920.81	1.34E+08
	Ireland to LME#24. Celtic-Biscay Shelf Israel to LME#26. Mediterranean	17,768.49 6,128.33	5.87E+07 5.64E+06
	Italy to LME#26. Mediterranean	7,754.52	4.48E+08
	Kosovo to LME#26. Mediterranean	6,004.91	1.15E+07
	Côte d'Ivoire to LME#28. Guinea Current	15,667.52	1.78E+08
	Jamaica to LME#12. Caribbean Sea	1,571.02	3.37E+06
392	Japan to LME#47. East China Sea	1,138.15	2.98E+07
	Japan to LME#49. Kuroshio Current	491.17	2.98E+07
	Japan to LME#50. Sea of Japan/East Sea	1,811.28	2.98E+07
	Japan to LME#51. Oyashio Current	228.17	2.98E+07
	Japan to LME#52. Sea of Okhotsk	1,098.56	2.98E+07
	Jordan to LME#33. Red Sea	13,339.20	2.11E+07
	Kenya to LME#31. Somali Coastal Current	1,162.60	4.01E+08
408	Democratic People's Republic of Korea to LME#47. East China Sea	1,949.18	4.23E+07 4.23E+07
	Democratic People's Republic of Korea to LME#48. Yellow Sea Democratic People's Republic of Korea to LME#50. Sea of Japan/East Sea	5,288.96 3,101.98	4.23E+07
410	Republic of Korea to LME#47. East China Sea	2,131.22	2.60E+07
410	Republic of Korea to LME#48. Yellow Sea	5,782.93	2.60E+07
	Republic of Korea to LME#50. Sea of Japan/East Sea	3,391.69	2.60E+07
418	Lao People's Democratic Republic to LME#36. South China Sea	9,051.71	1.62E+08
422	Lebanon to LME#26. Mediterranean	6,439.34	3.81E+06
428	Latvia to LME#23. Baltic Sea	35,828.36	3.93E+07
430	Liberia to LME#28. Guinea Current	18,505.35	2.34E+07
	Libyan Arab Jamahiriya to LME#26. Mediterranean	6,311.36	5.48E+07
	Lithuania to LME#23. Baltic Sea	33,510.99	5.53E+07
	Madagascar to LME#30. Agulhas Current	6,968.10	2.44E+08
458	Malaysia to LME#34. Bay of Bengal	3,758.44	9.41E+07
	Malaysia to LME#35. Gulf of Thailand Malaysia to LME#36. South China Sea	76.35 2,425.58	9.41E+07 9.41E+07
466	Mali to LME#27. Canary Current	914.58	1.48E+08
-100	Mali to LME#28. Guinea Current	4,968.83	1.48E+08
478	Mauritania to LME#27. Canary Current	2,965.74	8.71E+07
484	Mexico to LME#3. California Current	247.74	4.34E+08
	Mexico to LME#4. Gulf of California	2,370.27	4.34E+08
	Mexico to LME#5. Gulf of Mexico	2,377.19	4.34E+08
	Moldova to LME#62. Black Sea	19,732.66	5.15E+07
	Montenegro to LME#26. Mediterranean	6,004.91	1.49E+07
504	Morocco to LME#26. Mediterranean	2,867.41	7.03E+07
	Morocco to LME#27. Canary Current Mozambique to LME#30. Agulhas Current	985.96 5,012.94	7.03E+07 4.06E+08
	Oman to LME#32. Arabian Sea	21,274.65	4.48E+07
	Namibia to LME#29. Benguela Current	3,124.29	4.48E+07 1.25E+08
	Nepal to LME#34. Bay of Bengal	9,178.18	2.85E+08
	Netherlands to LME#22. North Sea	14,615.34	1.28E+08
	New Caledonia to LME#40. Northeast Australia	1,692.66	1.01E+06
	New Zealand to LME#46. New Zealand Shelf	2,518.46	8.06E+07
558	Nicaragua to LME#11. Pacific Central-American	691.81	3.21E+07
	Nicaragua to LME#12. Caribbean Sea	378.91	3.21E+07
	Niger to LME#28. Guinea Current	10,873.93	1.56E+08
	Nigeria to LME#28. Guinea Current	11,375.19	7.85E+08
578	Norway to LME#21. Norwegian Sea	1,528.58	2.58E+07
	Norway to LME#22. North Sea	5,111.80	2.58E+07
586	Pakistan to LME#32. Arabian Sea	13,556.88	7.85E+08



591	Panama to LME#11. Pacific Central-American	736.68	1.33E+07
	Panama to LME#12. Caribbean Sea	403.49	1.33E+07
	Paraguay to LME#14. Patagonian Shelf	3,331.12	2.24E+08
	Peru to LME#13. Humboldt Current	301.05	3.12E+08
608	Philippines to LME#36. South China Sea Philippines to LME#37. Sulu-Celebes Sea	5,097.96 6,425.88	5.70E+07 5.70E+07
616	Poland to LME#23. Baltic Sea	35,107.62	5.63E+08
	Portugal to LME#25. Iberian Coastal	2,497.74	9.22E+07
	Guinea-Bissau to LME#28. Guinea Current	18,512.85	1.16E+07
626	Timor-Leste to LME#38. Indonesian Sea	8,710.92	4.28E+06
630	Puerto Rico to LME#12. Caribbean Sea	1,612.49	3.68E+06
642	Romania to LME#62. Black Sea	20,602.61	3.47E+08
643	Russian Federation to LME#20. Barents Sea	128.55	3.40E+08
	Russian Federation to LME#54. Chukchi Sea	88.56	3.40E+08
	Russian Federation to LME#56. East Siberian Sea	46.31	3.40E+08
	Russian Federation to LME#57. Laptev Sea Russian Federation to LME#58. Kara Sea	175.99 134.64	3.40E+08 3.40E+08
	Russian Federation to LME#62. Black Sea	1,078.91	3.40E+08
	Russian Federation to LME#64. Arctic Ocean	6.09	3.40E+08
	Russian Federation to LME#50. Sea of Japan/East Sea	513.89	3.40E+08
	Russian Federation to LME#51. Oyashio Current	64.74	3.40E+08
	Russian Federation to LME#52. Sea of Okhotsk	311.68	3.40E+08
	Russian Federation to LME#53. West Bering Sea	42.33	3.40E+08
682	Saudi Arabia to LME#32. Arabian Sea	5,684.01	2.37E+08
	Saudi Arabia to LME#33. Red Sea	5,252.84	2.37E+08
	Senegal to LME#27. Canary Current	3,391.52	8.92E+07
688	Serbia to LME#62. Black Sea Serbia to LME#26. Mediterranean	8,438.03 2,257.43	4.18E+07 4.18E+07
694	Sierra Leone to LME#28. Guinea Current	17,638.63	4.18E+07 2.48E+07
	Slovakia to LME#62. Black Sea	19,961.73	9.68E+07
	Viet Nam to LME#36. South China Sea	10,915.28	3.78E+08
705	Slovenia to LME#26. Mediterranean	6,616.68	3.80E+07
706	Somalia to LME#31. Somali Coastal Current	538.42	1.33E+08
	Somalia to LME#32. Arabian Sea	7,436.70	1.33E+08
710	South Africa to LME#29. Benguela Current	1,201.24	3.59E+08
	South Africa to LME#30. Agulhas Current	2,046.03	3.59E+08
	Zimbabwe to LME#30. Agul has Current	4,303.58 714.43	1.86E+08
/24	Spain to LME#25. Iberian Coastal Spain to LME#26. Mediterranean	2,964.33	3.26E+08 3.26E+08
736	Sudan to LME#33. Red Sea	11,750.93	1.54E+09
	Swaziland to LME#30. Agulhas Current	5,466.38	2.47E+07
	Sweden to LME#23. Baltic Sea	16,311.16	7.76E+07
	Sweden to LME#22. North Sea	4,843.57	7.76E+07
756	Switzerland to LME#22. North Sea	2,711.07	2.75E+07
	Switzerland to LME#26. Mediterranean	1,423.46	2.75E+07
	Switzerland to LME#62. Black Sea	5,320.73	2.75E+07
	Syrian Arab Republic to LME#26. Mediterranean	5,188.23	1.22E+08
	Thailand to LME#34. Bay of Bengal	13,886.51 14,057.36	3.54E+08 4.64E+07
	Togo to LME#28. Guinea Current United Arab Emirates to LME#32. Arabian Sea	20,715.44	2.68E+07
	Tunisia to LME#26. Mediterranean	7,601.66	4.53E+07
	Turkey to LME#26. Mediterranean	5,982.32	6.56E+08
	Uganda to LME#26. Mediterranean	4,814.88	2.51E+08
	Ukraine to LME#62. Black Sea	18,287.34	8.65E+08
	The FYR of Macedonia to LME#26. Mediterranean	6,534.89	2.78E+07
	Egypt to LME#26. Mediterranean	5,560.13	1.79E+08
826	United Kingdom of GB and NI to LME#22. North Sea	5,874.84	2.32E+08
	United Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf	4,837.75	2.32E+08 6.97E+08
	United Republic of Tanzania: Mainland to LME#30. Agulhas Current United States to LME#1. East Bering Sea	4,084.75 339.36	8.50E+08
640	United States to LME#2. Gulf of Alaska	99.95	8.50E+08
	United States to LME#3. California Current	48.97	8.50E+08
	United States to LME#4. Gulf of California	468.48	8.50E+08
	United States to LME#5. Gulf of Mexico	469.85	8.50E+08
	United States to LME#6. Southeast U.S. Continental Shelf	60.10	8.50E+08
	United States to LME#7. Northeast U.S. Continental Shelf	194.64	8.50E+08
	United States to LME#10. Insular Pacific-Hawaiian	16.63	8.50E+08
	United States to LME#54. Chukchi Sea	101.59	8.50E+08
	United States to LME#55. Beaufort Sea	142.75	8.50E+08
	Uruguay to LME#14. Patagonian Shelf Venezuela (Bolivarian Republic of) to LME#12. Caribbean Sea	4,786.56	1.74E+08
	Yemen to LME#32. Arabian Sea	874.99 18,551.47	5.62E+08 1.29E+08
	Zambia to LME#30. Agulhas Current	3,721.39	6.64E+08
n=214	, and the second s	.,.==	





**Table 3.17:** Characterisation Factors (CF) and total N emission to surface freshwater (sfw) at Country-to-LME scale.

	Emissi	on: N to freshwater	
	Resolution sca	ale: Country-to-LME	
		CF "N to freshwater"	Emission to fw
	Country-to-LME	(PAF·)[m <sup>3</sup> ·d/kg]	[kg/yr]
	Albania to LME#26. Mediterranean	11,128.87	1.47E+13
	Algeria to LME#26. Mediterranean Angola to LME#29. Benguela Current	11,128.87 4,613.74	1.44E+14 7.25E+13
	Argentina to LME#14. Patagonian Shelf	5,793.14	5.01E+14
	Australia to LME#39. North Australia	3,094.40	1.05E+13
50	Australia to LME#40. Northeast Australia	966.37	1.05E+13
	Australia to LME#41. East-Central Australia	1,054.97	1.05E+13
	Australia to LME#42. Southeast Australia	1,634.43	1.05E+13
	Australia to LME#43. Southwest Australia	1,566.22	1.05E+13
	Australia to LME#44. West-Central Australia	1,195.88	1.05E+13
	Australia to LME#45. Northwest Australia	1,506.92	1.05E+13
	Austria to LME#26. Mediterranean	11,128.87	4.08E+13
	Bahamas to LME#12. Caribbean Sea	1,163.28	1.35E+12
	Bangladesh to LME#34. Bay of Bengal	21,167.69	9.71E+14
	Belgium to LME#22. North Sea	21,195.67	9.43E+13 3.89E+10
	Bhutan to LME#34. Bay of Bengal Bolivia to LME#13. Humboldt Current	21,167.69 422.52	3.89E+10 1.01E+14
	Bosnia and Herzegovina to LME#26. Mediterranean	11,128.87	1.35E+13
	Botswana to LME#30. Agulhas Current	7,858.44	3.42E+13
	Brazil to LME#15. South Brazil Shelf	2,212.79	2.11E+14
	Brazil to LME#16. East Brazil Shelf	962.97	2.11E+14
	Brazil to LME#17. North Brazil Shelf	4,500.99	2.11E+14
84	Belize to LME#12. Caribbean Sea	1,163.28	1.84E+12
92	Virgin Islands (British) to LME#12. Caribbean Sea	1,163.28	8.07E+08
100	Bulgaria to LME#26. Mediterranean	11,128.87	7.62E+12
	Bulgaria to LME#62. Black Sea	41,598.53	7.62E+12
	Myanmar to LME#34. Bay of Bengal	21,167.69	1.90E+14
	Belarus to LME#23. Baltic Sea Cambodia to LME#3. California Current	71,378.35 1,645.78	8.36E+13 8.64E+11
	Cameroon to LME#28. Guinea Current	20,790.05	7.03E+11
	Canada to LME#2. Gulf of Alaska	3,359.50	1.33E+13
	Canada to LME#63. Hudson Bay	8,141.68	1.33E+13
	Canada to LME#9. Newfoundland-Labrador Shelf	2,452.32	1.33E+13
	Canada to LME#8. Scotian Shelf	16,466.06	1.33E+13
	Canada to LME#64. Arctic Ocean	234.71	1.33E+13
144	Sri Lanka to LME#34. Bay of Bengal	21,167.69	7.71E+13
	Chile to LME#13. Humboldt Current	422.52	1.22E+14
156	China, People's Republic of to LME#36. South China Sea	13,660.98	1.03E+15
	China, People's Republic of to LME#47. East China Sea	12,450.11	1.03E+15
470	China, People's Republic of to LME#48. Yellow Sea Colombia to LME#11. Pacific Central-American	33,782.51	1.03E+15 9.09E+13
170	Colombia to LME#12. Caribbean Sea	2,123.90 1,163.28	9.09E+13
178	Congo to LME#28. Guinea Current	20,790.05	6.09E+12
	Democratic Republic of the Congo to LME#28. Guinea Current	20,790.05	3.53E+13
	Costa Rica to LME#11. Pacific Central-American	2,123.90	8.32E+12
	Costa Rica to LME#12. Caribbean Sea	1,163.28	8.32E+12
191	Croatia to LME#26. Mediterranean	11,128.87	2.73E+13
	Cuba to LME#12. Caribbean Sea	1,163.28	4.79E+13
	Cyprus to LME#26. Mediterranean	11,128.87	9.33E+12
	Czech Republic to LME#22. North Sea	21,195.67	3.01E+13
	Benin to LME#28. Guinea Current Denmark to LME#22. North Sea	20,790.05	2.26E+13
208	Denmark to LME#22. North Sea Denmark to LME#23. Baltic Sea	21,195.67	7.97E+12
	Denmark to LME#23. Baitic Sea Denmark to LME#60. Faroe Plateau	71,378.35 1,280.49	7.97E+12 7.97E+12
214	Dominican Republic to LME#12. Caribbean Sea	1,163.28	3.61E+13
	Ecuador to LME#11. Pacific Central-American	2,123.90	7.92E+13
	El Salvador to LME#11. Pacific Central-American	2,123.90	2.29E+13
	Equatorial Guinea to LME#28. Guinea Current	20,790.05	6.68E+11
231	Ethiopia to LME#32. Arabian Sea	30,169.71	8.50E+13
	Ethiopia to LME#33. Red Sea	27,881.15	8.50E+13
	Eritrea to LME#33. Red Sea	27,881.15	2.32E+13
	Estonia to LME#23. Baltic Sea	71,378.35	6.34E+12
	Falkland Islands (Malvinas) to LME#14. Patagonian Shelf	5,793.14	2.30E+11
	Finland to LME#23. Baltic Sea	71,378.35	4.20E+13
250	France to LME#22. North Sea France to LME#24. Celtic-Biscay Shelf	21,195.67	3.42E+13
	France to LME#24. Celtic-Biscay Shelf France to LME#26. Mediterranean	17,453.98 11,128.87	3.42E+13 3.42E+13
		11,128.87	3.42ET13



262	Diibauti ta IME#22, Arabian Soa	30,169.71	1.99E+11
	Djibouti to LME#32. Arabian Sea Gabon to LME#28. Guinea Current	20,790.05	4.61E+12
	Georgia to LME#62. Black Sea	41,598.53	5.73E+13
	Gambia to LME#28. Guinea Current	20,790.05	2.92E+12
276	Germany to LME#22. North Sea	21,195.67	7.50E+13
	Germany to LME#23. Baltic Sea	71,378.35	7.50E+13
	Ghana to LME#28. Guinea Current	20,790.05	2.35E+13
	Greece to LME#26. Mediterranean Guatemala to LME#11. Pacific Central-American	11,128.87 2,123.90	3.93E+13 1.65E+13
320	Guatemala to LME#12. Caribbean Sea	1,163.28	1.65E+13
324	Guinea to LME#28. Guinea Current	20,790.05	3.02E+13
328	Guyana to LME#17. North Brazil Shelf	4,500.99	3.40E+12
332	Haiti to LME#12. Caribbean Sea	1,163.28	3.25E+13
	Honduras to LME#12. Caribbean Sea	1,163.28	5.76E+13
	Hungary to LME#62. Black Sea	41,598.53	5.78E+13
	Iceland to LME#59. Iceland Shelf India to LME#32. Arabian Sea	1,510.10	2.97E+12
356	India to LME#32. Arabian Sea	30,169.71 21,167.69	2.65E+15 2.65E+15
360	Indonesia to LME#38. Indonesian Sea	5,930.87	7.26E+14
	Iran, Islamic Republic of to LME#32. Arabian Sea	30,169.71	7.24E+14
368	Iraq to LME#32. Arabian Sea	30,169.71	1.97E+14
372	Ireland to LME#24. Celtic-Biscay Shelf	17,453.98	1.03E+14
	Israel to LME#26. Mediterranean	11,128.87	3.27E+13
	Italy to LME#26. Mediterranean	11,128.87	1.16E+14
	Kosovo to LME#26. Mediterranean Côte d'Ivoire to LME#28. Guinea Current	11,128.87 20,790.05	5.75E+12 3.75E+13
	Jamaica to LME#12. Caribbean Sea	1,163.28	6.59E+12
	Japan to LME#47. East China Sea	12,450.11	1.33E+13
	Japan to LME#49. Kuroshio Current	5,372.88	1.33E+13
	Japan to LME#50. Sea of Japan/East Sea	19,813.46	1.33E+13
	Japan to LME#51. Oyashio Current	2,495.94	1.33E+13
	Japan to LME#52. Sea of Okhotsk	12,016.99	1.33E+13
	Jordan to LME#33. Red Sea Kenya to LME#31. Somali Coastal Current	27,881.15 2,184.28	2.03E+13 1.51E+14
	Democratic People's Republic of Korea to LME#47. East China Sea	12,450.11	7.77E+12
100	Democratic People's Republic of Korea to LME#48. Yellow Sea	33,782.51	7.77E+12
	Democratic People's Republic of Korea to LME#50. Sea of Japan/East Sea	19,813.46	7.77E+12
410	Republic of Korea to LME#47. East China Sea	12,450.11	1.45E+13
	Republic of Korea to LME#48. Yellow Sea	33,782.51	1.45E+13
	Republic of Korea to LME#50. Sea of Japan/East Sea	19,813.46	1.45E+13
	Lao People's Democratic Republic to LME#36. South China Sea Lebanon to LME#26. Mediterranean	13,660.98 11,128.87	2.52E+13 1.87E+13
	Latvia to LME#23. Baltic Sea	71,378.35	9.95E+12
	Liberia to LME#28. Guinea Current	20,790.05	6.39E+11
434	Libyan Arab Jamahiriya to LME#26. Mediterranean	11,128.87	5.41E+13
440	Lithuania to LME#23. Baltic Sea	71,378.35	2.24E+13
	Madagascar to LME#30. Agulhas Current	7,858.44	9.91E+13
458	Malaysia to LME#34. Bay of Bengal	21,167.69	1.14E+13
	Malaysia to LME#35. Gulf of Thailand Malaysia to LME#36. South China Sea	429.98 13,660.98	1.14E+13
466	Mali to LME#27. Canary Current	3,826.67	2.25E+13
	Mali to LME#28. Guinea Current	20,790.05	2.25E+13
478	Mauritania to LME#27. Canary Current	3,826.67	6.91E+12
484	Mexico to LME#3. California Current	1,645.78	8.73E+13
	Mexico to LME#4. Gulf of California	15,746.08	8.73E+13
	Mexico to LME#5. Gulf of Mexico	15,792.03	8.73E+13
	Moldova to LME#62. Black Sea Montenegro to LME#26. Mediterranean	41,598.53 11,128.87	9.82E+12 7.44E+12
	Morocco to LME#26. Mediterranean	11,128.87	4.95E+13
	Morocco to LME#27. Canary Current	3,826.67	4.95E+13
508	Mozambique to LME#30. Agulhas Current	7,858.44	4.58E+13
	Oman to LME#32. Arabian Sea	30,169.71	4.62E+10
	Namibia to LME#29. Benguela Current	4,613.74	1.13E+13
	Nepal to LME#34. Bay of Bengal	21,167.69	1.95E+14
	Netherlands to LME#22. North Sea New Caledonia to LME#40. Northeast Australia	21,195.67 966.37	9.78E+13 7.98E+11
	New Zealand to LME#46. New Zealand Shelf	1,871.56	2.89E+11
	Nicaragua to LME#11. Pacific Central-American	2,123.90	6.69E+12
	Nicaragua to LME#12. Caribbean Sea	1,163.28	6.69E+12
562	Niger to LME#28. Guinea Current	20,790.05	3.68E+13
	Nigeria to LME#28. Guinea Current	20,790.05	2.28E+14
578	Norway to LME#21. Norwegian Sea	6,338.15	8.14E+12
E 0 /	Norway to LME#22. North Sea	21,195.67 30,169.71	8.14E+12 2.49E+15
200		50,105.71	2.732713



591	Panama to LME#11. Pacific Central-American	2,123.90	3.19E+12
	Panama to LME#12. Caribbean Sea	1,163.28	3.19E+12
	Paraguay to LME#14. Patagonian Shelf	5,793.14	9.22E+13
	Peru to LME#13. Humboldt Current Philippines to LME#36. South China Sea	422.52	1.29E+14 6.49E+13
	Philippines to LME#35. South China Sea Philippines to LME#37. Sulu-Celebes Sea	13,660.98 17,219.40	6.49E+13 6.49E+13
	Poland to LME#23. Baltic Sea	71,378.35	1.75E+14
	Portugal to LME#25. Iberian Coastal	2,682.17	4.74E+13
624	Guinea-Bissau to LME#28. Guinea Current	20,790.05	6.93E+12
626	Timor-Leste to LME#38. Indonesian Sea	5,930.87	1.82E+11
630	Puerto Rico to LME#12. Caribbean Sea	1,163.28	9.16E+12
	Romania to LME#62. Black Sea	41,598.53	1.16E+14
	Russian Federation to LME#20. Barents Sea	4,956.31	4.93E+12
	Russian Federation to LME#54. Chukchi Sea	3,414.44	4.93E+12
	Russian Federation to LME#56. East Siberian Sea	1,785.58	4.93E+12
	Russian Federation to LME#57. Laptev Sea Russian Federation to LME#58. Kara Sea	6,785.50 5,191.29	4.93E+12 4.93E+12
	Russian Federation to LME#62. Black Sea	41,598.53	4.93E+12
	Russian Federation to LME#64. Arctic Ocean	234.71	4.93E+12
	Russian Federation to LME#50. Sea of Japan/East Sea	19,813.46	4.93E+12
	Russian Federation to LME#51. Oyashio Current	2,495.94	4.93E+12
	Russian Federation to LME#52. Sea of Okhotsk	12,016.99	4.93E+12
	Russian Federation to LME#53. West Bering Sea	1,632.19	4.93E+12
	Saudi Arabia to LME#32. Arabian Sea	30,169.71	2.97E+13
	Saudi Arabia to LME#33. Red Sea	27,881.15	2.97E+13
	Senegal to LME#27. Canary Current	3,826.67	4.68E+13
	Serbia to LME#62. Black Sea Serbia to LME#26. Mediterranean	41,598.53 11,128.87	1.05E+13 1.05E+13
	Sierra Leone to LME#28. Guinea Current	20,790.05	6.57E+12
	Slovakia to LME#62. Black Sea	41,598.53	1.99E+13
	Viet Nam to LME#36. South China Sea	13,660.98	5.07E+14
705	Slovenia to LME#26. Mediterranean	11,128.87	1.42E+13
706	Somalia to LME#31. Somali Coastal Current	2,184.28	2.98E+13
	Somalia to LME#32. Arabian Sea	30,169.71	2.98E+13
	South Africa to LME#29. Benguela Current	4,613.74	6.25E+13
	South Africa to LME#30. Agulhas Current	7,858.44	6.25E+13
	Zimbabwe to LME#30. Agulhas Current	7,858.44	6.93E+13
	Spain to LME#25. Iberian Coastal Spain to LME#26. Mediterranean	2,682.17	1.03E+14 1.03E+14
	Sudan to LME#33. Red Sea	11,128.87 27,881.15	4.27E+14
	Swaziland to LME#30. Agulhas Current	7,858.44	5.39E+12
	Sweden to LME#23. Baltic Sea	71,378.35	6.86E+12
	Sweden to LME#22. North Sea	21,195.67	6.86E+12
756	Switzerland to LME#22. North Sea	21,195.67	3.85E+12
	Switzerland to LME#26. Mediterranean	11,128.87	3.85E+12
	Switzerland to LME#62. Black Sea	41,598.53	3.85E+12
	Syrian Arab Republic to LME#26. Mediterranean	11,128.87	1.27E+14
	Thailand to LME#34. Bay of Bengal	21,167.69	3.30E+14
	Togo to LME#28. Guinea Current	20,790.05	9.38E+12 2.31E+10
	United Arab Emirates to LME#32. Arabian Sea Tunisia to LME#26. Mediterranean	30,169.71 11,128.87	6.29E+13
	Turkey to LME#26. Mediterranean	11,128.87	4.30E+14
	Uganda to LME#26. Mediterranean	11,128.87	6.18E+13
	Ukraine to LME#62. Black Sea	41,598.53	2.04E+14
807	The FYR of Macedonia to LME#26. Mediterranean	11,128.87	8.19E+12
818	Egypt to LME#26. Mediterranean	11,128.87	6.28E+14
	United Kingdom of GB and NI to LME#22. North Sea	21,195.67	4.52E+13
	United Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf	17,453.98	4.52E+13
	United Republic of Tanzania: Mainland to LME#30. Agulhas Current	7,858.44	1.48E+14
	United States to LME#1. East Bering Sea United States to LME#2. Gulf of Alaska	11,406.01	3.41E+13
	United States to LME#2. Guil of Alaska United States to LME#3. California Current	3,359.50 1,645.78	3.41E+13 3.41E+13
	United States to LME#4. Gulf of California	15,746.08	3.41E+13
	United States to LME#5. Gulf of Mexico	15,792.03	3.41E+13
	United States to LME#6. Southeast U.S. Continental Shelf	2,019.95	3.41E+13
	United States to LME#7. Northeast U.S. Continental Shelf	6,541.93	3.41E+13
	United States to LME#10. Insular Pacific-Hawaiian	558.87	3.41E+13
	United States to LME#54. Chukchi Sea	3,414.44	3.41E+13
	United States to LME#55. Beaufort Sea	4,797.87	3.41E+13
	Uruguay to LME#14. Patagonian Shelf	5,793.14	1.02E+14
	Venezuela (Bolivarian Republic of) to LME#12. Caribbean Sea	1,163.28	2.06E+14
	Yemen to LME#32. Arabian Sea Zambia to LME#30. Agulbas Current	30,169.71	7.41E+13 5.20E+13
894	Zambia to LME#30. Agulhas Current	7,858.44	5.20E+13





**Table 3.18:** Characterisation Factors (CF) and total N emission to groundwater (gw) at Country-to-LME scale.

	Emission:	N to groundwater	
	Resolution scale:	Country-to-LME	
		CF "N to groundwater"	Emission to gw
	Country-to-LME	(PAF·)[m <sup>3</sup> ·d/kg]	[kg/yr]
8	Albania to LME#26. Mediterranean Algeria to LME#26. Mediterranean	3,940.04 3,940.04	1.81E+14
	Angola to LME#29. Benguela Current	1,633.44	1.48E+15 1.56E+15
	Argentina to LME#14. Patagonian Shelf	2,050.99	5.10E+15
	Australia to LME#39. North Australia	1,095.53	1.97E+15
	Australia to LME#40. Northeast Australia	342.13	1.97E+15
	Australia to LME#41. East-Central Australia	373.50	1.97E+15
	Australia to LME#42. Southeast Australia	578.65	1.97E+15
	Australia to LME#43. Southwest Australia	554.50	1.97E+15
	Australia to LME#44. West-Central Australia Australia to LME#45. Northwest Australia	423.39 533.51	1.97E+15 1.97E+15
40	Australia to LME#26. Mediterranean	3,940.04	3.92E+14
	Bahamas to LME#12. Caribbean Sea	411.84	5.91E+12
50	Bangladesh to LME#34. Bay of Bengal	7,494.15	3.69E+15
56	Belgium to LME#22. North Sea	7,504.06	7.13E+14
64	Bhutan to LME#34. Bay of Bengal	7,494.15	3.45E+12
	Bolivia to LME#13. Humboldt Current	149.59	1.30E+15
	Bosnia and Herzegovina to LME#26. Mediterranean	3,940.04	1.63E+14
	Botswana to LME#30. Agulhas Current Brazil to LME#15. South Brazil Shelf	2,782.18 783.41	7.38E+14 5.01E+15
/6	Brazil to LME#16. East Brazil Shelf	340.93	5.01E+15
	Brazil to LME#17. North Brazil Shelf	1,593.52	5.01E+15
84	Belize to LME#12. Caribbean Sea	411.84	1.04E+13
92	Virgin Islands (British) to LME#12. Caribbean Sea	411.84	7.40E+10
100	Bulgaria to LME#26. Mediterranean	3,940.04	2.33E+14
	Bulgaria to LME#62. Black Sea	14,727.43	2.33E+14
	Myanmar to LME#34. Bay of Bengal	7,494.15	1.21E+15
	Belarus to LME#23. Baltic Sea Cambodia to LME#3. California Current	25,270.60 582.67	1.18E+15 7.98E+13
	Cameroon to LME#28. Guinea Current	7,360.45	7.65E+14
	Canada to LME#2. Gulf of Alaska	1,189.39	9.62E+14
	Canada to LME#63. Hudson Bay	2,882.46	9.62E+14
	Canada to LME#9. Newfoundland-Labrador Shelf	868.21	9.62E+14
	Canada to LME#8. Scotian Shelf	5,829.60	9.62E+14
	Canada to LME#64. Arctic Ocean	83.09	9.62E+14
	Sri Lanka to LME#34. Bay of Bengal	7,494.15	4.80E+14
	Chile to LME#13. Humboldt Current China, People's Republic of to LME#36. South China Sea	149.59 4,836.50	1.19E+15 3.04E+16
150	China, People's Republic of to LME#47. East China Sea	4,407.80	3.04E+16
	China, People's Republic of to LME#48. Yellow Sea	11,960.27	3.04E+16
170	Colombia to LME#11. Pacific Central-American	751.94	1.72E+15
	Colombia to LME#12. Caribbean Sea	411.84	1.72E+15
	Congo to LME#28. Guinea Current	7,360.45	1.82E+14
	Democratic Republic of the Congo to LME#28. Guinea Current	7,360.45	8.97E+14
188	Costa Rica to LME#11. Pacific Central-American	751.94	1.46E+14
101	Costa Rica to LME#12. Caribbean Sea Croatia to LME#26. Mediterranean	411.84 3,940.04	1.46E+14 3.89E+14
	Cuba to LME#12. Caribbean Sea	411.84	3.30E+14
	Cyprus to LME#26. Mediterranean	3,940.04	5.24E+13
203	Czech Republic to LME#22. North Sea	7,504.06	4.35E+14
204	Benin to LME#28. Guinea Current	7,360.45	1.81E+14
208	Denmark to LME#22. North Sea	7,504.06	2.02E+14
	Denmark to LME#23. Baltic Sea	25,270.60	2.02E+14
	Denmark to LME#60. Faroe Plateau Dominican Republic to LME#12. Caribbean Sea	453.34 411.84	2.02E+14
	Ecuador to LME#11. Pacific Central-American	751.94	2.52E+14 4.00E+14
	El Salvador to LME#11. Pacific Central-American	751.94	1.70E+14
	Equatorial Guinea to LME#28. Guinea Current	7,360.45	1.60E+13
	Ethiopia to LME#32. Arabian Sea	10,681.20	2.12E+15
	Ethiopia to LME#33. Red Sea	9,870.96	2.12E+15
	Eritrea to LME#33. Red Sea	9,870.96	3.76E+14
	Estonia to LME#23. Baltic Sea	25,270.60	8.72E+13
	Falkland Islands (Malvinas) to LME#14. Patagonian Shelf	2,050.99	1.47E+13
	Finland to LME#23. Baltic Sea France to LME#22. North Sea	25,270.60 7,504.06	6.15E+14 1.53E+15
250	France to LME#24. Celtic-Biscay Shelf	6,179.36	1.53E+15
	France to LME#26. Mediterranean	3,940.04	1.53E+15



	Djibouti to LME#32. Arabian Sea	10,681.20	1.50E+13
	Gabon to LME#28. Guinea Current	7,360.45	1.11E+14
	Georgia to LME#62. Black Sea	14,727.43	3.92E+14
	Gambia to LME#28. Guinea Current Germany to LME#22. North Sea	7,360.45	2.52E+13 2.05E+15
270	Germany to LME#23. Baltic Sea	25,270.60	2.05E+15
288	Ghana to LME#28. Guinea Current	7,360.45	3.76E+14
300	Greece to LME#26. Mediterranean	3,940.04	8.59E+14
320	Guatemala to LME#11. Pacific Central-American	751.94	2.26E+14
	Guatemala to LME#12. Caribbean Sea	411.84	2.26E+14
	Guinea to LME#28. Guinea Current	7,360.45	3.86E+14
	Guyana to LME#17. North Brazil Shelf	1,593.52	-4.51E+12
	Haiti to LME#12. Caribbean Sea Honduras to LME#12. Caribbean Sea	411.84 411.84	2.04E+14 5.30E+14
	Hungary to LME#62. Black Sea	411.84	5.30E+14 7.03E+14
	Iceland to LME#59. Iceland Shelf	534.63	7.25E+13
	India to LME#32. Arabian Sea	10,681.20	2.51E+16
	India to LME#34. Bay of Bengal	7,494.15	2.51E+16
360	Indonesia to LME#38. Indonesian Sea	2,099.75	4.43E+15
364	Iran, Islamic Republic of to LME#32. Arabian Sea	10,681.20	5.57E+15
368	Iraq to LME#32. Arabian Sea	10,681.20	1.19E+15
	Ireland to LME#24. Celtic-Biscay Shelf	6,179.36	1.47E+15
	Israel to LME#26. Mediterranean	3,940.04	2.29E+14
	Italy to LME#26. Mediterranean	3,940.04	4.38E+14
	Kosovo to LME#26. Mediterranean Côte d'Ivoire to LME#28. Guinea Current	3,940.04 7,360.45	5.95E+13
	Jamaica to LME#12. Caribbean Sea	411.84	5.21E+14 5.22E+13
	Japan to LME#47. East China Sea	4,407.80	5.14E+14
552	Japan to LME#49. Kuroshio Current	1,902.20	5.14E+14
	Japan to LME#50. Sea of Japan/East Sea	7,014.70	5.14E+14
	Japan to LME#51. Oyashio Current	883.65	5.14E+14
	Japan to LME#52. Sea of Okhotsk	4,254.46	5.14E+14
400	Jordan to LME#33. Red Sea	9,870.96	1.10E+14
	Kenya to LME#31. Somali Coastal Current	773.32	1.80E+15
408	Democratic People's Republic of Korea to LME#47. East China Sea	4,407.80	2.66E+14
	Democratic People's Republic of Korea to LME#48. Yellow Sea	11,960.27	2.66E+14 2.66E+14
410	Democratic People's Republic of Korea to LME#50. Sea of Japan/East Sea Republic of Korea to LME#47. East China Sea	7,014.70 4,407.80	5.26E+14
410	Republic of Korea to LME#48. Yellow Sea	11,960.27	5.26E+14
	Republic of Korea to LME#50. Sea of Japan/East Sea	7,014.70	5.26E+14
418	Lao People's Democratic Republic to LME#36. South China Sea	4,836.50	3.58E+14
422	Lebanon to LME#26. Mediterranean	3,940.04	1.34E+14
428	Latvia to LME#23. Baltic Sea	25,270.60	1.63E+14
	Liberia to LME#28. Guinea Current	7,360.45	3.52E+13
	Libyan Arab Jamahiriya to LME#26. Mediterranean	3,940.04	5.20E+14
	Lithuania to LME#23. Baltic Sea	25,270.60	3.87E+14
	Madagascar to LME#30. Agulhas Current	2,782.18	1.18E+15
458	Malaysia to LME#34. Bay of Bengal Malaysia to LME#35. Gulf of Thailand	7,494.15 152.23	2.92E+14 2.92E+14
	Malaysia to LME#36. South China Sea	4,836.50	2.92E+14
466	Mali to LME#27. Canary Current	1,354.78	6.81E+14
	Mali to LME#28. Guinea Current	7,360.45	6.81E+14
478	Mauritania to LME#27. Canary Current	1,354.78	4.38E+14
484	Mexico to LME#3. California Current	582.67	2.35E+15
	Mexico to LME#4. Gulf of California	5,574.70	2.35E+15
	Mexico to LME#5. Gulf of Mexico	5,590.97	2.35E+15
	Moldova to LME#62. Black Sea	14,727.43	6.42E+13
	Montenegro to LME#26. Mediterranean Morocco to LME#26. Mediterranean	3,940.04 3,940.04	7.69E+13 8.93E+14
504	Morocco to LME#27. Canary Current	1,354.78	8.93E+14
508	Mozambique to LME#30. Agulhas Current	2,782.18	1.14E+15
	Oman to LME#32. Arabian Sea	10,681.20	4.75E+12
516	Namibia to LME#29. Benguela Current	1,633.44	5.99E+14
524	Nepal to LME#34. Bay of Bengal	7,494.15	8.73E+14
	Netherlands to LME#22. North Sea	7,504.06	9.02E+14
	New Caledonia to LME#40. Northeast Australia	342.13	1.93E+13
	New Zealand to LME#46. New Zealand Shelf	662.60	2.94E+15
558	Nicaragua to LME#11. Pacific Central-American	751.94	1.16E+14
500	Nicaragua to LME#12. Caribbean Sea	411.84 7,360.45	1.16E+14 6.09E+14
	Nigeria to LME#28. Guinea Current	7,360.45	2.59E+14
	Norway to LME#21. Norwegian Sea	2,243.94	2.29E+14
	Norway to LME#22. North Sea	7,504.06	2.29E+14
586	Pakistan to LME#32. Arabian Sea	10,681.20	1.02E+16



591 Panama to LME#11. Pacific Central-American	751.94	9.20E+13
Panama to LME#12. Caribbean Sea	411.84	9.20E+13
600 Paraguay to LME#14. Patagonian Shelf	2,050.99 149.59	9.35E+14
604 Peru to LME#13. Humboldt Current 608 Philippines to LME#36. South China Sea	4,836.50	1.56E+15 8.55E+14
Philippines to LME#37. Sulu-Celebes Sea	6,096.31	8.55E+14
616 Poland to LME#23. Baltic Sea	25,270.60	2.09E+15
620 Portugal to LME#25. Iberian Coastal	949.59	3.94E+14
624 Guinea-Bissau to LME#28. Guinea Current	7,360.45	6.47E+13
626 Timor-Leste to LME#38. Indonesian Sea	2,099.75	1.22E+13
630 Puerto Rico to LME#12. Caribbean Sea	411.84	8.27E+13
642 Romania to LME#62. Black Sea	14,727.43	1.15E+15
643 Russian Federation to LME#20. Barents Sea Russian Federation to LME#54. Chukchi Sea	1,754.72 1,208.84	7.71E+14 7.71E+14
Russian Federation to LME#56. East Siberian Sea	632.16	7.71E+14 7.71E+14
Russian Federation to LME#57. Laptev Sea	2,402.32	7.71E+14
Russian Federation to LME#58. Kara Sea	1,837.91	7.71E+14
Russian Federation to LME#62. Black Sea	14,727.43	7.71E+14
Russian Federation to LME#64. Arctic Ocean	83.09	7.71E+14
Russian Federation to LME#50. Sea of Japan/East Sea	7,014.70	7.71E+14
Russian Federation to LME#51. Oyashio Current	883.65	7.71E+14
Russian Federation to LME#52. Sea of Okhotsk	4,254.46	7.71E+14
Russian Federation to LME#53. West Bering Sea	577.86	7.71E+14
682 Saudi Arabia to LME#32. Arabian Sea Saudi Arabia to LME#33. Red Sea	10,681.20 9,870.96	8.54E+14 8.54E+14
686 Senegal to LME#27. Canary Current	1,354.78	8.54E+14 5.44E+14
688 Serbia to LME#62. Black Sea	14,727.43	2.16E+14
Serbia to LME#26. Mediterranean	3,940.04	2.16E+14
694 Sierra Leone to LME#28. Guinea Current	7,360.45	1.01E+14
703 Slovakia to LME#62. Black Sea	14,727.43	2.33E+14
704 Viet Nam to LME#36. South China Sea	4,836.50	3.09E+15
705 Slovenia to LME#26. Mediterranean	3,940.04	1.75E+14
706 Somalia to LME#31. Somali Coastal Current	773.32	1.02E+15
Somalia to LME#32. Arabian Sea	10,681.20	1.02E+15
710 South Africa to LME#29. Benguela Current South Africa to LME#30. Agulhas Current	1,633.44 2,782.18	1.94E+15 1.94E+15
716 Zimbabwe to LME#30. Agulhas Current	2,782.18	1.00E+15
724 Spain to LME#25. Iberian Coastal	949.59	2.15E+15
Spain to LME#26. Mediterranean	3,940.04	2.15E+15
736 Sudan to LME#33. Red Sea	9,870.96	6.28E+15
748 Swaziland to LME#30. Agulhas Current	2,782.18	5.66E+13
752 Sweden to LME#23. Baltic Sea	25,270.60	2.15E+14
Sweden to LME#22. North Sea	7,504.06	2.15E+14
756 Switzerland to LME#22. North Sea	7,504.06	1.05E+14
Switzerland to LME#26. Mediterranean Switzerland to LME#62. Black Sea	3,940.04 14,727.43	1.05E+14 1.05E+14
760 Syrian Arab Republic to LME#26. Mediterranean	3,940.04	1.03E+14
764 Thailand to LME#34. Bay of Bengal	7,494.15	2.70E+15
768 Togo to LME#28. Guinea Current	7,360.45	1.52E+14
784 United Arab Emirates to LME#32. Arabian Sea	10,681.20	2.35E+12
788 Tunisia to LME#26. Mediterranean	3,940.04	5.58E+14
792 Turkey to LME#26. Mediterranean	3,940.04	4.85E+15
800 Uganda to LME#26. Mediterranean	3,940.04	7.54E+14
804 Ukraine to LME#62. Black Sea	14,727.43	2.10E+15
807 The FYR of Macedonia to LME#26. Mediterranean 818 Egypt to LME#26. Mediterranean	3,940.04 3,940.04	1.32E+14 3.02E+15
818 Egypt to Livit#26. Mediterranean 826 United Kingdom of GB and NI to LME#22. North Sea	7,504.06	1.41E+15
United Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf	6,179.36	1.41E+15
834 United Republic of Tanzania: Mainland to LME#30. Agulhas Current	2,782.18	1.87E+15
840 United States to LME#1. East Bering Sea	4,038.15	4.22E+15
United States to LME#2. Gulf of Alaska	1,189.39	4.22E+15
United States to LME#3. California Current	582.67	4.22E+15
United States to LME#4. Gulf of California	5,574.70	4.22E+15
United States to LME#5. Gulf of Mexico	5,590.97	4.22E+15
United States to LME#6. Southeast U.S. Continental Shelf	715.14	4.22E+15
United States to LME#7. Northeast U.S. Continental Shelf United States to LME#10. Insular Pacific-Hawaiian	2,316.09 197.86	4.22E+15
United States to LME#10. Insular Pacific-Hawalian United States to LME#54. Chukchi Sea	1,208.84	4.22E+15 4.22E+15
United States to LME#55. Beaufort Sea	1,698.62	4.22E+15
858 Uruguay to LME#14. Patagonian Shelf	2,050.99	1.23E+15
	411.84	1.90E+15
862 Venezuela (Bolivarian Republic of) to LME#12. Caribbean Sea		
862 Venezuela (Bolivarian Republic of) to LME#12. Caribbean Sea 887 Yemen to LME#32. Arabian Sea	10,681.20	7.13E+14



**Table 3.19:** Characterisation Factors (CF) and total N emission directly to marine costal waters (mw) at Country-to-LME scale.

a Numar to UMER26. Mediterranean         23,282.27         ////////////////////////////////////		Emission:	N to marine water	
IDE         IPAF (Int) 4(A)         IPAF (Int) 4(A)           Namia to UME25. Mediterranean         23,528.27           Applie to UME25. Mediterranean         23,528.27           Jama Section 1         2,528.27           Jama Section 1         3,511.26           Jama Section 1         3,511.26           Jama Section 1         3,511.26           Jama Section 1         3,511.26           Jama Section 1         3,512.26           Jama Section 1         3,512.26           Jama Section 1         3,528.27           Jama Section 1         3,538.27           Jama Section 1         3,538.27           Jama Section 1         3,53		Resolution scale:	Country-to-LME	
a Number 10 UMER26. Melleraneen         23.28.22         ////           J Aperia to UMER26. Melleraneen         23.28.22         ////           J Aperia to UMER26. Melleraneen         23.28.22         ///           J Aperia to UMER26. Melleraneen         23.28.22         ///           J Australia to UMER2. Northeast Australia         20.430.37         ///           Australia to UMER2. Districtural Australia         20.430.37         ///           Australia to UMER2. Esst-Central Australia         3.455.46         ///           Australia to UMER2. Southeast Australia         3.131.26         ///           Australia to UMER2. Southeast Australia         3.135.88         ///           J Australia to UMER2. Northwest Australia         3.135.88         ///           J Australia to UMER2. Northwest Australia         3.135.82         ///           J Australia to UMER2. Northwest Australia         3.135.82         ///           J Australia to UMER2. North See         4.451.14         ///           J Balgeria to UMER2. Australia Southeest Australia         3.135.26         ///           J Sovia and HER2. Australia Southeest Australia         3.135.27         ///           J Sovia and HER2. Australia Southeest Australia         3.135.27         ///           J Sovia and LMER2. Australia Southeest Australia </th <th></th> <th></th> <th>-</th> <th>Emission to mw</th>			-	Emission to mw
12         Argenia to LMER26. Mediterranean         23,232.27           2         Argenia to LMER26. North Astralia         2,247.67           3         Matralia to LMER30. North Astralia         2,247.67           4         Matralia to LMER30. North Astralia         2,283.07           4         Matralia to LMER30. North Astralia         2,283.07           4         Matralia to LMER40. Northest Astralia         2,328.27           4         Matralia to LMER42. Southest Astralia         3,328.28           4         Matralia to LMER42. Northest Astralia         3,328.28           4         Matralia to LMER42. Northest Astralia         3,328.28           4         Matralia to LMER20. Morthest Astralia         3,328.28           4         Matralia to LMER20. Morthest Astralia         3,328.28           5         Balgianto LMER20. Morthest Astralia         3,328.28           6         Matralia to LMER20. Morthest Astralia         3,328.28           6         Matralia to LMER20. Morthest Astralia         3,438.38           6         Matralia to LMER20. Morthest Astralia         4,475.200           6         Matralia to LMER20. Morthest Astralia         3,485.39           6         Matralia to LMER20. Morthest Astralia         3,485.39           6 <t< td=""><td></td><td></td><td></td><td>[kg/yr]</td></t<>				[kg/yr]
2         Appendix to LMER29. Regula Current         9,754.22           Appendix to LMER29. North Astralia         2,247.66           Australia to LMER40. Northeast Australia         2,043.07           Australia to LMER40. Southeast Australia         2,043.07           Australia to LMER40. Southeast Australia         3,455.46           Australia to LMER40. Southeast Australia         3,455.46           Australia to LMER40. Southeast Australia         3,455.82           Australia to LMER40. Northwest Australia         3,455.82           Australia to LMER40. Northwest Australia         3,455.82           Australia to LMER40. Northwest Australia         3,455.82           Bangledesh to LMER40. Age of Bengal         4,457.200           Bangledesh to LMER40. Age of Bengal         4,457.200           Bangledesh to LMER40. Age of Bengal         4,457.200           Bangledesh LMER40. Age of Bengal         4,475.200           Bangledesh LMER40. Age of Bengal         4,475.200           Bangledesh LMER40				
a         Argentina to LMEBA, Australia o LMEBA, North Australia o LMEBA, North Australia o LMEBA, North Australia o LMEBA, North Australia o LMEBA, Such Australia CMA Australia OLMA Australia o LMEBA, Such Austral		-		
30         Australia to LMER9. North Australia         654.207           Australia to LMER0. Northeast Australia         2,083.07           Australia to LMER1. Southeast Australia         3455.46           Australia to LMER1. Southeast Australia         3,311.66           Australia to LMER1. Southeast Australia         3,312.66           Australia to LMER4. Net Central Australia         2,528.27           Australia to LMER4. Net Central Australia         3,358.86           O Austria to LMER4. Net Central Australia         2,558.27           O Austria to LMER4. Net Central Australia         4,475.20.0           O Banglideth DMER4. Bay of Bengal         44,752.00           O Austria to LMER3. Net Menol & Current         893.27           O Austria to LMER3. Science 315.861         4,078.20           O Banglideth Central Australia         3,078.87           O Austria to LMER3. Science 315.861         4,078.20           O Austria to LMER3. Australia Science         2,073.87           O Banglideth Less Australia         4,078.20           O Australia to LMER3. Australia Science         2,035.87				
Australia to LME4D. Northest Australia         2,043,07           Australia to LME4D. Southest Australia         2,043,07           Australia to LME4D. Southest Australia         3,112           Australia to LME4D. Southest Australia         3,112           Australia to LME4D. Southest Australia         3,112           Australia to LME4D. Southest Australia         3,185,88           Australia to LME4D. Konthwest Australia         3,185,88           Australia to LME4D. Southest Australia         3,185,88           Australia to LME4D. Morthwest Australia         3,185,88           Balvisto LME4D. Augtralia Regione         2,528,227           Australia to LME4D. Augtralia Regione         2,528,227           Balvisto LME4D. Auguthes Current         833,27           Barali to LME2D. Auguthes Current         1,661,404           Barali to LME2D. South Brazil Sheff         2,459,37           Oulgaria to LME2D. Caribbean Sea         2,459,37           Oulgaria to LME2D. Caribbean Sea         2,459,37           Oulgaria to LME2D. South Brazil Sheff         2,459,37           Oulgaria to LME2D. Caribbean Sea         2,459,37           Oulgaria to LME3D. South Brazil Sheff         2,459,37           Oulgaria to LME3D. South Brazil Sheff         2,459,37           Oulgaria to LME3D. South Brazil Sheff				
Australia to IMERAI. East-Central Australia         2,280.37           Australia to IMERAI. Southeast Australia         3,485.46           Australia to IMERAI. Southeast Australia         3,381.26           Australia to IMERAI. Mest-Central Australia         2,528.27           Australia to IMERAI. Mest-Central Australia         3,385.88           Australia to IMERAI. Agribbena Sea         2,459.37           Banglideh IDMERAI. Agribbena Sea         2,459.37           Banglideh IDMERAI. By Oregal         44.81.14           Mustralia to IMERAI. Carribbena Sea         2,459.37           Bolivia to IMERAI. Surve Sengal         44.81.14           Bolivia to IMERAI. By Oregal         44.81.14           Obsensa to IMERAI. Surve Sengal         44.75.200           Bolivia to IMERAI. Surve Sengal         2,459.37           Obsensa to IMERAI. Surve Sengal         44.75.200           Bolivia to IMERAI. Surve Sengal         2,459.37           Obsensa to IMERAI. Surve Sengal         2,459.37           Virue Instance Exastralia Steff         2,558.33           Oversa to IMERAI. Surve Sengal         2,459.37           Virue Instance Exastralia Steff         2,459.37           Oversa to IMERAI. Surve Sengal         2,459.37           Diagria to IMERAI. Surve Sengal         2,459.37	30			
Australia to IMER2 Southest Australia         3,455.46         0,77           Australia to IMER4. West-Central Australia         3,311.26         0,77           Australia to IMER4. Morthwest Australia         3,155.88         0,77           Australia to IMER4. Morthwest Australia         3,155.88         0,77           Australia to IMER5. Morthwest Australia         3,155.88         0,77           Banglidesh to IMER2. Caribbean Sea         2,459.37         0,77           Balvia to IMER3. Hay of Bengal         44,752.00         0,77           Bolvia to IMER3. Humbol Current         833.27         0,77           Bolvia to IMER3. South matil Sheff         2,055.87         0,77           Brazi to IMER15. South matil Sheff         2,055.87         0,77           Brazi to IMER15. South Brazi ISheff         2,055.87         0,77           Brazi to IMER15. Australia Sole         2,052.87         0,77           Brazi to IMER15. Australia Sole         2,052.87         0,77				
Australia to LME43. Southwest Australia         331125         97/7           Australia to LME43. Southwest Australia         3512823         97/7           Australia to LME43. Molteranean         3558837         97/7           Balmans to LME12. Caribbean Sea         245937         97/7           Balmans to LME12. Caribbean Sea         245937         97/7           Bellutin to LME23. Apy of Bengal         44,75200         97/7           Bolta to LME13. Apy of Bengal         44,75200         97/7           Bolta to LME13. Apy of Bengal         44,75200         97/7           Bolta to LME13. Apy of Bengal         44,75200         97/7           Boralia and Kerzeyovin to LME20. Moltiferanean         25,528.77         97/7           Barali to LME15. Satt Brail Shelf         46,752.00         97/7           Barali to LME21. Caribbean Sea         24,593.77         97/7           Barali to LME22. Caribbean Sea         24,593.77         97/7           Barali to LME23. Baltic Sea				n/a
Australia to LME#25. Northwest Australia         3,185.88         n/A           40         Australia to LME#25. Antibean San         2,453.37         (A)           51         Bangladeith to LME#21. Antibean San         2,453.37         (A)           52         Bangladeith to LME#21. Antibean San         2,453.37         (A)           54         Bangladeith to LME#24. Bay of Bengal         44,752.00         (A)           55         Benglam to LME#20. Antibe LME#26. Mediterranean         23528.27         (A)           50         Bonia and LME#26. Mediterranean         23528.27         (A)           50         Bonia and LME#26. Mediterranean         23528.27         (A)           50         Bonia and LME#26. Mediterranean         23528.27         (A)           50         Bulgaria to LME#26. Antibera San         2,459.37         (A)           51         Bulgaria to LME#27. Caribbean San         2,459.37         (A)           52         Wigrin Islands (British) to LME#12. Caribbean San         2,459.37         (A)           54         Belize to LME#27. Caribbean San         2,459.37         (A)           54         Belize to LME#27. Caribbean San         2,459.37         (A)           54         Belize to LME#27. Caribbean San         2,459.37		Australia to LME#43. Southwest Australia		n/a
40         Justria to LMER2. Caribbean Sea         2,3528.27         n/4           41         Bahamas to LMER2. Caribbean Sea         2,459.37         n/4           52         Beiguin to LMER2. Caribbean Sea         2,459.37         n/4           54         Beiguin to LMER2. North Sea         44,811.14         n/4           55         Beiguin to LMER2. North Sea         44,811.14         n/4           56         Boilvia to LMER3. Humbold Current         83.27         n/4           70         Bostian and Herzegovina to LMER2. Kedtlerranean         23.528.27         n/4           71         Bostian to LMER3. Current         16.61.40         n/4           72         Bostian to LMER3. Caribbean Sea         2,459.37         n/4           73         Brazil to LMER2. Caribbean Sea         2,459.37         n/4           74         Bulgaria to LMER2. Bailtic Sea         2,459.37         n/4 <td< td=""><td></td><td>Australia to LME#44. West-Central Australia</td><td>2,528.28</td><td>n/a</td></td<>		Australia to LME#44. West-Central Australia	2,528.28	n/a
44         Bahamas to LMEH2. Caribbean Sea         2,459.37         n/4           50         Bangladesh to LMEH2. Any of Bengal         44,752.00         n/4           64         Buitun to LMER2. North Sea         444,752.00         n/4           65         Bolivia to LMER2. North Sea         444,752.00         n/4           66         Bolivia to LMER2. North Sea         16,614.04         n/4           70         Bosnia and Herzegovina to LMER26. Mediterranean         23,528.27         n/4           71         Bosnia and Herzegovina to LMER26. Mediterranean         23,528.27         n/4           71         Brazit to LMER15. South Brazil Shelf         2,035.87         n/4           72         Bolivia to LMER2. North Brazil Shelf         2,459.37         n/4           73         Bulgaria to LMER2. North Brazil Shelf         2,459.37         n/4           74         Bulgaria to LMER2. North Brazil Shelf         2,459.37         n/4           74         Bulgaria to LMER2. North Brazil Shelf         2,459.37         n/4           74         Bulgaria to LMER2. North Brazil Shelf         3,479.4         n/4           74         Balary to LMER2. North Brazil Shelf         3,479.4         n/4           74         Balary to LMER2. North Brazil Shelf		Australia to LME#45. Northwest Australia	3,185.88	n/a
90Bangladesh to LMER34. Bay of Bengal44,752.00/n/a56Belgium to LMER34. Bay of Bengal44,752.00/n/a68Bhutan to LMER34. Bay of Bengal44,752.00/n/a68Bolivia to LMER34. Bay of Bengal44,752.00/n/a70Bosnia and Herzegorina to LMER26. Mediterranean23,528.27/n/a71Bosnia and Herzegorina to LMER26. Mediterranean23,528.27/n/a72Botswan to LMER30. Aguihas Current16,61.40/n/a73Brazil to LMER15. East Brazil Shelf4,678.20/n/a74Brazil to LMER12. North Brazil Shelf2,459.37/n/a74Bulgaria to LMER26. Mediterranean23,528.27/n/a74Bulgaria to LMER26. Mediterranean23,528.27/n/a75Bulgaria to LMER26. Mediterranean23,528.27/n/a76Bulgaria to LMER26. Mediterranean23,528.27/n/a76Bulgaria to LMER26. Mediterranean23,528.27/n/a76Bulgaria to LMER26. Mediterranean23,528.27/n/a77Bulgaria to LMER26. Mediterranean23,528.27/n/a78Bulgaria to LMER26. Mediterranean23,528.27/n/a79Bulgaria to LMER26. Mediterranean23,528.27/n/a70Bulgaria to LMER26. Mediterranean23,528.27/n/a70Canada to LMER26. Mediterranean23,528.27/n/a71Canada to LMER26. Mediterranean26,521.58/n/a72Canada to LMER26. Mediteranean26	40	Austria to LME#26. Mediterranean	23,528.27	n/a
35         Belgium to LMER22. North Sea         44,811.14         N/A           64         Bhutan to LMER3. Any of Bengal         44,752.00         N/A           70         Bosinia and Herzegovina to LMER3. Mediterranean         23,528.27         N/A           72         Botixa no LMER3. Any of Bengal         16,614.04         N/A           72         Botixa no LMER3. Any of Bengal         46,720         N/A           73         Botixa to LMER15. South Brazil Shelf         2,035.87         N/A           74         Belize to LMER12. Carribbean Sea         2,459.37         N/A           75         Divigin Islands (British) to LMER12. Caribbean Sea         2,459.37         N/A           70         Buigaria to LMER25. Baltek Sea         87.946.16         N/A           712         Belaris to LMER26. Baltek Sea         87.946.16         N/A           712         Baltaris to LMER28. Baltek Sea         15.0005.61         N/A           712         Baltaris to LMER28. Baltek Sea         15.0005.61         N/A           712         Baltaris to LMER28. Baltek Sea         15.02005.61         N/A           712         Baltaris to LMER28. Baltek Sea         7.02.53         N/A           712         Baltaso LMER28. Baltek Sea         7.02.53	44	Bahamas to LME#12. Caribbean Sea	2,459.37	n/a
a         Bhutan to LMEB34. Bay of Bengal         44,752.00           b         Bosnia and Herzegovina to LME/26. Multiferramean         25,252.27           c         Bosnia and Herzegovina to LME/26. Multiferramean         25,252.27           c         Brazil to LMEB15. South Brazil Shelf         4,678.20           d         Frazil to LMEB17. East Brazil Shelf         2,653.27           d         Parizi to LMEB17. Caribbean Sea         2,459.37           g         Virgin Islands (Brittsh) to LMEB12. Caribbean Sea         2,459.37           g         Urgin Islands (Brittsh) to LMEB12. Caribbean Sea         2,459.37           g         Urgin Islands (Brittsh) to LMEB12. Caribbean Sea         2,459.37           g         Mayaria to LMEB26. Mediterramean         23,528.27           g         Mayaria to LMEB26. Mediterramean         23,528.27           g         Mayaria to LMEB26. Mediterramean         24,59.37           g         Caradato LMEB26. Multifa Current         3,979.46           g         Caradato LMEB3. Multifa Caradato Shelf         5,184.60           g         Canada to LMEB3. Multifa Current         3,811.98           g         Canada to LMEB3. Altifa Current         3,83.27           g         Cinia, People's Republic of to LMEB48. Stello Sca         7,42.28     <	50	Bangladesh to LME#34. Bay of Bengal	44,752.00	n/a
8Bolivia to LME#13. Humbold. Current893.27n/a70Bosinia and Herzegovina to LME#26. Mediterranean23,528.27n/a71Borzali to LME#15. South Brazil Shelf2,055.87n/a72Brazil to LME#15. South Brazil Shelf2,055.87n/a73Brazil to LME#12. North Brazil Shelf2,055.87n/a74Brazil to LME#12. Caribbean Sea2,459.37n/a75Bulgaria to LME#26. Melteranean2,852.82n/a76Bulgaria to LME#26. Black Sea87.946.16n/a712Belrize to LME#23. Baltic Sea10.05.65n/a713Belrize to LME#23. Baltic Sea10.05.65n/a714Maynmar to LME#34. Bay of Bengal44.752.00n/a715Cameoon to LME#23. Bulic Sea10.02.5n/a716Camada to LME#23. Guinea Current34.97.44n/a717Canada to LME#2. Guinfo Alasha7,122.34n/a718Canada to LME#3. Hudson Bay17,212.84n/a719Canada to LME#3. Humbold Current89.27n/a714Sri Lanka to LME#3. Alus of Bengal44.752.00n/a715China, People's Republic of to LME#36. South China Sea2,83.59n/a716Colombia to LME#3. Humbold Current89.27n/a717Colombia to LME#3. Humbold Current43.95.59n/a718Control to LME#32. Guinea Current43.95.59n/a719Colombia to LME#12. Caribbean Sea2,459.37n/a <t< td=""><td>56</td><td>Belgium to LME#22. North Sea</td><td>44,811.14</td><td>n/a</td></t<>	56	Belgium to LME#22. North Sea	44,811.14	n/a
20         Bosnia and Herzegovina to LMER26. Mediterranean         23,528.27         n/a           20         Boraul to LMER5. South Brazil Shelf         16,614.04         n/a           30         Brazil to LMER5. South Brazil Shelf         2,035.87         n/a           31         Belziz to LMER15. South Brazil Shelf         2,035.87         n/a           32         Belzizo LMER15. South Brazil Shelf         2,035.87         n/a           34         Belzizo LMER20. Anothe Brazil Shelf         2,059.37         n/a           34         Belzizo LMER20. Caribbean Sea         2,459.37         n/a           30         Bulgaria to LMER20. Anothe Mediterranean         23,528.27         n/a           310         Bulgaria to LMER20. Mediterranean         23,528.27         n/a           312         Belarus to LMER20. Mediterranean         23,528.27         n/a           312         Ganada to LMER3. Huadon Bay         7,122.53         n/a           313         Ganada to LMER3. Huadon Bay         7,122.53				n/a
12         Botswana to LMER30. Aguihas Current         16,614.04           76         Brazi to LMER15. South Brazil Sheff         4,678.20           8         Parzi to LMER15. Esst Brazil Sheff         9,515.83           84         Belize to LMER12. Caribbean Sea         2,459.37           9         Urgin Is lands (British) to LMER12. Caribbean Sea         2,459.37           9         Urgin Is lands (British) to LMER12. Caribbean Sea         2,459.37           100         Bulgaria to LMER26. Mediterranean         23,528.27           101         Myanmar to LMER34. Bay Of Bengl         47,475.200           102         Cambodia to LMER32. Baltic Sea         150,905.61           103         Camada to LMER34. California Current         3,479.44           104         Canada to LMER34. California Current         3,479.44           105         Camada to LMER34. Suds of Bengl         1,712.28           104         Canada to LMER34. Suds of Bengl         1,712.28           105         China, People's Republic of to LMER34. Suds of Bengl         1,712.28           104         Striants to LMER34. Agu of Bengl         1,712.28           105         China, People's Republic of to LMER48. Schich Suds China Sea         2,881.56           104         Strianta to LMER34. Agu of Bengl         1,742.				n/a
ProbBrazil to LME#15. South Brazil Shelf4,678.20n/nBrazil to LME#15. South Brazil Shelf2,055.83n/nBrazil to LME#12. Caribbean Sea2,459.37n/n20Virgin Island's (British) to LME#12. Caribbean Sea2,459.37n/n21Bulgaria to LME#26. Mediterranean23,528.27n/n20Bulgaria to LME#26. Mediterranean23,528.27n/n21Belarus to LME#26. Mediterranean23,528.27n/n21Belarus to LME#26. Sallors Sea2,459.37n/n22Cameroon to LME#26. Gulfera Current3,953.59n/n23Camaroon to LME#28. Gulfera Current3,953.59n/n24Canada to LME#63. Hudson Bay7,222.54n/n25Canada to LME#63. Hudson Bay7,221.244n/n26Canada to LME#63. Hudson Bay17,212.84n/n27Canada to LME#63. Hudson Bay17,212.84n/n28Canada to LME#63. Hudson Bay17,212.84n/n29Canada to LME#64. Scotian Shelf3,818.65n/n20China, People's Republic Of to LME#45. South China Sea26,321.58n/n21China, People's Republic of to LME#45. South China Sea2,459.37n/n20Colombia to LME#12. Caribbean Sea2,459.37n/n21Colombia to LME#12. Caribbean Sea2,459.37n/n22China, People's Republic of to LME#45. South China Sea2,459.37n/n23Colombia to LME#12. Caribbean Sea2,459.37n/n<		-		n/a
Brazil to LME#12. Aroth Brazil Shelf2,035.87n/aBellze to LME#12. Caribbean Sea2,459.37n/aVirgin Islands (British) to LME#12. Caribbean Sea2,459.37n/aBulgaria to LME#12. Caribbean Sea2,459.37n/aBulgaria to LME#12. Caribbean Sea2,528.27n/aBulgaria to LME#25. Mediterranean23,528.27n/aBulgaria to LME#25. Baltic Sea150,905.61n/aCando to LME#32. Baltic Sea150,905.61n/aCando to LME#32. Baltic Sea150,905.61n/aCanada to LME#32. Guinea Current3,93.59n/aCanada to LME#32. Guinea Current3,93.59n/aCanada to LME#32. Guinea Current3,93.59n/aCanada to LME#32. Guinea Current3,93.59n/aCanada to LME#32. Baltic Sea1,92.50n/aCanada to LME#34. Netwoindiand-Labrador Shelf3,83.58n/aChina, People's Republic of to LME#35. South China Sea2,82.81.58n/aChina, People's Republic of to LME#36. South China Sea2,83.51.59n/aColombia to LME#32. Caribbean Sea2,459.37n/aColombia to LME#32. Caribbean Sea2,459.37n/aColombia to LME#32. Guinea Current3,953.59n/aColombi		-		n/a
Brazil to LME#17. North Brazil Shelf         9,515.83         7,7           Bilez to LME#12. Caribbean Sea         2,459.37         7,7           Wirgin Islands (British) to LME#12. Caribbean Sea         2,459.37         7,7           Bulgaria to LME#26. Mediterranean         2,328.27         7,7           Bulgaria to LME#26. Black Sea         87,946.16         7,7           Belarus to LME#28. Buite Sea         150,905.61         7,7           Belarus to LME#28. Guinea Current         3,479.44         7,7           Canada to LME#28. Guinea Current         3,479.44         7,7           Canada to LME#3. Hudson Bay         17,212.84         7,7           Canada to LME#63. Hudson Bay         17,212.84         7,7           Canada to LME#64. Arctic Ocean         483.25         7,7           Canada to LME#64. Arctic Ocean         893.27         7,7           Canada to LME#64. Arctic Ocean         483.25         7,7           Canada to LME#64. Arctic Ocean         493.25         7,7           Canada to LME#64. Arctic Ocean         493.25	76			
Ballize to LME#12. Caribbean Sea2,459.37n/a20Virgin Island's (British) to LME#12. Caribbean Sea2,459.37n/a30Bulgaria to LME#26. Mediterranean23,528.27n/a100Myanmar to LME#32. Black Sea87,946.16n/a101Myanmar to LME#32. Black Sea150,090.561n/a102Belarus to LME#32. Baltic Sea150,090.561n/a103Cameroon to LME#28. Guinea Current43,953.59n/a104Canada to LME#32. Guinea Current43,953.59n/a105Canada to LME#32. Guinea Current43,953.59n/a104Canada to LME#63. Hudson Bay17,212.84n/a104Canada to LME#63. Hudson Bay17,212.84n/a105Canada to LME#64. Arctic Ocean496.21n/a106Canada to LME#64. Bay of Bengal44,952.00n/a107Colombia to LME#13. Humboldt Current893.27n/a108Colombia to LME#14. Sea China Sea2,815.85n/a109Colombia to LME#11. Pacific Central-American4,490.26n/a100Colombia to LME#11. Pacific Central-American4,490.26n/a101Colombia to LME#11. Pacific Central-American4,490.26n/a101Colombia to LME#12. Caribbean Sea2,353.59n/a102Colombia to LME#12. Caribbean Sea2,459.37n/a103Costa Rica to LME#12. Caribbean Sea2,459.37n/a104Costa Rica to LME#12. Caribbean Sea2,459.37n/a </td <td></td> <td></td> <td></td> <td></td>				
129Virgin Islands (British) to LME#12. Caribbean Sea2,459.37///a100Bulgaria to LME#26. Mediterranean23,528.27//a111Myanmar to LME#26. Black Sea87,946.16//a111Myanmar to LME#32. Baltic Sea150,905.61//a112Belarus to LME#32. Baltic Sea150,905.61//a113Cambodia to LME#32. Guifornia Current3,479.44//a114Cameon to LME#28. Guinea Current3,479.44//a115Canada to LME#32. Guifornia Current3,479.44//a116Canada to LME#32. Guifornia Current3,481.198//a117Canada to LME#38. Scotian Shelf3,481.198//a118Canada to LME#38. Scotian Shelf3,481.198//a119Canada to LME#38. Scotian Shelf//a//a114Sri Lanka to LME#38. Myand Bengal44,752.00//a115China, People's Republic of to LME#36. South China Sea26,321.58//a116Colombia to LME#38. Myand Subt China Sea2,6331.58//a117Colombia to LME#12. Caribbean Sea2,459.37//a118Congot to LME#32. Guinea Current4,395.359//a119Congot to LME#32. Guinea Current3,353.59//a119Congot to LME#32. Mediterranean2,352.82//a119Congot to LME#32. Caribbean Sea2,459.37//a110Congot to LME#32. Caribbean Sea2,459.37//a1111Colombia to LME#12. Caribbean Sea2,459.37 </td <td></td> <td></td> <td></td> <td></td>				
InternationalInternationalBulgaria to LME#26, Mack Sea87,946.16Nayanmar to LME#28, Batk Sea87,946.16Nayanmar to LME#34, Bay of Bengal44,752.00Belarus to LME#32, Saltic Sea150,905.61International Control LME#32, Guinea Current3,479.44Into Cameroon to LME#28, Guinea Current3,479.44Canada to LME#28, Guinea Current43,955.359Canada to LME#32, Guil of Alaska7,102.53Canada to LME#32, Guil of Alaska7,102.53Canada to LME#63, Hudson Bay7,212.84Canada to LME#64, Nudson Bay7,212.84Canada to LME#65, Hudson Bay7,212.84Canada to LME#64, Scottan Shelf3,481.60Canada to LME#64, Scottan Shelf3,481.60Canada to LME#64, Artic Ocean496.21Canada to LME#64, Trict Cocean496.21China, People's Republic of to LME#36. South China Sea26,821.56China, People's Republic of to LME#36. South China Sea7,421.80Colombia to LME#11, Pacific Central-American4,490.26Colombia to LME#12, Caribbean Sea2,459.37Congo to LME#28, Guinea Current4,3953.59Croatia to LME#28, Guinea Current4,3953.59Croatia to LME#28, Guinea Current3,558.37Colombia to LME#28, Guinea Current <td></td> <td></td> <td></td> <td></td>				
Bulgaria to LMEH62. Black Sea         87,946.16         n/a           104         Myanmar to LMEH32. Bay of Bengal         44,752.00         n/a           112         Belarus to LMEH32. Baltic Sea         150,905.61         n/a           112         Belarus to LMEH32. Baltic Sea         150,905.61         n/a           112         Canada to LMEH32. Guinea Current         3,479.44         n/a           112         Canada to LMEH32. Guinea Current         3,479.44         n/a           112         Canada to LMEH32. Guinea Current         3,479.44         n/a           114         Canada to LMEH32. Guinea Current         3,481.98         n/a           114         Canada to LMEH32. Scotian Shelf         3,481.98         n/a           114         Sri Lanka to LMEH34. Arctic Ocean         44,752.00         n/a           114         Sri Lanka to LMEH34. Arctic Ocean         44,752.00         n/a           115         Chile to LMEH34. Nethold Current         89.37         n/a           116         Chile to LMEH31. Pacific Central-American         4,495.35         n/a           117         Colombia to LMEH31. Pacific Central-American         4,495.35         n/a           118         Colombia to LMEH31. Pacific Central-American         4,495.37 <td< td=""><td></td><td></td><td>,</td><td></td></td<>			,	
104 Myanmar to LME#34. Bay of Bengal44,752.00n/a112 Belarus to LME#32. Baltic Sea150,005.61n/a113 Cambodia to LME#32. Baltic Sea150,005.61n/a114 Cambodia to LME#32. Bulinea Current34,973.49n/a115Cameroon to LME#28. Guinea Current34,973.53n/a116 Canada to LME#32. Bulinea Current34,811.98n/a117 Canada to LME#32. Socian Shelf5,184.60n/a118 Canada to LME#34. Bay of Bengal44,752.00n/a1144 Sci Lanka to LME#34. Bay of Bengal44,752.00n/a1145 Chile to LME#34. Bay of Bengal44,752.00n/a1146 Chile to LME#34. Bay of Bengal44,852.00n/a1147 Colombia to LME#34. Bay of Bengal14,21.80n/a1148 Chile to LME#34. Bay of Bengal14,21.80n/a1149 Colombia to LME#13. Humbold Current89.27n/a1140 Colombia to LME#13. Pacific Central-American44,90.26n/a1150 Colombia to LME#12. Caribbean Sea24,59.37n/a1160 Congo to LME#28. Guinea Current34,95.59n/a1178 Congo to LME#28. Guinea Current34,59.35n/a1180 Conta to LME#12. Caribbean Sea24,59.37n/a1191 Cotati to LME#26. Mediterranean25,528.27n/a1192 Cubat to LME#26. Mediterranean25,528.27n/a1193 Cotati to LME#26. Mediterranean25,528.27n/a1194 Cotati to LME#26. Mediterranean25,528.27n/a <tr< td=""><td>100</td><td></td><td></td><td></td></tr<>	100			
116 120 Cameroon to LME#28. Guines Current3,479.44n/a120 Cameroon to LME#28. Guines Current43,953.59n/a121 Canada to LME#28. Guines Current7,212.84n/a1224 Canada to LME#63. Hudson Bay7,721.84n/a1235 Canada to LME#63. Hudson Bay7,721.84n/a1246 Canada to LME#64. Arctic Ocean446.12n/a1250 China, People's Republic of to LME#36. South China Sea28,881.56n/a1251 China, People's Republic of to LME#47. East China Sea26,821.58n/a1252 China, People's Republic of to LME#47. East China Sea24,851.37n/a1260 China, People's Republic of to LME#47. East China Sea24,851.37n/a1276 Colombia to LME#11. Pacific Central-American44,902.69n/a1278 Congo to LME#28. Guinea Current43,953.59n/a1280 Cotati ato LME#11. Pacific Central-American44,902.69n/a1291 Cotati ato LME#12. Caribbean Sea2,459.37n/a1292 Cuba to LME#12. Caribbean Sea2,459.37n/a1293 Cuba to LME#12. Caribbean Sea2,459.37n/a1294 Cuba to LME#12. Caribbean Sea2,459.37n/a1295 Cuba to LME#28. Guinea Current3,953.59n/a1296 Cotati ato LME#12. Caribbean Sea2,459.37n/a1291 Cuba to LME#12. Caribbean Sea2,459.37n/a1292 Cuba to LME#28. Multa Sea3,53.59n/a1293 Cuba to LME#28. Guinea Current3,953.59n/a1294 <b< td=""><td>104</td><td></td><td></td><td>n/a</td></b<>	104			n/a
120Cameroon to LME#28. Guirea Current43,953.59n/a124Canada to LME#2. Guif of Alaska7,102.53n/a126Canada to LME#63. Hudson Bay17,212.84n/a127Canada to LME#63. Hudson Bay7,102.53n/a128Canada to LME#63. Hudson Shelf34,811.98n/a129Canada to LME#64. Arctic Ocean496.21n/a121Canada to LME#64. Arctic Ocean496.21n/a122Chile to LME#13. Humboldt Current893.27n/a125China, People's Republic of to LME#36. South China Sea26,321.58n/a126China, People's Republic of to LME#37. East China Sea26,321.58n/a127Colombia to LME#11. Pacific Central-American44,90.26n/a128Colombia to LME#12. Caribbean Sea2,459.37n/a129Costa Rica to LME#12. Caribbean Sea2,459.37n/a129Costa Rica to LME#12. Caribbean Sea2,459.37n/a120Costa Rica to LME#12. Caribbean Sea2,459.37n/a121Costa Rica to LME#12. Caribbean Sea2,459.37n/a122Cuba to LME#12. Caribbean Sea2,459.37n/a123Cuba to LME#23. Buitice Sea1,00,00,00n/a124Costa Rica to LME#12. Caribbean Sea2,459.37n/a125Cuba to LME#12. Caribbean Sea2,459.37n/a126China, People's Republic of MCE#23. Suitice Central-American4,490.26n/a125Cuba to LME#12. Caribbean Sea<	112	Belarus to LME#23. Baltic Sea	150,905.61	n/a
124Canada to LME#2. Gulf of Alaska7,102.53n/aCanada to LME#63. Hudson Bay17,212.84n/aCanada to LME#63. Hudson Bay17,212.84n/aCanada to LME#63. Kotian Shelf34,811.98n/aCanada to LME#64. Arctic Ocean496.21n/aCanada to LME#64. Arctic Ocean496.21n/aCanada to LME#64. Arctic Ocean496.21n/aChile to LME#13. Humboldt Current893.27n/aChina, People's Republic of to LME#36. South China Sea26,321.58n/aChina, People's Republic of to LME#47. East China Sea2,459.37n/aColombia to LME#11. Pacific Central-American4,490.26n/aColombia to LME#12. Caribbean Sea2,459.37n/aColombia to LME#12. Caribbean Sea2,459.37n/aCosta Rica to LME#12. Caribbean Sea2,459.37n/aCosta Rica to LME#12. Caribbean Sea2,459.37n/aCotati to LME#26. Mediterranean23,528.27n/aCotati to LME#26. Mediterranean23,528.37n/aCotati to LME#27. North Sea44,811.14n/aDenm	116	Cambodia to LME#3. California Current	3,479.44	n/a
Canada to LME#63. Hudson Bay17,212.84Canada to LME#63. Hudson Bay17,212.84Canada to LME#64. Arctic Ocean348.811.98Canada to LME#64. Arctic Ocean496.21Sri Lanka to LME#13. Bay of Bengal44,752.00China, People's Republic of to LME#36. South China Sea28,881.56China, People's Republic of to LME#36. South China Sea28,881.56China, People's Republic of to LME#36. South China Sea28,881.56China, People's Republic of to LME#36. South China Sea24,593.77Colombia to LME#11. Pacific Central-American4,490.26China, People's Republic of to LME#38. Guinea Current3,953.59Congo to LME#28. Guinea Current3,953.59Congo to LME#26. Mediterranean23,528.27Cotat Rica to LME#11. Pacific Central-American4,490.26Cotat Rica to LME#12. Caribbean Sea2,459.37Cotat to LME#26. Mediterranean23,528.27Cotat to LME#26. Mediterranean23,528.27Cotat to LME#26. Mediterranean23,528.37Cota CutH#272. North Sea44,811.14Cota Rica to LME#28. Guinea Current3,953.59Demark to LME#28. Melia Sea2,707.16Cota Rica LME#28. Guinea Current3,953.59Demark to LME#28. Suinea Current3,953.59Cota Rica LME#28. Guinea Current4,490.26Demark to LME#28. Andita Sea2,894.53Cota Rica LME#28. Andita Sea	120	Cameroon to LME#28. Guinea Current	43,953.59	n/a
Canada to LME#9. Newfoundiand-Labrador Shelf5,184.60n/aCanada to LME#8. Scotian Shelf34,811.98n/aCanada to LME#8. Scotian Shelf34,811.98n/a144Sri Lanka to LME#3. Haw of Bengal44,752.00n/a152Chile to LME#13. Humboldt Current893.27n/a154China, People's Republic of to LME#36. South China Sea26,321.58n/a155China, People's Republic of to LME#48. Vellow Sea71,421.80n/a170Colombia to LME#11. Pacific Central-American4,490.26n/a171Colombia to LME#12. Caritbean Sea2,459.37n/a172Congo to LME#28. Guinea Current43,953.59n/a173Congo to LME#12. Caritbean Sea2,459.37n/a174Costa Rica to LME#11. Pacific Central-American4,490.26n/a175Costa Rica to LME#12. Caritbean Sea2,459.37n/a176Costa Rica to LME#12. Caritbean Sea2,459.37n/a177Costa Rica to LME#12. Caritbean Sea2,459.37n/a178Costa Rica to LME#12. Caritbean Sea2,459.37n/a179Costa Rica to LME#22. North Sea44,811.14n/a179Costa Rica to LME#22. North Sea44,811.14n/a179Costa Rica to LME#22. North Sea150,905.61n/a179Costa Rica to LME#22. North Sea150,905.61n/a179Denmark to LME#22. North Sea2,459.37n/a179LME#22. Saltic Sea3,53.59n/a	124	Canada to LME#2. Gulf of Alaska	7,102.53	n/a
Canada to LME#8. Scotian Shelf34,811.98n/aCanada to LME#64. Arctic Ocean496.21144Sri lanka to LME#34. Bay of Bengal44,752.00152Chile to LME#13. Humbold Current893.27156China, People's Republic of to LME#36. South China Sea26,821.58177Colombia to LME#11. Pacific Central-American44,90.26178Colombia to LME#12. Caribbean Sea71,421.80179Colombia to LME#12. Caribbean Sea2,459.37179Congo to LME#26. Guinea Current43,953.59178Congo to LME#26. Guinea Current43,953.59179Cotat ca LME#12. Caribbean Sea2,459.37179Cotat ca LME#12. Caribbean Sea2,459.37179Cotat ic LME#12. Caribbean Sea2,459.37179Cotat ic LME#26. Mediterranean23,528.27179Cotat ic LME#26. Mediterranean23,528.27170Cotat ic LME#26. Mediterranean23,528.27171Cotat ic LME#26. Mediterranean23,528.27172Cuba to LME#26. Mediterranean23,528.27173Cuba to LME#26. Mediterranean23,528.27174Denmark to LME#26. Mediterranean23,528.27175Coratia to LME#27. North Sea44,811.14176Denmark to LME#28. Guinea Current43,953.59177Denmark to LME#28. Guinea Current43,953.59178Cech Republic to LME#12. Caribbean Sea2,459.37179Denmark to LME#28. Guinea Current43,953.59171Denmark to LME#28. Guinea		Canada to LME#63. Hudson Bay	17,212.84	n/a
Canada to LME#64. Arctic Ocean496.21144Sri Lanka to LME#34. Bay of Bengal44,752.00152Chile to LME#13. Humboldt Current893.27156China, People's Republic of to LME#36. South China Sea28,881.56157China, People's Republic of to LME#47. East China Sea26,321.58158China, People's Republic of to LME#48. Yellow Sea71,421.80170Colombia to LME#11. Pacific Central-American4,490.26171Congo to LME#28. Guinea Current43,953.59172Congo to LME#28. Guinea Current43,953.59173Congo to LME#11. Pacific Central-American4,490.26174Corati co to LME#11. Pacific Central-American4,490.26175Congo to LME#28. Guinea Current43,953.59176Corati co to LME#11. Pacific Central-American2,459.37178Costa Rica to LME#11. Pacific Central-American4,490.26179Costa Rica to LME#12. Caribbean Sea2,459.37179Cypus to LME#26. Mediterranean23,528.27179Cuba to LME#26. Mediterranean23,528.27179Cypus to LME#26. Mediterranean23,528.27179Cypus to LME#26. Mediterranean23,528.27179Cache Republic to LME#27. North Sea44,811.14170Demmark to LME#28. Guinea Current43,953.59170Demmark to LME#28. Suinea Current43,953.59171Demmark to LME#28. Cuinea Current4,490.26171Demmark to LME#28. Cuinea Current4,490.26172Ediv		Canada to LME#9. Newfoundland-Labrador Shelf	5,184.60	n/a
144Sri Lanka to LME#34. Bay of Bengal44,752.00n/a152Chile to LME#13. Humboldt Current893.27n/a156China, People's Republic of to LME#36. South China Sea28,881.56n/a170Colombia to LME#11. Fast China Sea26,321.58n/a170Colombia to LME#11. Pacific Central-American4,490.26n/a170Colombia to LME#12. Caribbean Sea2,459.37n/a170Congo to LME#28. Guinea Current43,953.59n/a178Congo to LME#11. Pacific Central-American4,490.26n/a179Congo to LME#12. Caribbean Sea2,459.37n/a170Congo to LME#12. Caribbean Sea2,459.37n/a171Costa Rica to LME#11. Pacific Central-American4,490.26n/a172Costa Rica to LME#12. Caribbean Sea2,459.37n/a173Costa Rica to LME#12. Caribbean Sea2,459.37n/a174Costa Rica to LME#12. Caribbean Sea2,459.37n/a175Costa Rica to LME#12. Caribbean Sea2,459.37n/a176Cyrus to LME#26. Mediterranean23,528.27n/a177Caeh LME#21. Caribbean Sea150,905.61n/a178Denmark to LME#22. North Sea44,811.44n/a179Denmark to LME#23. Baltic Sea150,905.61n/a179Denmark to LME#23. Baltic Sea150,905.61n/a179Caedor to LME#11. Pacific Central-American4,490.26n/a170Eduador to LME#12. Caribbean Sea <td></td> <td></td> <td></td> <td>n/a</td>				n/a
1152Chile to LME#13. Humboldt Current893.27n/a156China, People's Republic of to LME#36. South China Sea28,881.56n/aChina, People's Republic of to LME#47. East China Sea26,321.58n/aChina, People's Republic of to LME#48. Vellow Sea71,421.80n/a170Colombia to LME#11. Pacific Central-American4,490.26n/aColombia to LME#12. Caribbean Sea2,459.37n/a180Democratic Republic of the Congo to LME#28. Guinea Current43,953.59n/a191Croatia to LME#11. Pacific Central-American4,490.26n/a192Costa Rica to LME#12. Caribbean Sea2,459.37n/a193Croatia to LME#12. Caribbean Sea2,459.37n/a194Costa Rica to LME#12. Caribbean Sea2,459.37n/a195Croatia to LME#26. Mediterranean23,528.27n/a196Cyprus to LME#26. Mediterranean23,528.27n/a197Cuba to LME#26. Mediterranean23,528.27n/a198Casta Rica to LME#26. Mediterranean23,528.27n/a199Cuba to LME#26. Mediterranean23,528.27n/a190Cuba to LME#26. Mediterranean23,528.27n/a191Cuba to LME#26. Mediterranean23,528.27n/a192Cuba to LME#26. Mediterranean23,528.27n/a193Creatia to LME#26. Mediterranean23,528.77n/a194Demmark to LME#26. Mediterranean23,528.77n/a195Demark to LME#28. Guinea C				n/a
156China, People's Republic of to LME#36. South China Sea28,881.56n/aChina, People's Republic of to LME#47. East China Sea26,321.58n/aChina, People's Republic of to LME#48. Yellow Sea71,421.80n/a170Colombia to LME#11. Pacific Central-American4,490.26n/a173Congo to LME#12. Caribbean Sea2,459.37n/a180Democratic Republic of the Congo to LME#28. Guinea Current4,3953.59n/a181Costa Rica to LME#11. Pacific Central-American4,490.26n/a193Croata it to LME#12. Caribbean Sea2,459.37n/a194Costa Rica to LME#28. Guinea Sea2,459.37n/a195Croatia to LME#12. Caribbean Sea2,459.37n/a196Cyprus to LME#26. Mediterranean23,528.27n/a197Cuba to LME#21. North Sea44,811.14n/a198Denmark to LME#28. Guinea Current43,953.59n/a199Cuba to LME#28. Guinea Current43,953.59n/a190Denmark to LME#28. Guinea Current43,953.59n/a191Denmark to LME#28. Guinea Current43,953.59n/a192Delmark to LME#28. Guinea Current3,953.59n/a193Denmark to LME#28. Guinea Current4,90.26n/a194Dominican Republic to LME#11. Pacific Central-American4,490.26n/a193Ecuador to LME#28. Guinea Current4,3953.59n/a194Dominican Republic to LME#28. Guinea Current4,3953.59n/a <td></td> <td></td> <td></td> <td></td>				
China, People's Republic of to LME#47. East China Sea26,321.58n/aChina, People's Republic of to LME#48. Yellow Sea71,421.80n/aColombia to LME#11. Pacific Central-American4,490.26n/aColombia to LME#12. Caribbean Sea2,459.37n/aCongo to LME#12. Caribbean Sea2,459.37n/aCosta Rica to LME#28. Guinea Current23,528.27n/aCosta Rica to LME#28. Guinea Current23,528.27n/aCosta Rica to LME#28. Guinea Current23,528.27n/aCosta Rica to LME#28. Guinea Current3,935.59n/aCosta Rica to LME#28. Guinea Current4,481.14n/aDenmark to LME#28. Guinea Current3,953.59n/aDenmark to LME#28. Guinea Current2,707.16n/aDenmark to LME#29. North Sea2,459.37n/aDenmark to LME#20. Caribbean Sea2,459.37n/aCosta Rica to LME#11. Pacific Central-American4,490.26n/aCosta Rica to LME#28. Guinea Current3,953.59n/aCosta Rica to LME#28. Guinea Current4,990.26n/aCosta Rica to LME#28. Guinea Current4,990.26n/aCosta Rica to LME#28. Guinea Current4,990.26n/aCosta Rica to LME				
China, People's Republic of to LME#48. Yellow Sea71,421.80n/a170Colombia to LME#11. Pacific Central-American4,490.26n/a171Colombia to LME#12. Caribbean Sea2,459.37n/a172Congo to LME#28. Guinea Current43,953.59n/a178Democratic Republic of the Congo to LME#28. Guinea Current43,953.59n/a178Costa Rica to LME#11. Pacific Central-American4,490.26n/a179Costa Rica to LME#12. Caribbean Sea2,459.37n/a179Cuba to LME#12. Caribbean Sea2,459.37n/a179Cuba to LME#26. Mediterranean23,528.27n/a179Cuba to LME#26. Mediterranean23,528.27n/a170Cuba to LME#28. Guinea Current43,953.59n/a171Cuba to LME#28. Guinea Current43,953.59n/a172Cuba to LME#28. Guinea Current43,953.59n/a173Denmark to LME#28. Guinea Current43,953.59n/a174Denmark to LME#28. Guinea Current2,707.16n/a174Denmark to LME#28. Guinea Current2,707.16n/a174Denmark to LME#28. Guinea Current4,490.26n/a174Denmark to LME#28. Guinea Current4,490.26n/a175Cuba to LME#11. Pacific Central-American4,490.26n/a176Euador to LME#11. Pacific Central-American4,490.26n/a177Euador to LME#33. Red Sea63,783.75n/a178Euador to LME#33. Red Sea58	156			
170Colombia to LME#11. Pacific Central-American4,490.26178Colombia to LME#12. Caribbean Sea2,459.37178Congo to LME#28. Guinea Current43,953.59178Democratic Republic of the Congo to LME#28. Guinea Current43,953.59180Democratic Republic of the Congo to LME#28. Guinea Current4,490.26181Costa Rica to LME#11. Pacific Central-American4,490.26191Croatia to LME#12. Caribbean Sea2,459.37192Cuba to LME#12. Caribbean Sea2,459.37193Croatia to LME#12. Caribbean Sea2,459.37194Costa Rica to LME#26. Mediterranean23,528.27195Cyprus to LME#26. Mediterranean23,528.27196Cyprus to LME#28. Guinea Current43,953.59197Czech Republic to LME#22. North Sea44,811.14198Denmark to LME#23. Baltic Sea150,905.61199Denmark to LME#23. Baltic Sea2,459.37190Denmark to LME#11. Pacific Central-American4,490.26191Crozific Central-American4,490.26192Eulador to LME#11. Pacific Central-American4,490.26193Ethiopia to LME#23. Rabia Sea3,783.75194Eulayabii to LME#32. Arabian Sea63,783.75195Circleat and Sea3,895.35194Catinia to LME#33. Red Sea58,945.34195Circleat and Sea3,895.35195Circleat and Sea150,905.61195Faltia to LME#33. Red Sea58,945.34195Circl				
Colombia to LME#12. Caribbean Sea2,459.37n/a178Congo to LME#28. Guinea Current43,953.59n/a180Democratic Republic of the Congo to LME#28. Guinea Current43,953.59n/a181Costa Rica to LME#11. Pacific Central-American4,490.26n/a182Costa Rica to LME#12. Caribbean Sea2,459.37n/a191Croatia to LME#12. Caribbean Sea2,459.37n/a192Cuba to LME#12. Caribbean Sea2,459.37n/a193Croatia to LME#26. Mediterranean23,528.27n/a194Cypus to LME#26. Mediterranean23,528.27n/a195Cypus to LME#28. Guinea Current43,953.59n/a196Cypurs to LME#28. Guinea Current43,953.59n/a197Denmark to LME#28. Guinea Current43,953.59n/a198Denmark to LME#28. Baltic Sea150,905.61n/a199Denmark to LME#28. Guinea Current2,707.16n/a199Denmark to LME#11. Pacific Central-American4,490.26n/a199Ecuador to LME#11. Pacific Central-American4,490.26n/a199Ecuador to LME#11. Pacific Central-American4,490.26n/a199Ecuatorial Guinea to LME#28. Guinea Current43,953.59n/a199Ecuador to LME#11. Pacific Central-American4,490.26n/a199Ecuatorial Guinea to LME#28. Guinea Current43,953.59n/a199Ecuatorial Guinea to LME#28. Guinea Current43,953.59n/a199 <td>170</td> <td></td> <td></td> <td></td>	170			
178Congo to LME#28. Guinea Current43,953.59n/a180Democratic Republic of the Congo to LME#28. Guinea Current43,953.59n/a181Costa Rica to LME#11. Pacific Central-American4,490.26n/aCosta Rica to LME#12. Caribbean Sea2,459.37n/a191Croatia to LME#12. Caribbean Sea2,459.37n/a192Cuba to LME#12. Caribbean Sea2,459.37n/a193Croatia to LME#12. Caribbean Sea2,459.37n/a194Costa Rica to LME#12. Caribbean Sea2,459.37n/a195Cypus to LME#26. Mediterranean23,528.27n/a196Cypus to LME#26. Mediterranean23,528.27n/a197Cuba to LME#28. Guinea Current43,953.59n/a198Denmark to LME#28. Guinea Current43,953.59n/a199Denmark to LME#28. Baltic Sea150,905.61n/a199Denmark to LME#28. Baltic Sea2,707.16n/a199Denmark to LME#11. Pacific Central-American4,490.26n/a1214Dominican Republic to LME#12. Caribbean Sea2,459.37n/a1215Ecuador to LME#11. Pacific Central-American4,490.26n/a1226El salvador to LME#11. Pacific Central-American4,490.26n/a1231Ethiopia to LME#33. Red Sea58,945.34n/a1232Eritrea to LME#33. Red Sea58,945.34n/a1233Estonia to LME#33. Red Sea150,905.61n/a1234Ethiopia to LME#33. Red Sea15	170			
180Democratic Republic of the Congo to LME#28. Guinea Current43,953.59n/a188Costa Rica to LME#11. Pacific Central-American4,490.26n/a191Croatia to LME#12. Caribbean Sea2,459.37n/a192Cuba to LME#12. Caribbean Sea2,459.37n/a193Croatia to LME#26. Mediterranean23,528.27n/a194Cuba to LME#12. Caribbean Sea2,459.37n/a195Cyprus to LME#26. Mediterranean23,528.27n/a196Cyprus to LME#26. Mediterranean23,528.27n/a107Zech Republic to LME#22. North Sea44,811.14n/a108Bennark to LME#28. Guinea Current43,953.59n/a109Denmark to LME#21. North Sea44,811.14n/a1208Denmark to LME#23. Baltic Sea150,905.61n/a1209Denmark to LME#13. Baltic Sea2,459.37n/a1214Dominican Republic to LME#12. Caribbean Sea2,459.37n/a1214Dominican Republic to LME#12. Caribbean Sea2,459.37n/a1214Dominican Republic to LME#14. Caribbean Sea2,459.37n/a1214Bolmican Republic to LME#11. Pacific Central-American4,490.26n/a1221El Salvador to LME#11. Pacific Central-American4,490.26n/a1232Ethiopia to LME#32. Arabian Sea63,783.75n/a1233Ethiopia to LME#33. Red SeaS8,945.34n/a1234Ethiopia to LME#33. Red SeaS8,945.34n/a1235E	178			
188Costa Rica to LME#11. Pacific Central-American4,490.26n/aCosta Rica to LME#12. Caribbean Sea2,459.37n/a191Croatia to LME#12. Caribbean Sea2,459.37n/a192Cuba to LME#12. Caribbean Sea2,459.37n/a193Croatia to LME#26. Mediterranean23,528.27n/a194Cyprus to LME#26. Mediterranean23,528.27n/a195Cyprus to LME#26. Mediterranean23,528.27n/a196Cyprus to LME#22. North Sea44,811.14n/a208Denmark to LME#22. North Sea44,811.14n/a208Denmark to LME#22. North Sea44,811.14n/a209Denmark to LME#23. Baltic Sea150,905.61n/a201Demark to LME#23. Baltic Sea2,707.16n/a212Dominican Republic to LME#11. Pacific Central-American4,490.26n/a222El Salvador to LME#11. Pacific Central-American4,490.26n/a223Ethiopia to LME#32. Arabia Sea58,945.34n/a233Ethiopia to LME#33. Red Sea58,945.34n/a234Filtrea to LME#33. Red Sea58,945.34n/a235Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a246Finland to LME#23. Baltic Sea150,905.61n/a		-		
191Croatia to LME#26. Mediterranean23,528.27n/a192Cuba to LME#12. Caribbean Sea2,459.37n/a196Cyprus to LME#26. Mediterranean23,528.27n/a203Czech Republic to LME#22. North Sea44,811.14n/a204Benin to LME#28. Guinea Current43,953.59n/a205Denmark to LME#22. North Sea44,811.14n/a206Denmark to LME#22. North Sea44,811.14n/a207Denmark to LME#23. Baltic Sea150,905.61n/a208Denmark to LME#24. Saltic Sea2,707.16n/a209Denmark to LME#10. Farce Plateau2,707.16n/a201Dominican Republic to LME#12. Caribbean Sea2,459.33n/a202El Salvador to LME#11. Pacific Central-American4,490.26n/a203Ethiopia to LME#28. Guinea Current43,953.59n/a204Ethiopia to LME#32. Arabian Sea63,783.75n/a205Ethiopia to LME#33. Red Sea58,945.34n/a206Ethiopia to LME#33. Red Sea150,905.61n/a207Ethiopia to LME#33. Red Sea150,905.61n/a208Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a209Finland to LME#23. Baltic Sea150,905.61n/a				n/a
191Croatia to LME#26. Mediterranean23,528.27n/a192Cuba to LME#12. Caribbean Sea2,459.37n/a196Cyprus to LME#26. Mediterranean23,528.27n/a203Czech Republic to LME#22. North Sea44,811.14n/a204Benin to LME#28. Guinea Current43,953.59n/a205Denmark to LME#22. North Sea44,811.14n/a206Denmark to LME#22. North Sea44,811.14n/a207Denmark to LME#22. North Sea44,811.14n/a208Denmark to LME#22. North Sea44,811.14n/a209Denmark to LME#22. North Sea44,811.14n/a2010Denmark to LME#23. Baltic Sea150,905.61n/a2021Dominican Republic to LME#12. Caribbean Sea2,459.37n/a2032Ecuador to LME#11. Pacific Central-American4,490.26n/a2033Ethiopia to LME#28. Guinea Current4,3953.59n/a2043Ethiopia to LME#32. Red Sea58,945.34n/a2054Ethiopia to LME#33. Red Sea58,945.34n/a2053Ethiopia to LME#33. Red Sea150,905.61n/a2054Faitrea to LME#33. Baltic Sea150,905.61n/a2054Faitrea to LME#23. Baltic Sea150,905.61n/a2055Faitland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a2054Finland to LME#23. Baltic Sea150,905.61n/a2055Faitland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66<				n/a
192Cuba to LME#12. Caribbean Sea2,459.37n/a196Cyprus to LME#26. Mediterranean23,528.27n/a203Czech Republic to LME#22. North Sea44,811.14n/a204Benin to LME#28. Guinea Current43,953.59n/a205Denmark to LME#22. North Sea44,811.14n/a206Denmark to LME#22. North Sea44,811.14n/a207Denmark to LME#22. North Sea44,811.14n/a208Denmark to LME#22. North Sea44,811.14n/a209Denmark to LME#23. Baltic Sea150,905.61n/a201Dominican Republic to LME#12. Caribbean Sea2,707.16n/a202El Salvador to LME#11. Pacific Central-American4,490.26n/a203Etuador to LME#11. Pacific Central-American4,490.26n/a204Etuadoria to LME#23. Arabian Sea63,783.75n/a205Etitopia to LME#33. Red Sea58,945.34n/a206Etitopia to LME#33. Red Sea58,945.34n/a207Etitopia to LME#33. Red Sea150,905.61n/a208Falkand Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a209Falkand Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a209Finland to LME#23. Baltic Sea150,905.61n/a209Falkand Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a209Finland to LME#23. Baltic Sea150,905.61n/a209Finland to LME#23. Baltic	191	Croatia to LME#26. Mediterranean		n/a
200Zeck Republic to LME#22. North Sea44,811.14n/a201Benin to LME#28. Guinea Current43,953.59n/a202Denmark to LME#22. North Sea44,811.14n/a203Denmark to LME#22. North Sea150,905.61n/a204Denmark to LME#23. Baltic Sea2,707.16n/a205Denmark to LME#20. Farce Plateau2,707.16n/a216Dominican Republic to LME#12. Caribbean Sea2,459.37n/a217Dominican Republic to LME#11. Pacific Central-American4,490.26n/a226Equatorial Guinea to LME#28. Guinea Current43,953.59n/a231Ethiopia to LME#32. Arabian Sea63,783.75n/a232Eritrea to LME#33. Red Sea58,945.34n/a233Stonia to LME#33. Red Sea150,905.61n/a234Hithad Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a246Finland to LME#23. Baltic Sea150,905.61n/a			2,459.37	n/a
204Benin to LME#28. Guinea Current43,953.59n/a208Denmark to LME#22. North Sea44,811.14n/a209Denmark to LME#22. North Sea150,905.61n/a201Denmark to LME#23. Baltic Sea2,707.16n/a202Denmark to LME#10. Farce Plateau2,707.16n/a203Ecuador to LME#11. Pacific Central-American4,490.26n/a204E Salvador to LME#11. Pacific Central-American4,490.26n/a205E Salvador to LME#32. Arabian Sea63,783.75n/a206Eutorial Guinea to LME#32. Guinea Current3,953.59n/a207Ethiopia to LME#33. Red Sea58,945.34n/a208Estonia to LME#33. Red Sea58,945.34n/a209Estonia to LME#23. Baltic Sea150,905.61n/a201Estonia to LME#23. Baltic Sea150,905.61n/a			23,528.27	n/a
208Denmark to LME#22. North Sea44,811.14n/aDenmark to LME#23. Baltic Sea150,905.61n/aDenmark to LME#60. Faroe Plateau2,707.16n/a214Dominican Republic to LME#12. Caribbean Sea2,459.37n/a218Ecuador to LME#11. Pacific Central-American4,490.26n/a226E Jalvador to LME#11. Pacific Central-American4,490.26n/a218Ethiopia to LME#32. Guinea Current43,953.59n/a219Ethiopia to LME#33. Red Sea58,945.34n/a210Ethiopia to LME#33. Red Sea58,945.34n/a212Eritrea to LME#33. Red Sea58,945.34n/a213Ethiopia to LME#32. Baltic Sea150,905.61n/a214Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a			44,811.14	n/a
Denmark to LME#23. Baltic Sea150,905.61Denmark to LME#26. Farce Plateau2,707.16Denmark to LME#60. Farce Plateau2,707.16214Dominican Republic to LME#12. Caribbean Sea2,459.37218Ecuador to LME#11. Pacific Central-American4,490.26220Ef Salvador to LME#11. Pacific Central-American4,490.26231Ethiopia to LME#32. Guinea Current4,395.59232Ethiopia to LME#33. Red Sea58,945.34233Ethiopia to LME#33. Red Sea58,945.34234Ethiopia to LME#33. Red Sea150,905.61235Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66246Finland to LME#23. Baltic Sea150,905.61			43,953.59	n/a
Denmark to LME#60. Farce Plateau2,707.1614Dominican Republic to LME#12. Caribbean Sea2,459.3715Ecuador to LME#11. Pacific Central-American4,490.2616Stavador to LME#11. Pacific Central-American4,490.2617Et Salvador to LME#11. Pacific Central-American4,490.2618Equatorial Guinea to LME#28. Guinea Current4,395.35918Ethiopia to LME#32. Arabian Sea63,783.7519Ethiopia to LME#33. Red Sea58,945.3410Tirrea to LME#33. Red Sea58,945.34123Etonia to LME#32. Baltic Sea150,905.611238Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.661246Finland to LME#23. Baltic Sea150,905.611246Finland to LME#23. Baltic Sea150,905.61	208			n/a
211Dominican Republic to LME#12. Caribbean Sea2,459.37218Ecuador to LME#11. Pacific Central-American4,490.26220El Salvador to LME#11. Pacific Central-American4,490.26221El Salvador to LME#11. Pacific Central-American4,490.26222Equatorial Guinea to LME#28. Guinea Current43,953.59233Ethiopia to LME#32. Arabian Sea63,783.75234Ethiopia to LME#33. Red Sea58,945.34235Etrirea to LME#33. Red Sea58,945.34236Stonia to LME#23. Baltic Sea150,905.61237Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66246Finland to LME#23. Baltic Sea150,905.61				n/a
218Ecuador to LME#11. Pacific Central-American4,490.26n/a222El Salvador to LME#11. Pacific Central-American4,490.26n/a226Equatorial Guinea to LME#28. Guinea Current43,953.59n/a231Ethiopia to LME#32. Arabian Sea63,783.75n/a232Ethiopia to LME#33. Red Sea58,945.34n/a233Etonia to LME#32. Baltic Sea150,905.61n/a234Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a246Finland to LME#23. Baltic Sea150,905.61n/a				n/a
222El Salvador to LME#11. Pacific Central-American4,490.26n/a226Equatorial Guinea to LME#28. Guinea Current43,953.59n/a231Ethiopia to LME#32. Arabian Sea63,783.75n/a232Ethiopia to LME#33. Red Sea58,945.34n/a233Estonia to LME#33. Baltic Sea150,905.61n/a238Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a246Finland to LME#23. Baltic Sea150,905.61n/a				n/a
226Equatorial Guinea to LME#28. Guinea Current43,953.59n/a231Ethiopia to LME#32. Arabian Sea63,783.75n/a232Ethiopia to LME#33. Red Sea58,945.34n/a233Estonia to LME#33. Red Sea58,945.34n/a234Estonia to LME#23. Baltic Sea150,905.61n/a238Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a246Finland to LME#23. Baltic Sea150,905.61n/a				
231Ethiopia to LME#32. Arabian Sea63,783.75n/aEthiopia to LME#33. Red Sea58,945.34n/a232Eritrea to LME#33. Red Sea58,945.34n/a233Estonia to LME#23. Baltic Sea150,905.61n/a238Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a246Finland to LME#23. Baltic Sea150,905.61n/a				
Ethiopia to LME#33. Red Sea58,945.34n/a232Eritrea to LME#33. Red Sea58,945.34n/a233Estonia to LME#23. Baltic Sea150,905.61n/a238Falkland Islands (Malvinas) to LME#14. Patagonian Shelf12,247.66n/a246Finland to LME#23. Baltic Sea150,905.61n/a				
232         Eritrea to LME#33. Red Sea         58,945.34         n/a           233         Estonia to LME#23. Baltic Sea         150,905.61         n/a           238         Falkland Islands (Malvinas) to LME#14. Patagonian Shelf         12,247.66         n/a           246         Finland to LME#23. Baltic Sea         150,905.61         n/a	231			
233         Estonia to LME#23. Baltic Sea         150,905.61         n/a           238         Falkland Islands (Malvinas) to LME#14. Patagonian Shelf         12,247.66         n/a           246         Finland to LME#23. Baltic Sea         150,905.61         n/a	222			
238         Falkland Islands (Malvinas) to LME#14. Patagonian Shelf         12,247.66         n/a           246         Finland to LME#23. Baltic Sea         150,905.61         n/a				
246 Finland to LME#23. Baltic Sea 150,905.61 n/a				n/a
				n/a
				n/a
France to LME#24. Celtic-Biscay Shelf 36,900.59 n/a				n/a
		France to LME#26. Mediterranean		n/a



262	Diibauti ta IME#22 Arabian Caa	62 782 75	2/2
	Djibouti to LME#32. Arabian Sea Gabon to LME#28. Guinea Current	63,783.75 43,953.59	n/a n/a
	Georgia to LME#62. Black Sea	87,946.16	n/a
	Gambia to LME#28. Guinea Current	43,953.59	n/a
276	Germany to LME#22. North Sea	44,811.14	n/a
	Germany to LME#23. Baltic Sea	150,905.61	n/a
288	Ghana to LME#28. Guinea Current	43,953.59	n/a
	Greece to LME#26. Mediterranean	23,528.27	n/a
320	Guatemala to LME#11. Pacific Central-American	4,490.26	n/a
	Guatemala to LME#12. Caribbean Sea	2,459.37	n/a
	Guinea to LME#28. Guinea Current Guyana to LME#17. North Brazil Shelf	43,953.59 9,515.83	n/a n/a
	Haiti to LME#12. Caribbean Sea	2,459.37	n/a
	Honduras to LME#12. Caribbean Sea	2,459.37	n/a
	Hungary to LME#62. Black Sea	87,946.16	n/a
	Iceland to LME#59. Iceland Shelf	3,192.60	n/a
356	India to LME#32. Arabian Sea	63,783.75	n/a
	India to LME#34. Bay of Bengal	44,752.00	n/a
360	Indonesia to LME#38. Indonesian Sea	12,538.84	n/a
364	Iran, Islamic Republic of to LME#32. Arabian Sea	63,783.75	n/a
	Iraq to LME#32. Arabian Sea	63,783.75	n/a
	Ireland to LME#24. Celtic-Biscay Shelf	36,900.59	n/a
	Israel to LME#26. Mediterranean	23,528.27 23,528.27	n/a
	Italy to LME#26. Mediterranean Kosovo to LME#26. Mediterranean	23,528.27	n/a n/a
	Côte d'Ivoire to LME#28. Guinea Current	43,953.59	n/a
	Jamaica to LME#12. Caribbean Sea	2,459.37	n/a
	Japan to LME#47. East China Sea	26,321.58	n/a
	Japan to LME#49. Kuroshio Current	11,359.16	n/a
	Japan to LME#50. Sea of Japan/East Sea	41,888.91	n/a
	Japan to LME#51. Oyashio Current	5,276.82	n/a
	Japan to LME#52. Sea of Okhotsk	25,405.91	n/a
400	Jordan to LME#33. Red Sea	58,945.34	n/a
	Kenya to LME#31. Somali Coastal Current	4,617.93	n/a
408	Democratic People's Republic of Korea to LME#47. East China Sea	26,321.58	n/a
	Democratic People's Republic of Korea to LME#48. Yellow Sea Democratic People's Republic of Korea to LME#50. Sea of Japan/East Sea	71,421.80 41,888.91	n/a n/a
410	Republic of Korea to LME#47. East China Sea	26,321.58	n/a
410	Republic of Korea to LME#48. Yellow Sea	71,421.80	n/a
	Republic of Korea to LME#50. Sea of Japan/East Sea	41,888.91	n/a
418	Lao People's Democratic Republic to LME#36. South China Sea	28,881.56	n/a
422	Lebanon to LME#26. Mediterranean	23,528.27	n/a
428	Latvia to LME#23. Baltic Sea	150,905.61	n/a
	Liberia to LME#28. Guinea Current	43,953.59	n/a
	Libyan Arab Jamahiriya to LME#26. Mediterranean	23,528.27	n/a
	Lithuania to LME#23. Baltic Sea	150,905.61	n/a
	Madagascar to LME#30. Agulhas Current	16,614.04	n/a
458	Malaysia to LME#34. Bay of Bengal Malaysia to LME#35. Gulf of Thailand	44,752.00 909.05	n/a n/a
	Malaysia to LME#36. South China Sea	28,881.56	n/a
466	Mali to LME#27. Canary Current	8,090.22	n/a
	Mali to LME#28. Guinea Current	43,953.59	n/a
478	Mauritania to LME#27. Canary Current	8,090.22	n/a
484	Mexico to LME#3. California Current	3,479.44	n/a
	Mexico to LME#4. Gulf of California	33,289.80	n/a
	Mexico to LME#5. Gulf of Mexico	33,386.96	n/a
	Moldova to LME#62. Black Sea	87,946.16	n/a
	Montenegro to LME#26. Mediterranean	23,528.27	n/a
504	Morocco to LME#26. Mediterranean Morocco to LME#27. Canary Current	23,528.27 8,090.22	n/a n/a
508	Mozambique to LME#30. Agulhas Current	16,614.04	n/a
	Oman to LME#32. Arabian Sea	63,783.75	n/a
	Namibia to LME#29. Benguela Current	9,754.22	n/a
	Nepal to LME#34. Bay of Bengal	44,752.00	n/a
528	Netherlands to LME#22. North Sea	44,811.14	n/a
540	New Caledonia to LME#40. Northeast Australia	2,043.07	n/a
	New Zealand to LME#46. New Zealand Shelf	3,956.78	n/a
558	Nicaragua to LME#11. Pacific Central-American	4,490.26	n/a
	Nicaragua to LME#12. Caribbean Sea	2,459.37	n/a
	Niger to LME#28. Guinea Current	43,953.59	n/a
	Nigeria to LME#28. Guinea Current	43,953.59	n/a
578	Norway to LME#21. Norwegian Sea	13,399.88	n/a
586	Norway to LME#22. North Sea Pakistan to LME#32. Arabian Sea	44,811.14 63,783.75	n/a n/a



591	Panama to LME#11. Pacific Central-American	4,490.26	n/a
	Panama to LME#12. Caribbean Sea	2,459.37	n/a
600	Paraguay to LME#14. Patagonian Shelf	12,247.66	n/a
	Peru to LME#13. Humboldt Current Philippines to LME#36. South China Sea	893.27 28,881.56	n/a
608	Philippines to LME#37. Sulu-Celebes Sea	36,404.65	n/a n/a
616	Poland to LME#23. Baltic Sea	150,905.61	n/a
	Portugal to LME#25. Iberian Coastal	5,670.55	n/a
624	Guinea-Bissau to LME#28. Guinea Current	43,953.59	n/a
626	Timor-Leste to LME#38. Indonesian Sea	12,538.84	n/a
	Puerto Rico to LME#12. Caribbean Sea	2,459.37	n/a
	Romania to LME#62. Black Sea	87,946.16	n/a
643	Russian Federation to LME#20. Barents Sea	10,478.46	n/a
	Russian Federation to LME#54. Chukchi Sea	7,218.69	n/a
	Russian Federation to LME#56. East Siberian Sea Russian Federation to LME#57. Laptev Sea	3,775.00 14,345.67	n/a n/a
	Russian Federation to LME#58. Kara Sea	10,975.25	n/a
	Russian Federation to LME#62. Black Sea	87,946.16	n/a
	Russian Federation to LME#64. Arctic Ocean	496.21	n/a
	Russian Federation to LME#50. Sea of Japan/East Sea	41,888.91	n/a
	Russian Federation to LME#51. Oyashio Current	5,276.82	n/a
	Russian Federation to LME#52. Sea of Okhotsk	25,405.91	n/a
	Russian Federation to LME#53. West Bering Sea	3,450.72	n/a
682	Saudi Arabia to LME#32. Arabian Sea	63,783.75	n/a
	Saudi Arabia to LME#33. Red Sea	58,945.34	n/a
	Senegal to LME#27. Canary Current Serbia to LME#62. Black Sea	8,090.22 87,946.16	n/a
688	Serbia to LME#26. Mediterranean	23,528.27	n/a n/a
694	Sierra Leone to LME#28. Guinea Current	43,953.59	n/a
	Slovakia to LME#62. Black Sea	87,946.16	n/a
704	Viet Nam to LME#36. South China Sea	28,881.56	n/a
705	Slovenia to LME#26. Mediterranean	23,528.27	n/a
706	Somalia to LME#31. Somali Coastal Current	4,617.93	n/a
	Somalia to LME#32. Arabian Sea	63,783.75	n/a
710	South Africa to LME#29. Benguela Current	9,754.22	n/a
	South Africa to LME#30. Agulhas Current	16,614.04	n/a
	Zimbabwe to LME#30. Agulhas Current Spain to LME#25. Iberian Coastal	16,614.04 5,670.55	n/a n/a
724	Spain to LME#25. Ibertain Coastan Spain to LME#26. Mediterranean	23,528.27	n/a
736	Sudan to LME#33. Red Sea	58,945.34	n/a
	Swaziland to LME#30. Agulhas Current	16,614.04	n/a
752	Sweden to LME#23. Baltic Sea	150,905.61	n/a
	Sweden to LME#22. North Sea	44,811.14	n/a
756	Switzerland to LME#22. North Sea	44,811.14	n/a
	Switzerland to LME#26. Mediterranean	23,528.27	n/a
	Switzerland to LME#62. Black Sea	87,946.16	n/a
	Syrian Arab Republic to LME#26. Mediterranean	23,528.27	n/a
	Thailand to LME#34. Bay of Bengal Togo to LME#28. Guinea Current	44,752.00 43,953.59	n/a n/a
	United Arab Emirates to LME#32. Arabian Sea	63,783.75	n/a
	Tunisia to LME#26. Mediterranean	23,528.27	n/a
	Turkey to LME#26. Mediterranean	23,528.27	n/a
	Uganda to LME#26. Mediterranean	23,528.27	n/a
804	Ukraine to LME#62. Black Sea	87,946.16	n/a
	The FYR of Macedonia to LME#26. Mediterranean	23,528.27	n/a
	Egypt to LME#26. Mediterranean	23,528.27	n/a
826	United Kingdom of GB and NI to LME#22. North Sea	44,811.14	n/a
	United Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf	36,900.59	n/a
	United Republic of Tanzania: Mainland to LME#30. Agulhas Current	16,614.04	n/a
840	United States to LME#1. East Bering Sea United States to LME#2. Gulf of Alaska	24,114.20 7,102.53	n/a n/a
	United States to LME#3. California Current	3,479.44	n/a
	United States to LME#4. Gulf of California	33,289.80	n/a
	United States to LME#5. Gulf of Mexico	33,386.96	n/a
	United States to LME#6. Southeast U.S. Continental Shelf	4,270.51	n/a
	United States to LME#7. Northeast U.S. Continental Shelf	13,830.72	n/a
	United States to LME#10. Insular Pacific-Hawaiian	1,181.53	n/a
	United States to LME#54. Chukchi Sea	7,218.69	n/a
	United States to LME#55. Beaufort Sea	10,143.49	n/a
	Uruguay to LME#14. Patagonian Shelf	12,247.66	n/a
	Venezuela (Bolivarian Republic of) to LME#12. Caribbean Sea Yemen to LME#32. Arabian Sea	2,459.37	n/a n/a
	Zambia to LME#32. Agulhas Current	63,783.75 16,614.04	n/a n/a
n=214		10,014.04	,u



### Table 3.20: Characterisation Factors (CF) and total N emission to air at country scale.

	Emission:	N to air	
	Resolution scale:	Country	
	_	CF "N to air"	Emission to air
	Country	(PAF·)[m <sup>3</sup> ·d/kg]	[kg/yr]
8 12	Albania Algeria	7,606.07 7,211.38	2.21E+07 1.76E+08
24	-	2,490.13	8.24E+08
32		4,416.45	1.09E+09
36		550.68	1.60E+09
40	Austria	5,986.51	1.74E+08
	Bahamas	1,490.85	3.91E+06
	Bangladesh	11,107.20	4.99E+08
	Belgium	14,146.99	9.24E+07
	Bhutan Bolivia	9,743.61 214.72	3.36E+07 4.31E+08
	Bosnia and Herzegovina	6,433.01	4.51L+08 3.59E+07
	Botswana	4,689.03	1.14E+08
	Brazil	974.66	5.27E+09
84	Belize	1,097.00	1.66E+07
	Virgin Islands (British)	1,692.38	2.47E+04
	Bulgaria	11,041.33	1.52E+08
	Myanmar	12,033.02	4.63E+08
	Belarus Cambodia	29,863.38	2.11E+08
	Campodia	1,187.57 10,509.35	1.58E+08 3.07E+08
	Canada	1,974.47	1.49E+09
	Sri Lanka	25,932.46	4.68E+07
152	Chile	369.57	9.13E+07
156	China, People's Republic of	7,937.94	1.48E+10
170	Colombia	809.98	6.12E+08
	Congo	10,781.75	1.11E+08
	Democratic Republic of the Congo	8,817.57 1,152.00	1.59E+09
	Costa Rica Croatia	6,318.80	3.22E+07 6.39E+07
	Cuba	1,445.79	8.10E+07
	Cyprus	8,841.96	3.92E+06
	Czech Republic	10,857.65	1.76E+08
204	Benin	13,077.95	9.12E+07
208	Denmark	13,803.73	7.14E+07
	Dominican Republic	1,545.87	3.20E+07
	Ecuador	1,521.96	1.27E+08
	El Salvador Equatorial Guinea	2,097.28 14,004.93	2.60E+07 5.00E+06
	Ethiopia	11,144.71	9.12E+08
	Eritrea	15,412.99	5.24E+07
	Estonia	38,535.67	2.16E+07
238	Falkland Islands (Malvinas)	9,187.22	4.05E+05
246	Finland	38,643.28	1.17E+08
	France	6,843.27	9.60E+08
	Djibouti	18,417.86	8.30E+06
	Gabon	13,043.97	5.03E+07
	Georgia Gambia	17,264.22 19,658.43	4.72E+07 3.96E+06
	Germany	19,927.80	9.95E+08
	Ghana	14,639.52	1.85E+08
	Greece	8,120.22	8.86E+07
320	Guatemala	1,007.93	7.11E+07
	Guinea	16,406.40	1.57E+08
	Guyana	3,889.58	1.05E+07
	Haiti	1,517.80	1.15E+07
	Honduras	1,133.63	9.10E+07 1.55E+08
	Hungary Iceland	20,356.52 1,402.27	1.55E+08 4.32E+06
	India	10,776.02	4.32E+00 6.37E+09
	Indonesia	6,011.18	1.04E+09
	Iran, Islamic Republic of	13,376.15	7.71E+08
	Iraq	12,920.81	1.34E+08
	Ireland	17,768.49	5.87E+07
	Israel	6,128.33	5.64E+06
	Italy	7,754.52	4.48E+08
	Kosovo Côte d'Ivoire	6,004.91	1.15E+07
	Côte d'Ivoire Jamaica	15,667.52 1,571.02	1.78E+08 3.37E+06
	Japan	4,767.33	1.49E+08
2		.,	

	Jordan	13,339.20	2.11E+07
	Kenya	1,162.60	4.01E+08
	Democratic People's Republic of Korea Republic of Korea	10,340.12 11,305.84	1.27E+08 7.80E+07
	Lao People's Democratic Republic	9,051.71	1.62E+08
	Lebanon	6,439.34	3.81E+06
	Latvia	35,828.36	3.93E+07
430	Liberia	18,505.35	2.34E+07
434	Libyan Arab Jamahiriya	6,311.36	5.48E+07
	Lithuania	33,510.99	5.53E+07
	Madagascar	6,968.10	2.44E+08
	Malaysia	6,260.37	2.82E+08
	Mali Mauritania	5,883.41 2,965.74	2.95E+08 8.71E+07
	Mexico	4,995.20	1.30E+09
	Moldova	19,732.66	5.15E+07
504	Montenegro	6,004.91	1.49E+07
508	Morocco	3,853.37	1.41E+08
	Mozambique	5,012.94	4.06E+08
	Oman	21,274.65	4.48E+07
	Namibia	3,124.29	1.25E+08
	Nepal Netherlands	9,178.18 14,615.34	2.85E+08 1.28E+08
	New Caledonia	1,692.66	1.01E+06
	New Zealand	2,518.46	8.06E+07
	Nicaragua	1,070.72	6.42E+07
562	Niger	10,873.93	1.56E+08
566	Nigeria	11,375.19	7.85E+08
	Norway	6,640.38	5.16E+07
	Pakistan	13,556.88	7.85E+08
	Panama	1,140.17	2.66E+07
	Paraguay Peru	3,331.12 301.05	2.24E+08 3.12E+08
	Philippines	11,523.83	1.14E+08
	Poland	35,107.62	5.63E+08
620	Portugal	2,497.74	9.22E+07
624	Guinea-Bissau	18,512.85	1.16E+07
	Timor-Leste	8,710.92	4.28E+06
	Puerto Rico	1,612.49	3.68E+06
	Romania	20,602.61	3.47E+08
	Russian Federation Saudi Arabia	2,591.69 10,936.85	3.74E+09 4.73E+08
	Senegal	3,391.52	4.73E+08 8.92E+07
	Serbia	10,695.46	8.36E+07
	Sierra Leone	17,638.63	2.48E+07
703	Slovakia	19,961.73	9.68E+07
704	Viet Nam	10,915.28	3.78E+08
	Slovenia	6,616.68	3.80E+07
	Somalia	7,975.11	2.67E+08
	South Africa	3,247.27	7.18E+08
	Zimbabwe	4,303.58	1.86E+08
	Spain Sudan	3,678.77 11,750.93	6.53E+08 1.54E+09
	Swaziland	5,466.38	2.47E+07
	Sweden	21,154.72	1.55E+08
756	Switzerland	9,455.26	8.26E+07
	Syrian Arab Republic	5,188.23	1.22E+08
	Thailand	13,886.51	3.54E+08
	Togo	14,057.36	4.64E+07
	United Arab Emirates	20,715.44	2.68E+07
	Tunisia Turkey	7,601.66 5,982.32	4.53E+07 6.56E+08
	Uganda	4,814.88	2.51E+08
	Ukraine	18,287.34	8.65E+08
	The FYR of Macedonia	6,534.89	2.78E+07
818	Egypt	5,560.13	1.79E+08
	United Kingdom of GB and NI	10,712.59	4.63E+08
	United Republic of Tanzania: Mainland	4,084.75	6.97E+08
	United States	1,942.30	8.50E+09
	Uruguay	4,786.56	1.74E+08
862	Venezuela (Bolivarian Republic of)	874.99 18,551.47	5.62E+08 1.29E+08
007			
	Yemen Zambia	3,721.39	6.64E+08



### Table 3.21: Characterisation Factors (CF) and total N emission to surface freshwater (sfw) at country scale.

	Emission:	N to freshwater	
	Resolution scale:	Country	
		CF "N to freshwater"	Emission to fw
	Country Albania	(PAF·)[m <sup>3</sup> ·d/kg] 11,128.87	[kg/yr] 1.47E+13
8 12	Algeria	11,128.87	1.47E+13 1.44E+14
	Angola	4,613.74	7.25E+13
	Argentina	5,793.14	5.01E+14
36	Australia	11,019.20	7.38E+13
40	Austria	11,128.87	4.08E+13
44		1,163.28	1.35E+12
50		21,167.69	9.71E+14
56	Belgium	21,195.67	9.43E+13
64 68	Bhutan Bolivia	21,167.69 422.52	3.89E+10 1.01E+14
	Bosnia and Herzegovina	11,128.87	1.35E+13
	Botswana	7,858.44	3.42E+13
76	Brazil	7,676.74	6.32E+14
84	Belize	1,163.28	1.84E+12
	Virgin Islands (British)	1,163.28	8.07E+08
	Bulgaria	52,727.40	1.52E+13
	Myanmar Belarus	21,167.69 71,378.35	1.90E+14 8.36E+13
	Cambodia	1,645.78	8.36E+13 8.64E+11
	Cameroon	20,790.05	7.03E+13
	Canada	30,654.26	6.64E+13
	Sri Lanka	21,167.69	7.71E+13
152	Chile	422.52	1.22E+14
156	China, People's Republic of	59,893.59	3.10E+15
	Colombia	3,287.18	1.82E+14
	Congo	20,790.05	6.09E+12
	Democratic Republic of the Congo Costa Rica	20,790.05	3.53E+13 1.66E+13
	Croatia	3,287.18 11,128.87	2.73E+13
	Cuba	1,163.28	4.79E+13
	Cyprus	11,128.87	9.33E+12
	Czech Republic	21,195.67	3.01E+13
204	Benin	20,790.05	2.26E+13
208	Denmark	93,854.51	2.39E+13
	Dominican Republic	1,163.28	3.61E+13
	Ecuador	2,123.90	7.92E+13
	El Salvador Equatorial Guinea	2,123.90 20,790.05	2.29E+13 6.68E+11
	Ethiopia	58,050.86	1.70E+14
	Eritrea	27,881.15	2.32E+13
	Estonia	71,378.35	6.34E+12
238	Falkland Islands (Malvinas)	5,793.14	2.30E+11
246	Finland	71,378.35	4.20E+13
	France	49,778.52	1.03E+14
	Djibouti	30,169.71	1.99E+11
	Gabon	20,790.05	4.61E+12
	Georgia Gambia	41,598.53 20,790.05	5.73E+13 2.92E+12
	Germany	92,574.02	1.50E+14
	Ghana	20,790.05	2.35E+13
	Greece	11,128.87	3.93E+13
	Guatemala	3,287.18	3.31E+13
	Guinea	20,790.05	3.02E+13
	Guyana	4,500.99	3.40E+12
	Haiti	1,163.28	3.25E+13
	Honduras	1,163.28	5.76E+13 5.78E+13
	Hungary Iceland	41,598.53 1,510.10	5.78E+13 2.97E+12
	India	51,337.41	5.30E+15
	Indonesia	5,930.87	7.26E+14
	Iran, Islamic Republic of	30,169.71	7.24E+14
	Iraq	30,169.71	1.97E+14
372	Ireland	17,453.98	1.03E+14
	Israel	11,128.87	3.27E+13
	Italy	11,128.87	1.16E+14
		11,128.87	5.75E+12
	Côte d'Ivoire Jamaica	20,790.05 1,163.28	3.75E+13 6.59E+12
	Japan	52,149.38	6.67E+13
552		52,145.30	0.072113

		Jordan	27,881.15	2.03E+13
		Kenya Democratic People's Republic of Korea	2,184.28	1.51E+14 2.33E+13
		Republic of Korea	66,046.07	4.35E+13
		Lao People's Democratic Republic	13,660.98	2.52E+13
		Lebanon	11,128.87	1.87E+13
		Latvia	71,378.35	9.95E+12
		Liberia	20,790.05	6.39E+11
		Libyan Arab Jamahiriya Lithuania	11,128.87 71,378.35	5.41E+13 2.24E+13
		Madagascar	7,858.44	9.91E+13
		Malaysia	35,258.65	3.41E+13
		Mali	24,616.72	4.51E+13
		Mauritania	3,826.67	6.91E+12
		Mexico	33,183.89	2.62E+14
		Moldova Montenegro	41,598.53 11,128.87	9.82E+12 7.44E+12
		Morocco	14,955.54	9.90E+13
		Mozambique	7,858.44	4.58E+13
5	516	Oman	30,169.71	4.62E+10
		Namibia	4,613.74	1.13E+13
		Nepal	21,167.69	1.95E+14
		Netherlands New Caledonia	21,195.67 966.37	9.78E+13 7.98E+11
		New Zealand	1,871.56	7.98E+11 2.89E+14
		Nicaragua	3,287.18	1.34E+13
		Niger	20,790.05	3.68E+13
		Nigeria	20,790.05	2.28E+14
		Norway	27,533.82	1.63E+13
		Pakistan	30,169.71	2.49E+15
		Panama Paraguay	3,287.18 5,793.14	6.38E+12 9.22E+13
		Peru	422.52	1.29E+14
		Philippines	30,880.38	1.30E+14
6	516	Poland	71,378.35	1.75E+14
		Portugal	2,682.17	4.74E+13
		Guinea-Bissau	20,790.05	6.93E+12
		Timor-Leste Puerto Rico	5,930.87 1,163.28	1.82E+11 9.16E+12
		Romania	41,598.53	1.16E+14
		Russian Federation	99,924.93	5.42E+13
6	682	Saudi Arabia	58,050.86	5.93E+13
6	586	Senegal	3,826.67	4.68E+13
		Serbia	52,727.40	2.09E+13
		Sierra Leone Slovakia	20,790.05 41,598.53	6.57E+12 1.99E+13
		Viet Nam	13,660.98	5.07E+14
		Slovenia	11,128.87	1.42E+13
7	706	Somalia	32,354.00	5.96E+13
		South Africa	12,472.19	1.25E+14
		Zimbabwe	7,858.44	6.93E+13
		Spain Sudan	13,811.04 27,881.15	2.06E+14 4.27E+14
		Swaziland	7,858.44	4.27E+14 5.39E+12
		Sweden	92,574.02	1.37E+13
		Switzerland	73,923.07	1.16E+13
7	60	Syrian Arab Republic	11,128.87	1.27E+14
		Thailand	21,167.69	3.30E+14
		Togo	20,790.05	9.38E+12
		United Arab Emirates Tunisia	30,169.71 11,128.87	2.31E+10 6.29E+13
		Turkey	11,128.87	4.30E+14
		Uganda	11,128.87	6.18E+13
		Ukraine	41,598.53	2.04E+14
		The FYR of Macedonia	11,128.87	8.19E+12
		Egypt	11,128.87	6.28E+14
		United Kingdom of GB and NI United Republic of Tanzania: Mainland	38,649.65 7,858.44	9.04E+13 1.48E+14
		United States	65,282.46	3.41E+14
		Uruguay	5,793.14	1.02E+14
		Venezuela (Bolivarian Republic of)	1,163.28	2.06E+14
8	887	Yemen	30,169.71	7.41E+13
0		Zambia	7,858.44	5.20E+13



### Table 3.22: Characterisation Factors (CF) and total N emission to groundwater (gw) at country scale.

	Emission:	N to groundwater	
	Resolution scale:	Country	
		CF "N to groundwater"	Emission to gw
	Country Albania	(PAF·)[m <sup>3</sup> ·d/kg] 3,940.04	[kg/yr] 1.81E+14
	Algeria	3,940.04	1.48E+15
	Angola	1,633.44	1.56E+15
	Argentina	2,050.99	5.10E+15
36	Australia	3,901.21	1.38E+16
40	Austria	3,940.04	3.92E+14
	Bahamas	411.84	5.91E+12
	Bangladesh	7,494.15	3.69E+15
	Belgium Bhutan	7,504.06 7,494.15	7.13E+14 3.45E+12
	Bolivia	149.59	1.30E+12
	Bosnia and Herzegovina	3,940.04	1.63E+14
	Botswana	2,782.18	7.38E+14
76	Brazil	2,717.85	1.50E+16
84	Belize	411.84	1.04E+13
	Virgin Islands (British)	411.84	7.40E+10
	Bulgaria	18,667.47	4.67E+14
	Myanmar Belarus	7,494.15 25,270.60	1.21E+15 1.18E+15
	Cambodia	582.67	7.98E+13
	Cameroon	7,360.45	7.65E+14
	Canada	10,852.75	4.81E+15
144	Sri Lanka	7,494.15	4.80E+14
152	Chile	149.59	1.19E+15
	China, People's Republic of	21,204.56	9.12E+16
	Colombia	1,163.78	3.43E+15
	Congo Democratic Republic of the Congo	7,360.45 7,360.45	1.82E+14 8.97E+14
	Costa Rica	1,163.78	2.92E+14
	Croatia	3,940.04	3.89E+14
192		411.84	3.30E+14
	Cyprus	3,940.04	5.24E+13
203	Czech Republic	7,504.06	4.35E+14
	Benin	7,360.45	1.81E+14
	Denmark	33,227.99	6.05E+14
	Dominican Republic	411.84	2.52E+14
	Ecuador El Salvador	751.94 751.94	4.00E+14 1.70E+14
	Equatorial Guinea	7,360.45	1.60E+13
	Ethiopia	20,552.17	4.25E+15
232	Eritrea	9,870.96	3.76E+14
233	Estonia	25,270.60	8.72E+13
	Falkland Islands (Malvinas)	2,050.99	1.47E+13
	Finland	25,270.60	6.15E+14
	France	17,623.45	4.59E+15
	Djibouti Gabon	10,681.20 7,360.45	1.50E+13 1.11E+14
	Georgia	14,727.43	3.92E+14
	Gambia	7,360.45	2.52E+13
	Germany	32,774.65	4.09E+15
	Ghana	7,360.45	3.76E+14
	Greece	3,940.04	8.59E+14
	Guatemala	1,163.78	4.52E+14
	Guinea	7,360.45	3.86E+14
	Guyana	1,593.52	-4.51E+12
332 340	Haiti Honduras	411.84 411.84	2.04E+14 5.30E+14
	Hungary	14,727.43	7.03E+14
	Iceland	534.63	7.25E+13
	India	18,175.36	5.02E+16
360	Indonesia	2,099.75	4.43E+15
	Iran, Islamic Republic of	10,681.20	5.57E+15
368		10,681.20	1.19E+15
	Ireland	6,179.36	1.47E+15
	Israel	3,940.04	2.29E+14
380	Italy Kosovo	3,940.04 3,940.04	4.38E+14 5.95E+13
	Côte d'Ivoire	7,360.45	5.95E+13 5.21E+14
204		411.84	5.22E+13
388	Jamaica	411.04	5.220.15

w r]	404	Jordan Kenya	9,870.96 773.32	1.10E+14 1.80E+15
		- 1-		
r]		Democratic People's Republic of Korea	23,382.77	7.99E+14
	410	Republic of Korea	23,382.77	1.58E+15
.4	418	Lao People's Democratic Republic	4,836.50	3.58E+14
.5		Lebanon	3,940.04	1.34E+14
.5		Latvia	25,270.60	1.63E+14
5		Liberia	7,360.45	3.52E+13
.6		Libyan Arab Jamahiriya Lithuania	3,940.04 25,270.60	5.20E+14 3.87E+14
2		Madagascar	2,782.18	1.18E+15
.5		Malaysia	12,482.88	8.75E+14
4		Mali	8,715.24	1.36E+15
2	478	Mauritania	1,354.78	4.38E+14
5		Mexico	11,748.33	7.04E+15
4		Moldova	14,727.43	6.42E+13
.4		Montenegro	3,940.04	7.69E+13
.6		Morocco	5,294.82 2,782.18	1.79E+15 1.14E+15
10		Mozambique Oman	10,681.20	4.75E+12
4		Namibia	1,633.44	5.99E+14
15		Nepal	7,494.15	8.73E+14
15		Netherlands	7,504.06	9.02E+14
3		New Caledonia	342.13	1.93E+13
.4		New Zealand	662.60	2.94E+15
15		Nicaragua	1,163.78	2.32E+14
L4 L5		Niger	7,360.45 7,360.45	6.09E+14 2.59E+15
16		Nigeria Norway	9,748.00	4.57E+14
15		Pakistan	10,681.20	4.37E+14 1.02E+16
4		Panama	1,163.78	1.84E+14
4	600	Paraguay	2,050.99	9.35E+14
4	604	Peru	149.59	1.56E+15
4	608	Philippines	10,932.80	1.71E+15
4		Poland	25,270.60	2.09E+15
13		Portugal	949.59	3.94E+14
L4 L4		Guinea-Bissau Timor-Leste	7,360.45 2,099.75	6.47E+13 1.22E+13
4		Puerto Rico	411.84	8.27E+13
4		Romania	14,727.43	1.15E+15
4		Russian Federation	35,377.15	8.48E+15
4	682	Saudi Arabia	20,552.17	1.71E+15
3		Senegal	1,354.78	5.44E+14
15		Serbia	18,667.47	4.32E+14
L4 L3		Sierra Leone Slovakia	7,360.45 14,727.43	1.01E+14 2.33E+14
13	703	Viet Nam	4,836.50	3.09E+15
4		Slovenia	3,940.04	1.75E+14
15		Somalia	11,454.52	2.04E+15
3	710	South Africa	4,415.62	3.89E+15
4	716	Zimbabwe	2,782.18	1.00E+15
4		Spain	4,889.62	4.29E+15
13		Sudan	9,870.96	6.28E+15
15 14		Swaziland Sweden	2,782.18 32,774.65	5.66E+13 4.31E+14
.4		Switzerland	26,171.52	4.31E+14 3.14E+14
.4		Syrian Arab Republic	3,940.04	1.03E+15
4		Thailand	7,494.15	2.70E+15
2		Тодо	7,360.45	1.52E+14
4		United Arab Emirates	10,681.20	2.35E+12
4		Tunisia	3,940.04	5.58E+14
4		Turkey	3,940.04	4.85E+15
3		Uganda	3,940.04	7.54E+14
L6		Ukraine The FYR of Macedonia	14,727.43 3,940.04	2.10E+15 1.32E+14
15		Egypt	3,940.04	3.02E+14
15		United Kingdom of GB and NI	13,683.42	2.81E+15
15		United Republic of Tanzania: Mainland	2,782.18	1.87E+15
4		United States	23,112.42	4.22E+16
4		Uruguay	2,050.99	1.23E+15
		Venezuela (Bolivarian Republic of)	411.84	1.90E+15
3			10 001 30	7 1 2 5 - 1 4
	887	Yemen Zambia	10,681.20 2,782.18	7.13E+14 9.74E+14



**Table 3.23:** Characterisation Factors (CF) and total N emission directly to marine costal waters (mw) at country scale.

141

	Emission: Resolution scale:	N to marine water	
	Resolution state.	CF "N to marine water"	Emission to mw
ISO #	Country	(PAF·)[m <sup>3</sup> ·d/kg]	[kg/yr]
8	Albania	23,528.27	n/a
	Algeria	23,528.27	n/a
	Angola	9,754.22	n/a
	Argentina Australia	12,247.66 23,296.40	n/a n/a
	Austria	23,528.27	n/a
44	Bahamas	2,459.37	n/a
50	Bangladesh	44,752.00	n/a
	Belgium	44,811.14	n/a
	Bhutan Bolivia	44,752.00 893.27	n/a n/a
	Bosnia and Herzegovina	23,528.27	n/a
	Botswana	16,614.04	n/a
76	Brazil	16,229.90	n/a
	Belize	2,459.37	n/a
	Virgin Islands (British)	2,459.37	n/a
	Bulgaria Myanmar	111,474.42 44,752.00	n/a n/a
	Belarus	150,905.61	n/a
	Cambodia	3,479.44	n/a
120	Cameroon	43,953.59	n/a
	Canada	64,808.16	n/a
	Sri Lanka	44,752.00	n/a
	Chile China, People's Republic of	893.27 126,624.94	n/a n/a
	Colombia	6,949.63	n/a
178	Congo	43,953.59	n/a
180	Democratic Republic of the Congo	43,953.59	n/a
	Costa Rica	6,949.63	n/a
	Croatia	23,528.27	n/a
	Cuba Cyprus	2,459.37 23,528.27	n/a n/a
	Czech Republic	44,811.14	n/a
	Benin	43,953.59	n/a
208	Denmark	198,423.91	n/a
	Dominican Republic	2,459.37	n/a
	Ecuador El Salvador	4,490.26 4,490.26	n/a n/a
	Equatorial Guinea	43,953.59	n/a
	Ethiopia	122,729.09	n/a
	Eritrea	58,945.34	n/a
	Estonia	150,905.61	n/a
	Falkland Islands (Malvinas) Finland	12,247.66 150,905.61	n/a
	France	105,240.00	n/a n/a
	Djibouti	63,783.75	n/a
266	Gabon	43,953.59	n/a
	Georgia	87,946.16	n/a
	Gambia	43,953.59	n/a
	Germany Ghana	195,716.75 43,953.59	n/a n/a
	Greece	23,528.27	n/a
	Guatemala	6,949.63	n/a
324	Guinea	43,953.59	n/a
	Guyana	9,515.83	n/a
	Haiti	2,459.37	n/a
	Honduras Hungary	2,459.37 87,946.16	n/a n/a
	Iceland	3,192.60	n/a
	India	108,535.75	n/a
	Indonesia	12,538.84	n/a
	Iran, Islamic Republic of	63,783.75	n/a
	Iraq	63,783.75 36,900.59	n/a n/a
	Ireland Israel	23,528.27	n/a n/a
	Italy	23,528.27	n/a
	Kosovo	23,528.27	n/a
	Côte d'Ivoire	43,953.59	n/a
	Jamaica	2,459.37	n/a
392	Japan	110,252.38	n/a

	lordan	E8 04E 24	n/2
400 404	Jordan Kenya	58,945.34 4,617.93	n/a n/a
408	Democratic People's Republic of Korea	139,632.29	n/a
410	Republic of Korea	139,632.29	n/a
	Lao People's Democratic Republic	28,881.56	n/a
	Lebanon	23,528.27	n/a
	Latvia Liberia	150,905.61 43,953.59	n/a n/a
	Libyan Arab Jamahiriya	23,528.27	n/a
	Lithuania	150,905.61	n/a
450	Madagascar	16,614.04	n/a
	Malaysia	74,542.60	n/a
	Mali	52,043.81	n/a
	Mauritania Mexico	8,090.22 70,156.21	n/a n/a
	Moldova	87,946.16	n/a
	Montenegro	23,528.27	n/a
508	Morocco	31,618.48	n/a
512	Mozambique	16,614.04	n/a
516	Oman	63,783.75	n/a
	Namibia Nepal	9,754.22 44,752.00	n/a n/a
	Netherlands	44,752.00	n/a
999	New Caledonia	2,043.07	n/a
554	New Zealand	3,956.78	n/a
558	Nicaragua	6,949.63	n/a
	Niger	43,953.59	n/a
	Nigeria	43,953.59 58,211.03	n/a
	Norway Pakistan	63,783.75	n/a n/a
	Panama	6,949.63	n/a
	Paraguay	12,247.66	n/a
604	Peru	893.27	n/a
608	Philippines	65,286.21	n/a
	Poland	150,905.61	n/a
	Portugal Guinea-Bissau	5,670.55 43,953.59	n/a n/a
	Timor-Leste	12,538.84	n/a
	Puerto Rico	2,459.37	n/a
642	Romania	87,946.16	n/a
643	Russian Federation	211,257.79	n/a
	Saudi Arabia	122,729.09	n/a
686	Senegal Serbia	8,090.22	n/a
	Sierra Leone	111,474.42 43,953.59	n/a n/a
	Slovakia	87,946.16	n/a
704	Viet Nam	28,881.56	n/a
705	Slovenia	23,528.27	n/a
	Somalia	68,401.68	n/a
710	South Africa Zimbabwe	26,368.26 16,614.04	n/a n/a
	Spain	29,198.82	n/a
	Sudan	58,945.34	n/a
748	Swaziland	16,614.04	n/a
	Sweden	195,716.75	n/a
	Switzerland	156,285.57	n/a
	Syrian Arab Republic Thailand	23,528.27 44,752.00	n/a n/a
	Тодо	44,752.00	n/a
	United Arab Emirates	63,783.75	n/a
	Tunisia	23,528.27	n/a
	Turkey	23,528.27	n/a
	Uganda	23,528.27	n/a
	Ukraine The FYR of Macedonia	87,946.16	n/a n/a
807 818	Egypt	23,528.27 23,528.27	n/a n/a
	United Kingdom of GB and NI	81,711.73	n/a
	United Republic of Tanzania: Mainland	16,614.04	n/a
840	United States	138,017.88	n/a
	Uruguay	12,247.66	n/a
	Venezuela (Bolivarian Republic of)	2,459.37	n/a
887 894	Yemen Zambia	63,783.75 16,614.04	n/a n/a
894 =143		_ 5,61 1.04	.,,,,,

n=143





### Appendix 3-XIII: Aggregation of Characterisation Factors

**Table 3.24:** Characterisation Factors (CF) for the emission route "N to air" aggregated to the Region/Continent and Global scales.

142

	Emission:	N to air		Emission:	N to air	
	Resolution scale:	Regional/Continental		Resolution scale:	Global	
		CF "N to air"	Emission to air		CF "N to air"	Emission to air
Reg. Code	Region/Continent	(PAF·)[m <sup>3</sup> ·d/kg]	[kg/yr]	Reg. Code Region/Continent	(PAF·)[m3·d/kg]	[kg/yr]
EU27	Europe (EU27)	15,005.26	6.14E+09	w World default	7,051.54	7.45E+10
EUR51	Europe (EUR51)	10,414.54	1.12E+10	n=1		
WE	Western Europe	14,575.96	6.54E+09			
EE	Eastern Europe	6,747.80	5.57E+09			
ME	Middle East	12,758.75	1.73E+09			
SAS	South Asia	11,095.47	7.52E+09			
SEA	Southeast Asia	8,674.59	2.95E+09			
EAS	East Asia	7,944.22	1.51E+10			
0	Oceania	666.46	1.68E+09			
AF	Africa	7,769.90	1.22E+10			
NA	North America	1,947.11	9.99E+09			
CA	Central America	4,016.43	1.77E+09			
SA	South America	1,968.62	9.41E+09			
n=13						

**Table 3.25:** Characterisation Factors (CF) for the emission route "N to surface freshwater (sfw)" aggregated to the Region/Continent and Global scales.

	Emission:	N to freshwater			Emission:	N to freshwater	
	Resolution scale:	Regional/Continental			Resolution scale:	Global	
		CF "N to freshwater"	Emission to fw			CF "N to freshwater"	Emission to fw
Reg. Code	Region/Continent	(PAF·)[m <sup>3</sup> ·d/kg]	[kg/yr]	Reg. Code	Region/Continent	(PAF·)[m <sup>3</sup> ·d/kg]	[kg/yr]
EU27	Europe (EU27)	39,581.60	1.64E+15	w	World default	33,429.28	2.47E+16
EUR51	Europe (EUR51)	36,263.18	2.41E+15	n=1			
WE	Western Europe	38,552.73	1.77E+15				
EE	Eastern Europe	32,724.77	8.39E+14				
ME	Middle East	28,747.94	1.25E+15				
SAS	South Asia	43,770.98	8.06E+15				
SEA	Southeast Asia	14,301.38	1.94E+15				
EAS	East Asia	59,860.93	3.23E+15				
0	Oceania	3,724.61	3.64E+14				
AF	Africa	17,201.61	3.16E+15				
NA	North America	59,638.59	4.08E+14				
CA	Central America	16,794.27	5.47E+14				
SA	South America	9,807.03	3.12E+15				

n=13





**Table 3.26:** Characterisation Factors (CF) for the emission route "N to groundwater (gw)" aggregated to theRegion/Continent and Global scales.

	Emission:	N to groundwater	
	Resolution scale:	Regional/Continental	
		CF "N to groundwater"	Emission to gw
Reg. Code	Region/Continent	(PAF·)[m <sup>3</sup> ·d/kg]	[kg/yr]
EU27	Europe (EU27)	16,289.49	2.86E+16
EUR51	Europe (EUR51)	18,462.31	4.58E+16
WE	Western Europe	15,888.06	3.08E+16
EE	Eastern Europe	22,653.36	1.71E+16
ME	Middle East	11,372.39	1.07E+16
SAS	South Asia	16,702.07	6.18E+16
SEA	Southeast Asia	5,875.60	1.45E+16
EAS	East Asia	21,185.19	9.61E+16
0	Oceania	3,327.48	1.68E+16
AF	Africa	7,012.16	4.52E+16
NA	North America	21,859.17	4.70E+16
CA	Central America	8,620.22	9.84E+15
SA	South America	2,490.05	3.58E+16
n=13			

	Emission:	N to groundwater	
	Resolution scale:	Global	
		CF "N to groundwater"	Emission to gw
Reg. Code	Region/Continent	(PAF·)[m3·d/kg]	[kg/yr]
w	World default	14,850.38	3.86E+17
n=1			

**Table 3.27:** Characterisation Factors (CF) for the emission route "N to marine costal waters (mw)" aggregated to the Region/Continent and Global scales.

Emission	N to marine water		Emission	N to marine water	
<b>Resolution scale</b>	Regional/Continental		Resolution scale	e: Global	
	CF "N to marine water"	Emission to mw		CF "N to marine water"	Emission to my
Reg. Code Region/Continent	(PAF·)[m <sup>3</sup> ·d/kg]	[kg/yr]	Reg. Code Region/Continent	(PAF·)[m3·d/kg]	[kg/yr
EU27 Europe (EU27)	n/a	n/a	w World default	n/a	n/a
EUR51 Europe (EUR51)	n/a	n/a	n=1		
WE Western Europe	n/a	n/a			
EE Eastern Europe	n/a	n/a			
ME Middle East	n/a	n/a			
sas South Asia	n/a	n/a			
SEA Southeast Asia	n/a	n/a			
EAS East Asia	n/a	n/a			
0 Oceania	n/a	n/a			
AF Africa	n/a	n/a			
NA North America	n/a	n/a			
CA Central America	n/a	n/a			
SA South America	n/a	n/a			

n=13

n/a: CF and NR not available as no country emissions of sewage water directly to coastal marine waters are available





#### **Appendix 3-XIV: Normalisation**

Table 3.28: Normalisation References (NR) and population considered at the Country-to-LME scale.

Resolution scale:

Country te J.M. Albania to LME25, Mediterranean Angola to LME26, Mediterranean Angola to LME29, Bengula Gurrent Angola to LME29, Bengula Gurrent Australia to LME29, North Australia Australia to LME20, Northest Justralia Australia to LME23, Southest Australia Australia to LME23, Southest Australia Australia to LME23, Southest Australia Australia to LME23, Southest Australia Australia to LME20, Carribban Sea Bangadach to LME22, North Sea Binglanto LME22, North Sea Biolivia to LME24, May of Bengal Bolivia to LME21, May of Bengal Bolivia to LME21, May of Bengal	NR, [PAF-](m <sup>1</sup> -d/(person.yr)] 7.55F+10 6.80F+10 3.70F+10 1.04F+11 9.15F+10	Population [person] 3,141,800 32,888,449 16,489,021	42: 421	Lao People's Democratic Republic to LME#36. South China Sea Lebanon to LME#26. Mediterranean Latvia to LME#23. Baltic Sea	9.24E+10 6.54E+10 5.02E+11	5,75 4,05 2,30
Ageria To LMEEZ. Mediterronen Angola to LMEEZ. Mediterronen Angola to LMEEZ. Medita Artagonian Sheff Australia to LMEES. North Australia Australia to LMEES. Southast Australia Australia to LMEES. Southast Australia Australia to LMEES. Southast Australia Australia to LMEES. Southast Australia Australia to LMEES. Mediterronen Bahamas to LMEES. Mediterronen Bahamas to LMEES. And Median Sas Bangladen to LMEES. And Sag Bangladen to LMEES. And Sag Bahamas to LMEES. Ang Bahamas to L	6.80E+10 3.70E+10 1.04E+11	32,888,449 16,489,021	421	Latvia to LME#23. Baltic Sea	5.02E+11	
Anggla Eu UMEE29. Bengulad Current Argentina to UMEE4, Antagonian Shef Australia to UMEE40. Antagonian Shef Australia to UME893. North Australia Australia to UMEE41. East-Central Australia Australia to UMEE43. Southeest Australia Australia to UME843. Southeest Australia Australia to UME843. Southeest Australia Australia to UME843. Meet-Central Australia Australia to UME843. Meet-Central Australia Australia to UME843. Meet-Central Australia Bahamsto LUME812. Caribbean Sea Banjadech to UME842. Averd Bengal Belgium to UME823. Nerdheest Bulata to UME843. Humboldt Current	3.70E+10 1.04E+11	16,489,021				
Australia to LMEB30. North Australia Australia to LMEB40. Northesst Australia Australia to LMEB41. East-Central Australia Australia to LMEB41. East-Central Australia Australia to LMEB43. Southesst Australia Australia to LMEB43. Southesst Australia Australia to LMEB45. Northwest Australia Baharas to LMEB45. Northwest Australia Baharas to LMEB45. Australia Sengal Baharas to LMEB43. Bay of Bengal Bidgium to LMEB48. Bay of Bengal Biduia to LMEB48. Hawy of Bengal Biduia to LMEB48. Hawy of Bengal			431	Liberia to LME#28. Guinea Current	1.30E+10	3,18
Australia to LMEBAD. Northesis Australia Australia to LMEBAL East-Central Australia Australia to LMEBAL East-Central Australia Australia to LMEBAL Southesis Australia Australia to LMEBAL Weis-Central Australia Australia to LMEBAL Weis-Central Australia Bahamsis to LMEBAL Caribbean Sea Dangladech to LMEBAL. Buy of Bengal Belgum to LMEBAL. Numbolit Current		38,681,174		Libyan Arab Jamahiriya to LME#26. Mediterranean	1.43E+11	5,76
Australia to UMERA2. Southeest Australia Australia to UMERA3. Southeest Australia Australia to UMERA5. Nertheest Australia Australia to UMERA5. Nertheest Australia Australia to UMERA2. Caribbean Sea Bandareh to UMERA2. Ray of Bengal Belgium to UMERA2. Nordh Sea Bihuat no LOHERA3. Bay of Bengal Bihuat no LOHERA3. Bay of Bengal Bihuat no LOHERA3.	2.86E+10	2,914,789	440	Lithuania to LME#23. Baltic Sea Madagascar to LME#30. Agulhas Current	7.79E+11 6.35E+10	3,41 17,88
Australia to UMER43. Southwest Australia Australia to UMER44. West-Central Australia Australia to UMER56. Northwest Australia Australia to UMER56. Mediterranean Bahamas to UMER56. Bay of Bengal Belgium to UMER54. Bay of Bengal Buluan to UMER34. Bay of Bengal Buluan to UMER34. Bay of Bengal Buluan to UMER34. Bay of Bengal	3.12E+10	2,914,789		Malaysia to LME#34. Bay of Bengal	5.49E+10	8,70
Australia to UMEMA. West-Contral Australia Australia to UMEMAS. Northwest Australia Australia to UMERZS. Mediterranean Baharasto LUMERIZ. Caribbean Sea Bangladeh to UMERIZ. North Sea Balguia to UMERIZ. North Sea Butuan to UMERIZ. North Sea Butuan to UMERIZ. North Sea Butuan to UMERIZ. North Sea	4.83E+10	2,914,789		Malaysia to LME#35. Gulf of Thailand	1.11E+09	8,70
Australia to UMERS, Northwest Australia Australia to UMERS /. Mediternanea Baharas to UMERIZ. Caritobean Sea Bangladesh to UMERIZ. North Sea Birutan to UMERIZ. North Sea Birutan to UMERIZ. North Sea Birutan to UMERIZ. North Sea	4.63E+10 3.54E+10	2,914,789		Malaysia to LME#36. South China Sea	3.54E+10	8,70
Bahamas to LME#12. Caribbean Sea Bangladesh to LME#34. Bay of Bengal Belgium to LME#22. North Sea Bhutan to LME#24. Bay of Bengal Bolivia to LME#13. Humboldt Current	3.54E+10 4.46E+10	2,914,789 2,914,789	461	Mali to LME#27. Canary Current Mali to LME#28. Guinea Current	2.83E+10 1.54E+11	6,51
Bangladesh to LME#34. Bay of Bengal Belgium to LME#22. North Sea Bhutan to LME#34. Bay of Bengal Bolivia to LME#13. Humboldt Current	7.55E+10	8,232,196		Mauritania to LME#27. Canary Current	2.98E+10	3,0
Belgium to LME#22. North Sea Bhutan to LME#34. Bay of Bengal Bolivia to LME#13. Humboldt Current	5.75E+09 1.68E+11	319,358 140,587,922	484	Mexico to LME#3. California Current	8.23E+09	35,4
Bhutan to LME#34. Bay of Bengal Bolivia to LME#13. Humboldt Current	1.68E+11 2.48E+11	140,587,922		Mexico to LME#4. Gulf of California Mexico to LME#5. Gulf of Mexico	7.87E+10 7.89E+10	35,4 35,4
	5.50E+09	659,293	491	Moldova to LME#62. Black Sea	1.36E+11	3,7
Bosnia and Herzegovina to LME#26. Mediterranean	6.98E+09	9,146,655		Montenegro to LME#26. Mediterranean	1.84E+11	6
Botswana to LME#30. Agulhas Current	5.82E+10 2.62E+11	3,781,001 1,875,673	504	Morocco to LME#26. Mediterranean Morocco to LME#27. Canary Current	6.13E+10 2.11E+10	15,1 15,1
Brazil to LME#15. South Brazil Shelf	2.62E+11 1.44E+10	61,995,655	501	Morambique to LME#30. Agulhas Current	3.38E+10	20,7
Brazil to LME#16. East Brazil Shelf	6.26E+09	61,995,655	513	Oman to LME#32. Arabian Sea	2.84E+09	2,4
Brazil to LME#17. North Brazil Shelf	2.93E+10	61,995,655		Namibia to LME#29. Benguela Current	7.61E+10	2,0
Belize to LME#12. Caribbean Sea Virgin Islands (British) to LME#12. Caribbean Sea	9.26E+09 1.95E+08	280,947 21,990	524 521	Nepal to LME#34. Bay of Bengal Netherlands to LME#22. North Sea	1.77E+11 1.72E+11	27,2 16,3
Bulgaria to LME#26. Mediterranean	4.77E+10	3,869,558		New Caledonia to LME#40. Northeast Australia	6.44E+09	10,2
Bulgaria to LME#62. Black Sea	1.78E+11	3,869,558		New Zealand to LME#46. New Zealand Shelf	1.82E+11	4,1
Myanmar to LME#34. Bay of Bengal	1.08E+11	46,321,162	554	Nicaragua to LME#11. Pacific Central-American	8.73E+09	2,7
Belarus to LME#23. Baltic Sea Cambodia to LME#3. California Current	9.35E+11 4.84E+08	9,825,102 13,357,574	56	Nicaragua to LME#12. Caribbean Sea	4.78E+09 9.63E+10	2,7
Cameroon to LME#28. Guinea Current	4.84E+08 1.18E+11	17,553,589		Nigeria to LME#28. Guinea Current	4.86E+10	12,9
Canada to LME#2. Gulf of Alaska	2.61E+10	6,456,683		Norway to LME#21. Norwegian Sea	4.64E+10	2,3
Canada to LME#63. Hudson Bay	6.33E+10	6,456,683		Norway to LME#22. North Sea	1.55E+11 5.49E+11	2,3
Canada to LME#9. Newfoundland-Labrador Shelf Canada to LME#8. Scotian Shelf	1.91E+10 1.28E+11	6,456,683 6,456,683		Pakistan to LME#32. Arabian Sea Panama to LME#11. Pacific Central-American	5.49E+11 8.82E+09	158,6
Canada to LME#64. Arctic Ocean	1.83E+09	6,456,683		Panama to LME#12. Caribbean Sea	4.83E+09	1,6
Sri Lanka to LME#34. Bay of Bengal	1.02E+11	19,842,536		Paraguay to LME#14. Patagonian Shelf	1.26E+11	5,8
Chile to LME#13. Humboldt Current China, People's Republic of to LME#36. South China Sea	4.36E+09 7.02E+10	16,301,726 428,274,369		Peru to LME#13. Humboldt Current	2.89E+09	27,5
China, People's Republic of to LME#36. South China Sea China, People's Republic of to LME#47. East China Sea	7.02E+10 6.39E+10	428,274,369 428,274,369	601	Philippines to LME#36. South China Sea Philippines to LME#37. Sulu-Celebes Sea	3.12E+10 3.93E+10	42,7 42,7
China, People's Republic of to LME#48. Yellow Sea	1.74E+11	428,274,369	610	Poland to LME#23. Baltic Sea	4.78E+11	38,3
Colombia to LME#11. Pacific Central-American	1.55E+10	21,520,279	620		1.59E+10	10,5
Colombia to LME#12. Caribbean Sea Congo to LME#28. Guinea Current	8.47E+09 7.70E+10	21,520,279 3,533,177	624		1.43E+11 3.83E+09	1,3 1,0
Democratic Republic of the Congo to LME#28. Guinea Curre		57,420,522		Puerto Rico to LME#12. Caribbean Sea	3.79E+09	3,7
Costa Rica to LME#11. Pacific Central-American	1.37E+10	2,154,707	643	Romania to LME#62. Black Sea	3.06E+11	21,7
Costa Rica to LME#12. Caribbean Sea	7.52E+09	2,154,707	64	Russian Federation to LME#20. Barents Sea	1.31E+10	13,0
Croatia to LME#26. Mediterranean Cuba to LME#12. Caribbean Sea	1.06E+11 6.26E+09	4,441,986 11.254,242		Russian Federation to LME#54. Chukchi Sea Russian Federation to LME#56. East Siberian Sea	9.02E+09 4.71E+09	13,0 13.0
Cyprus to LME#26. Mediterranean	1.67E+11	758,000		Russian Federation to LME#57. Laptev Sea	1.79E+10	13,0
Czech Republic to LME#22. North Sea	9.70E+10	10,220,638		Russian Federation to LME#58. Kara Sea	1.37E+10	13,0
Benin to LME#28. Guinea Current	8.05E+10	7,633,757		Russian Federation to LME#62. Black Sea	1.10E+11	13,0
Denmark to LME#22. North Sea Denmark to LME#23. Baltic Sea	1.84E+11 6.21E+11	1,806,481 1,806,481		Russian Federation to LME#64. Arctic Ocean Russian Federation to LME#50. Sea of Japan/East Sea	6.20E+08 5.23E+10	13,0 13.0
Denmark to LME#60. Faroe Plateau	1.11E+10	1,806,481		Russian Federation to LME#51. Oyashio Current	6.59E+09	13,0
Dominican Republic to LME#12. Caribbean Sea	5.74E+09	9,264,267		Russian Federation to LME#52. Sea of Okhotsk	3.17E+10	13,0
Ecuador to LME#11. Pacific Central-American	1.50E+10	13,426,402		Russian Federation to LME#53. West Bering Sea	4.31E+09	13,0
El Salvador to LME#11. Pacific Central-American Equatorial Guinea to LME#28. Guinea Current	1.03E+10 4.39E+10	6,050,513 607,739	683	Saudi Arabia to LME#32. Arabian Sea Saudi Arabia to LME#33. Red Sea	1.57E+11 1.45E+11	12,0 12,0
Ethiopia to LME#32. Arabian Sea	1.35E+11	37,131,931	684	Senegal to LME#27. Canary Current	2.38E+10	10,8
Ethiopia to LME#33. Red Sea	1.25E+11	37,131,931	681		2.10E+11	3,7
Eritrea to LME#33. Red Sea Estonia to LME#23. Baltic Sea	2.34E+11 5.14E+11	4,486,155 1.345.857		Serbia to LME#26. Mediterranean Sierra Leone to LME#28. Guinea Current	5.61E+10 4.21E+10	3,7
Falkland Islands (Malvinas) to LME#14. Patagonian Shelf	1.47E+12	3,140		Slovakia to LME#62. Black Sea	2.21E+11	5,4
Finland to LME#23. Baltic Sea	8.93E+11	5,244,342		Viet Nam to LME#36. South China Sea	1.03E+11	83,1
France to LME#22. North Sea	9.40E+10	20,945,479		Slovenia to LME#26. Mediterranean	1.16E+11	2,0
France to LME#24. Celtic-Biscay Shelf France to LME#26. Mediterranean	7.74E+10 4.94E+10	20,945,479 20,945,479	70	Somalia to LME#31. Somali Coastal Current Somalia to LME#32. Arabian Sea	3.61E+10 4.98E+11	4,:
Djibouti to LME#32. Arabian Sea	2.89E+10	808,367	710	South Africa to LME#29. Benguela Current	2.65E+10	23.8
Gabon to LME#28. Guinea Current	1.34E+11	1,370,729		South Africa to LME#30. Agulhas Current	4.51E+10	23,8
Georgia to LME#62. Black Sea	6.72E+11	4,477,006		Zimbabwe to LME#30. Agul has Current	6.74E+10	12,
Gambia to LME#28. Guinea Current Germany to LME#22. North Sea	5.37E+10 7.89E+10	1,503,678 41,270,370	724	Spain to LME#25. Iberian Coastal Spain to LME#26. Mediterranean	3.24E+11 1.34E+12	1,5 1,5
Germany to LME#23. Baltic Sea	2.66E+11	41,270,370	734	Sudan to LME#33. Red Sea	4.85E+11	38,4
Ghana to LME#28. Guinea Current	3.65E+10	21,639,806		Swaziland to LME#30. Agulhas Current	5.38E+10	1,:
Greece to LME#26. Mediterranean	7.19E+10	11,183,114	75	Sweden to LME#23. Baltic Sea	2.39E+11	4,5
Guatemala to LME#11. Pacific Central-American Guatemala to LME#12. Caribbean Sea	8.42E+09 4.61E+09	6,358,577 6,358,577	75.	Sweden to LME#22. North Sea Switzerland to LME#22. North Sea	7.10E+10 6.75E+10	4,5
Guinea to LME#28. Guinea Current	4.61E+09 1.03E+11	9,041,448	/54	Switzerland to LME#22. North Sea Switzerland to LME#26. Mediterranean	3.54E+10	2,4
Guyana to LME#17. North Brazil Shelf	3.28E+10	746,235		Switzerland to LME#62. Black Sea	1.32E+11	2,4
Haiti to LME#12. Caribbean Sea Honduras to LME#12. Caribbean Sea	5.02E+09 1.32E+10	9,347,262 6,879,243		Syrian Arab Republic to LME#26. Mediterranean Thailand to LME#34. Bay of Bengal	1.00E+11 1.37E+11	18,4 66,6
Honduras to LME#12. Caribbean Sea Hungary to LME#62. Black Sea	1.32E+10 3.49E+11	6,879,243 10,086,936		Thailand to LME#34. Bay of Bengal Togo to LME#28. Guinea Current	1.37E+11 5.85E+10	66,6 5,4
Iceland to LME#59. Iceland Shelf	2.93E+10	296,743		United Arab Emirates to LME#32. Arabian Sea	8.41E+08	4,0
India to LME#32. Arabian Sea	1.91E+11	570,021,432		Tunisia to LME#26. Mediterranean	9.46E+10	9,9
India to LME#34. Bay of Bengal Indonesia to LME#38. Indonesian Sea	1.34E+11 2.34E+10	570,021,432 227,303,175		Turkey to LME#26. Mediterranean Uganda to LME#26. Mediterranean	1.01E+11 3.55E+10	68,1 28,4
Iran, Islamic Republic of to LME#32. Arabian Sea	2.34E+10 4.06E+11	69,732,007		Ukraine to LME#62. Black Sea	2.52E+11	28,4 46,9
Iraq to LME#32. Arabian Sea	2.68E+11	27,359,461	80	The FYR of Macedonia to LME#26. Mediterranean	7.24E+10	2,0
Ireland to LME#24. Celtic-Biscay Shelf Israel to LME#26. Mediterranean	6.72E+11 6.98E+10	4,158,042 6,604,572		Egypt to LME#26. Mediterranean	1.12E+11 6.98E+10	74,2
Israel to LME#26. Mediterranean Italy to LME#26. Mediterranean	6.98E+10 2.52E+10	6,604,572 58,671,206	821	United Kingdom of GB and NI to LME#22. North Sea United Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf	6.98E+10 5.75E+10	30,1 30,1
Kosovo to LME#26. Mediterranean	3.70E+10	2,415,383	834	United Republic of Tanzania: Mainland to LME#30. Agulhas Current	4.57E+10	30,1
Côte d'Ivoire to LME#28. Guinea Current	6.63E+10	18,020,946		United States to LME#1. East Bering Sea	7.54E+10	29,6
Jamaica to LME#12. Caribbean Sea	3.73E+09	2,681,653		United States to LME#2. Gulf of Alaska	2.22E+10	29,6
Japan to LME#47. East China Sea Japan to LME#49. Kuroshio Current	1.63E+10 7.03E+09	25,278,589 25,278,589		United States to LME#3. California Current United States to LME#4. Gulf of California	1.09E+10 1.04E+11	29,6 29,6
Japan to LME#49. Kurosnio Current Japan to LME#50. Sea of Japan/East Sea	2.59E+10	25,278,589		United states to LME#4. Guit of California United States to LME#5. Gulf of Mexico	1.04E+11 1.04E+11	29,6
Japan to LME#51. Oyashio Current	3.26E+09	25,278,589		United States to LME#6. Southeast U.S. Continental Shelf	1.34E+10	29,6
Japan to LME#52. Sea of Okhotsk	1.57E+10	25,278,589		United States to LME#7. Northeast U.S. Continental Shelf	4.33E+10	29,6
Jordan to LME#33. Red Sea Kenya to LME#31. Somali Coastal Current	1.28E+11 1.35E+10	5,342,002 35,614,576		United States to LME#10. Insular Pacific-Hawaiian United States to LME#54. Chukchi Sea	3.69E+09 2.26E+10	29,6 29,6
Kenya to LME#31. Somali Coastal Current Democratic People's Republic of Korea to LME#47. East Chin		35,614,576 7,920,217		United States to LME#54. Chukchi Sea United States to LME#55. Beaufort Sea	2.26E+10 3.17E+10	29,6 29,6
Democratic People's Republic of Korea to LME#48. Yellow S	ea 7.67E+10	7,920,217		Uruguay to LME#14. Patagonian Shelf	2.60E+11	3,3
Democratic People's Republic of Korea to LME#50. Sea of Ja		7,920,217		Venezuela (Bolivarian Republic of) to LME#12. Caribbean Sea	1.22E+10	26,6
Republic of Korea to LME#47. East China Sea Republic of Korea to LME#48. Yellow Sea	2.75E+10 7.47E+10	15,681,375 15,681,375	883	Yemen to LME#32. Arabian Sea Zambia to LME#30. Agulhas Current	1.48E+11 6.13E+10	20,6





### **Table 3.29:** Normalisation References (NR) and population considered at the Country scale.

				40
	Resolution scale:	Country NR;	Population	4
ISO #	Country	(PAF·)[m <sup>3</sup> ·d/(person.yr)]	[person]	4
8	Albania	7.66E+10	3,141,800	4
12	Algeria	6.80E+10	32,888,449	4
24	Angola	3.70E+10	16,489,021	4
	Argentina Australia	1.04E+11 3.26E+11	38,681,174 20,403,520	43
36 40	Austria	7.55E+10	8,232,196	4
	Bahamas	5.83E+09	319,358	4
50		1.68E+11	140,587,922	4
56	Belgium	2.48E+11	10,414,209	44
64	Bhutan	5.65E+09	659,293	4
68		6.98E+09	9,146,655	4
	Bosnia and Herzegovina	5.82E+10	3,781,001	49
	Bots wana	2.62E+11	1,875,673	50
76 84	Brazil Belize	4.99E+10 9.26E+09	185,986,964 280,947	50
92	Virgin Islands (British)	1.93E+08	21,990	5:
100	Bulgaria	2.26E+11	7,739,115	5
104	Myanmar	1.08E+11	46,321,162	52
112	Belarus	9.35E+11	9,825,102	54
	Cambodia	4.84E+08	13,357,574	99
120		1.18E+11	17,553,589	5
124	Canada Sri Lanka	2.38E+11 1.02E+11	32,283,413	5
144 152	Chile	4.36E+09	19,842,536 16,301,726	51
	China, People's Republic of	3.08E+11	1,284,823,106	5
	Colombia	2.39E+10	43,040,558	51
178	Congo	7.70E+10	3,533,177	55
180	Democratic Republic of the Congo	2.53E+10	57,420,522	60
188		2.12E+10	4,309,413	60
	Croatia	1.06E+11	4,441,986	60
	Cuba	6.26E+09	11,254,242	6
196	Cyprus Czech Republic	1.67E+11 9.70E+10	758,000 10,220,638	6
203		8.05E+10	7,633,757	6
	Denmark	8.16E+11	5,419,444	6
214	Dominican Republic	5.74E+09	9,264,267	64
218	Ecuador	1.50E+10	13,426,402	64
	El Salvador	1.03E+10	6,050,513	61
	Equatorial Guinea	4.39E+10	607,739	61
	Ethiopia	2.60E+11	74,263,861	61
	Eritrea Estonia	2.34E+11 5.14E+11	4,486,155 1,345,857	69 70
	Falkland Islands (Malvinas)	1.47E+12	3,140	70
	Finland	8.93E+11	5,244,342	70
250	France	2.21E+11	62,836,438	70
262	Djibouti	2.89E+10	808,367	7
	Gabon	1.34E+11	1,370,729	7
268		6.72E+11	4,477,006	7
270	Gambia Germany	5.37E+10 3.45E+11	1,503,678 82,540,739	7:
276		3.65E+10	21,639,806	7
300		7.19E+10	11,183,114	7
320	Guatemala	1.30E+10	12,717,154	76
324	Guinea	1.03E+11	9,041,448	76
328	Guyana	3.28E+10	746,235	76
	Haiti	5.02E+09	9,347,262	71
	Honduras	1.32E+10	6,879,243	71
	Hungary Iceland	3.49E+11 2.93E+10	10,086,936 296,743	79
	India	3.25E+10	1,140,042,863	80 80
	Indonesia	2.34E+10	227,303,175	8
	Iran, Islamic Republic of	4.06E+11	69,732,007	8
368	Iraq	2.68E+11	27,359,461	8
	Ireland	6.72E+11	4,158,042	8
	Israel	6.98E+10	6,604,572	84
	Italy	2.52E+10	58,671,206	8
	Kosovo Côte d'Ivoire	3.70E+10 6.63E+10	2,415,383 18,020,946	8
	Jamaica	3.73E+09	2,681,653	8
	Japan	6.82E+10		o: n=14
552				

		1	
	Jordan	1.28E+11 1.35E+10	5,342,002
404	Kenya Democratic People's Republic of Korea	1.35E+10 1.50E+11	35,614,576 23,760,650
410	Republic of Korea	1.46E+11	47,044,126
418	Lao People's Democratic Republic	9.24E+10	5,753,341
422	Lebanon	6.54E+10	4,052,420
428	Latvia	5.02E+11	2,305,528
	Liberia	1.30E+10	3,182,539
434	Libyan Arab Jamahiriya	1.43E+11	5,769,709
440 450	Lithuania Madagascar	7.79E+11 6.35E+10	3,415,748 17,885,967
450	Malaysia	9.14E+10	26,100,241
	Mali	1.82E+11	13,176,642
478	Mauritania	2.98E+10	3,047,249
484	Mexico	1.66E+11	106,483,757
499	Moldova	1.36E+11	3,766,876
504	Montenegro	1.84E+11	626,739
508	Morocco	8.24E+10	30,392,473
	Mozambi que Oman	3.38E+10 2.84E+09	20,770,013 2,429,510
516 524	Namibia	7.61E+10	2,079,951
-	Nepal	1.77E+11	27,281,945
540	Netherlands	1.72E+11	16,305,457
999	New Caledonia	6.44E+09	231,080
554	New Zealand	1.82E+11	4,134,117
558	Nicaragua	1.35E+10	5,424,336
562	Niger	9.63E+10	12,993,884
566	Nigeria	4.86E+10	139,823,340 4,623,298
	Norway Pakistan	2.01E+11 5.49E+11	4,623,298
586 591	Panama	1.36E+10	3,238,321
	Paraguay	1.26E+11	5,897,816
604	Peru	2.89E+09	27,558,769
608	Philippines	7.05E+10	85,546,427
616	Poland	4.78E+11	38,165,040
620	Portugal	1.59E+10	10,543,663
624	Guinea-Bissau	1.43E+11	1,367,695
626	Timor-Leste Puerto Rico	3.83E+09 3.79E+09	1,010,367
642	Romania	3.06E+11	3,781,986 21,771,749
643	Russian Federation	2.64E+11	143,843,159
	Saudi Arabia	3.02E+11	24,041,116
686	Senegal	2.38E+10	10,871,908
688	Serbia	2.66E+11	7,440,769
	Sierra Leone	4.21E+10	5,153,435
703	Slovakia	2.21E+11	5,415,496
704	Viet Nam Slovenia	1.03E+11 1.16E+11	83,161,145 2,002,084
705	Somalia	5.34E+11	8,359,859
	South Africa	7.15E+10	47,792,787
	Zimbabwe	6.74E+10	12,570,686
	Spain	1.67E+12	3,065,954
736	Sudan	4.85E+11	38,410,320
748	Swaziland	5.38E+10	1,104,909
-	Sweden	3.10E+11	9,029,345
	Switzerland Svrian Arab Republic	2.35E+11	7,415,007
	Syrian Arab Republic Thailand	1.00E+11 1.37E+11	18,484,122 66,698,482
-	Togo	5.85E+10	5,408,044
	United Arab Emirates	8.41E+08	4,069,349
	Tunisia	9.46E+10	9,912,114
792	Turkey	1.01E+11	68,143,186
	Uganda	3.55E+10	28,431,204
	Ukraine	2.52E+11	46,923,927
	The FYR of Macedonia	7.24E+10	2,038,109
	Egypt	1.12E+11 1.27E+11	74,203,215
	United Kingdom of GB and NI United Republic of Tanzania: Mainland	1.27E+11 4.57E+10	60,202,727 37,758,024
	United States	4.37E+10	296,820,296
858	Uruguay	2.60E+11	3,322,529
	Venezuela (Bolivarian Republic of)	1.22E+10	26,664,122
887	Yemen	1.48E+11	20,648,643
	Zambia	6.13E+10	11,462,365
=143			





**Table 3.30:** Normalisation References (NR) and population considered at the aggregated scale (region/Continent and global). Inclusion of guidance to application for LCI data for practitioners.

	Resolution scale:	Regional/Continental		Resolution scale	:: Global	
		NRj	Population		NR <sub>j</sub>	Population
Reg. Code	Region/Continent	(PAF·)[m3·d/(person.yr)]	[person]	Reg. Code Region/Continent	(PAF·)[m <sup>3</sup> ·d/(person.yr)]	[person]
NA	North America	4.13E+11	329,103,709	w World default	2.32E+11	6,224,751,905
SAS	South Asia	3.45E+11	1,346,472,100	n=1		
0	Oceania	2.87E+11	25,779,084			
EAS	East Asia	2.80E+11	1,482,020,826			
ME	Middle East	2.69E+11	182,763,202			
EU27	Europe (EU27)	2.56E+11	451,073,067			
EE	Eastern Europe	2.50E+11	276,979,256			
EUR51	Europe (EUR51)	2.49E+11	717,349,231			
WE	Western Europe	2.49E+11	487,293,902			
AF	Africa	1.05E+11	846,679,825			
CA	Central America	1.01E+11	182,054,442			
SA	South America	7.88E+10	511,364,012			
SEA	Southeast Asia	6.67E+10	554,241,547			
n=13						
Guidance	on application:					
Note:		1) LCI <sub>i</sub> [kg] * CF	<sup>F</sup> <sub>i</sub> [PAF.m <sup>3</sup> .d/kg] = IS <sub>i</sub> [PAF.m	<sup>3</sup> .d] where i = emission route (a	ir, fw, gw, mw)	Characterisation
NR=1/NF		<b>2)</b> SUM IS <sub>i</sub> = To	tal Impact Score (IS <sub>j</sub> ) for Co	untry j [PAF.m <sup>3</sup> .d] (or Regio	n/Continent, World)	Aggregation
<u>N</u> ormalisati	on <u>R</u> eference	<b>3)</b> $IS_j / NR_j = Nc$	ormalised Impact Score for	country j [person.yr] (or Regio	n/Continent, World)	Normalisation
<u>N</u> ormalisati	on <u>F</u> actor	or 3) IS <sub>j</sub> * NF <sub>j</sub> = No	ormalised Impact Score for	country j [person.yr] (or Regio	n/Continent World)	Normalisation





#### Table 3.31: Country groupings used for the aggregation of CFs and NFs.

Countries listing and regional grouping			Abbreviations use
Country		Reg. Name	Reg. Code Reg. Name
Albania	WE	Western Europe	AFIAfrica
Algeria	AF	Africa	CA Central A
Angola	AF	Africa	EAS East Asia
Argentina	SA	South America	EE Eastern E
Australia	0	Oceania	EU27 Europe (E
Austria	WE	Western Europe	EUR51 Europe (E
Bahamas	CA	Central America	ME Middle E
Bangladesh	SA	South America	NA North Am
Belgium Bhutan	WE	Western Europe	O Oceania
Bolivia	SAS	South Asia	SA South Am
	SA	South America	SAS South Asi
Bosnia and Herzegovina Botswana	WE	Western Europe	SEA Southeas
Brazil	AF	Africa	WE Western
	SA	South America	
Belize	CA	Central America	
Virgin Islands (British)	CA	Central America	
Bulgaria	WE	Western Europe	
Myanmar Belarus	SEA	Southeast Asia	
	EE	Eastern Europe	
Cambodia	SEA	Southeast Asia	
Cameroon	AF	Africa	
Canada	NA	North America	
Sri Lanka	SAS	South Asia	
Chile	SA	South America	
China, People's Republic of	EAS	East Asia	
Colombia	SA	South America	
Congo	AF	Africa	
Democratic Republic of the Congo Costa Rica	AF	Africa	
Croatia	CA	Central America	
Cuba	WE CA	Western Europe	
Cyprus	WE	Central America	
Czech Republic	WE	Western Europe	
Benin	AF	Western Europe Africa	
Denmark	WE		
Dominican Republic	CA	Western Europe	
Ecuador	SA	Central America South America	
El Salvador	CA	Central America	
Equatorial Guinea	AF	Africa	
Ethiopia	AF	Africa	
Eritrea	AF	Africa	
Estonia			
Falkland Islands (Malvinas)	WE	Western Europe	
Finland	SA WE	South America Western Europe	
France	WE	Western Europe	
Djibouti	AF	Africa	
Gabon			
Georgia	AF EE	Africa Eastern Europe	
Gambia	AF	Africa	
Germany	WE	Western Europe	
Ghana	AF	Africa	
Greece	AF WE		
Guatemala	CA	Western Europe Central America	
Guinea	AF	Africa	

	Other groupings	
	EU27	EUR51
	Austria	Albania
a	Belgium	Andorra*
	Bulgaria	Armenia*
	Cyprus	Austria
	Czech Republic	Azerbaijan*
	Denmark	Belarus
	Estonia	Belgium
	Finland	Bosnia and Herzegovina
	France	Bulgaria
	Germany	Croatia
	Greece	Cyprus
	Hungary	Czech Republic
	Ireland	Denmark
	Italy	Estonia
	Latvia	Finland
	Lithuania	France
	Luxembourg*	Georgia
	Malta*	Germany
	Netherlands	Greece
	Poland	Hungary
	Portugal	Iceland
	Romania	Ireland
	Slovakia	Italy
	Slovenia	Kazakhstan*
	Spain	Kosovo
	Sweden	Latvia
	United Kingdom	Liechtenstein*
	n=27	Lithuania
		Luxembourg*
		Macedonia
		Malta*
		Moldova
		Monaco*
		Montenegro
		Netherlands
		Norway
		Poland
		Portugal
		Romania
		Russia
		San Marino*
		Serbia
		Slovakia
		Slovenia
		Spain
		Sweden
		Switzerland
		Turkey
		Turkey Ukraine
		Turkey

\* Country CF not available



Guyana SA CA Haiti Honduras CA Hungary Iceland WE WE India SAS Indonesia SEA Iran, Islamic Republic of ME ME Iraq Ireland WE Israel ME Italy Kosovo WE WE Côte d'Ivoire AF Jamaica CA Japan EAS Jordan ME Kenya AF Democratic People's Republic of Korea EAS Republic of Korea EAS Lao People's Democratic Republic Lebanon SEA ME Latvia WE Liberia AF Libyan Arab Jamahiriya AF Lithuania WE Madagascar AF Malaysia SEA Mali AF Mauritania AF Mexico CA Moldova EE Montenegro WE Morocco AF AF Mozambique ME Oman Namibia AF Nepal Netherlands SAS WE New Caledonia 0 0 CA New Zealand Nicaragua AF Niger AF WE Nigeria Norway Pakistan SAS CA SA Panama Paraguay Peru SA Philippines SEA Poland WE Portugal WE Guinea-Bissau AF Timor-Leste о Puerto Rico CA Romania WE Russian Federation EE Saudi Arabia ME Senegal Serbia AF WE Sierra Leone AF Slovakia WE Viet Nam SEA Slovenia WE Somalia AF South Africa AF AF WE Zimbabwe Spain Sudan AF AF Swaziland Sweden WE Switzerland WE Syrian Arab Republic ME Thailand SEA AF Togo United Arab Emirates ME Tunisia AF Turkey EE . Uganda Ukraine AF EE The FYR of Macedonia WE AF Egypt United Kingdom of GB and NI WE United Republic of Tanzania: Mainland AF United States NA Uruguay SA Venezuela (Bolivarian Republic of) SA Yemen ME Zambia AF

South America
Central America
Central America
Western Europe
Western Europe South Asia
Southeast Asia
Middle East
Middle East
Western Europe
Middle East
Western Europe
Western Europe
Africa
Central America East Asia
Middle East
Africa
East Asia
East Asia
Southeast Asia
Middle East
Western Europe
Africa
Africa Western Europe
Africa
Southeast Asia
Africa
Africa
Central America
Eastern Europe
Western Europe
Africa
Africa Middle East
Africa
South Asia
Western Europe
Oceania
Oceania
Central America
Africa
Africa
Western Europe South Asia
Central America
South America
South America
Southeast Asia
Western Europe
Western Europe
Africa
Oceania Central America
Western Europe
Eastern Europe
Middle East
Africa
Western Europe
Africa
Western Europe
Southeast Asia Western Europe
Western Europe Africa
Africa
Africa
Western Europe
Africa
Africa
Africa Western Europe
Africa Western Europe Western Europe
Africa Western Europe Western Europe Middle East
Africa Western Europe Western Europe Middle East Southeast Asia
Africa Western Europe Western Europe Middle East
Africa Western Europe Western Europe Middle East Southeast Asia Africa
Africa Western Europe Middle East Southeast Asia Africa Middle East Africa Eastern Europe
Africa Western Europe Middle East Southeast Asia Africa Middle East Africa Eastern Europe Africa
Africa Western Europe Widdle East Southeast Asia Africa Eastern Europe Africa Eastern Europe
Africa Western Europe Middle East Southeast Asia Africa Middle East Africa Eastern Europe Africa Eastern Europe Western Europe
Africa Western Europe Middle East Southeast Asia Africa Middle East Africa Eastern Europe Africa Eastern Europe Western Europe Africa
Africa Western Europe Middle East Southeast Asia Africa Middle East Africa Eastern Europe Africa Eastern Europe Western Europe Africa Western Europe
Africa Western Europe Western Europe Middle East Southeast Asia Africa Eastern Europe Africa Eastern Europe Western Europe Africa Western Europe Africa
Africa Western Europe Middle East Southeast Asia Africa Middle East Africa Eastern Europe Africa Eastern Europe Western Europe Africa Western Europe
Africa Western Europe Middle East Southeast Asia Africa Middle East Africa Eastern Europe Africa Eastern Europe Mestern Europe Africa Western Europe Africa North America
Africa Western Europe Western Europe Middle East Southeast Asia Africa Middle East Africa Eastern Europe Africa Eastern Europe Africa Western Europe Africa North America South America







#### Appendix 3-XV: Uncertainty quantification

**Table 3.32:** Uncertainty quantification on the CFs originated from the N-export splitting scenarios from one country to multiple receiving LME using the extreme values of the possible variation range.

	emission ro	te: N to	Air	N to sfw	N to gw	N to mw
		CF (even split)	max range	Country Country-to-LME	Country Country-to-LME	Country Country-to-LME
Country	Country-to-LME	PAF.m3.d/kgN		PAF.m3.d/kgN PAF.m3.d/kgN	PAF.m3.d/kgN PAF.m3.d/kgN	PAF.m3.d/kgN PAF.m3.d/kgN
Australia	Australia to LME#39. North Australia Australia to LME#40. Northeast Australia	154.64 48.29	0 - 1082.49 0 - 338.06	3,094.40 0 - 3094.4 966.37 0 - 966.37	1,095.53 0 - 2316.14 342.13 0 - 723.32	6,542.07 0 - 6542.07 2,043.07 0 - 2043.07
	Australia to LME#41. East-Central Australia	52.72	0 - 369.05	1,054.97 0 - 1054.97	373.50 0 - 789.63	2,230.37 0 - 2230.37
	Australia to LME#42. Southeast Australia	81.68	0 - 571.76	1,634.43 0 - 1634.43	578.65 0 - 1223.36	3,455.46 0 - 3455.46
	Australia to LME#43. Southwest Australia Australia to LME#44. West-Central Australia	78.27	0 - 547.9 0 - 418.35	1,566.22 0 - 1566.22 1,195.88 0 - 1195.88	554.50 0 - 1172.31 423.39 0 - 895.11	3,311.26 0 - 3311.26 2,528.28 0 - 2528.28
	Australia to LME#44. West-Central Australia Australia to LME#45. Northwest Australia	59.76 75.31	0 - 418.55	1,506.92 0 - 1506.92	423.39 0 - 893.11 533.51 0 - 1127.92	3,185.88 0 - 3185.88
Brazil	Brazil to LME#15. South Brazil Shelf	280.94	0 - 842.82	2,212.79 0 - 2212.79	783.41 0 - 1656.26	4,678.20 0 - 4678.2
	Brazil to LME#16. East Brazil Shelf	122.26	0 - 366.78	962.97 0 - 962.97	340.93 0 - 720.77	2,035.87 0 - 2035.87
P. des de	Brazil to LME#17. North Brazil Shelf	571.46		4,500.99 0 - 4500.99	1,593.52 0 - 3368.96	9,515.83 0 - 9515.83
Bulgaria	Bulgaria to LME#26. Mediterranean Bulgaria to LME#62. Black Sea	2,330.43 8,710.90	0 - 4660.86 0 - 17421.8	11,128.87 0 - 11128.87 41,598.53 0 - 41598.53	3,940.04 0 - 8329.88 14,727.43 0 - 31136.22	23,528.27 0 - 23528.27 87,946.16 0 - 87946.16
Canada	Canada to LME#2. Gulf of Alaska	216.39		3,359.50 0 - 3359.5	1,189.39 0 - 2514.56	7,102.53 0 - 7102.53
	Canada to LME#63. Hudson Bay	524.41	0 - 2622.07	8,141.68 0 - 8141.68	2,882.46 0 - 6093.99	17,212.84 0 - 17212.84
	Canada to LME#9. Newfoundland-Labrador Shelf	157.96	0 - 789.78	2,452.32 0 - 2452.32	868.21 0 - 1835.54	5,184.60 0 - 5184.6
	Canada to LME#8. Scotian Shelf Canada to LME#64. Arctic Ocean	1,060.60	0 - 5302.98 0 - 75.59	16,466.06 0 - 16466.06 234.71 0 - 234.71	5,829.60 0 - 12324.74 83.09 0 - 175.68	34,811.98 0 - 34811.98 496.21 0 - 496.21
China, People's Republic of	China, People's Republic of to LME#36. South China Sea	-	0 - 5431.63	13,660.98 0 - 13660.98	4,836.50 0 - 10225.15	28,881.56 0 - 28881.56
	China, People's Republic of to LME#47. East China Sea	1,650.06		12,450.11 0 - 12450.11	4,407.80 0 - 9318.82	26,321.58 0 - 26321.58
	China, People's Republic of to LME#48. Yellow Sea	4,477.33	0 - 13432	33,782.51 0 - 33782.51	11,960.27 0 - 25285.98	71,421.80 0 - 71421.8
Colombia	Colombia to LME#11. Pacific Central-American	523.34		2,123.90 0 - 2123.9	751.94 0 - 1589.72	4,490.26 0 - 4490.26
Costa Rica	Colombia to LME#12. Caribbean Sea Costa Rica to LME#11. Pacific Central-American	286.64 744.33	0 - 573.28 0 - 1488.65	1,163.28 0 - 1163.28 2,123.90 0 - 2123.9	411.84 0 - 870.71 751.94 0 - 1589.72	2,459.37 0 - 2459.37 4,490.26 0 - 4490.26
	Costa Rica to LME#12. Caribbean Sea	407.68	0 - 815.35	1,163.28 0 - 1163.28	411.84 0 - 870.71	2,459.37 0 - 2459.37
Denmark	Denmark to LME#22. North Sea	3,117.37	0 - 9352.11	21,195.67 0 - 21195.67	7,504.06 0 - 15864.81	44,811.14 0 - 44811.14
	Denmark to LME#23. Baltic Sea	10,498.03		71,378.35 0 - 71378.35	25,270.60 0 - 53426.21	150,905.61 0 - 150905.61
Ethiopia	Denmark to LME#60. Faroe Plateau Ethionia to LME#32. Arabian Sea	188.33	0 - 564.99 0 - 11584.08	1,280.49 0 - 1280.49 30,169.71 0 - 30169.71	453.34 0 - 958.44 10,681.20 0 - 22581.83	2,707.16 0 - 2707.16 63,783.75 0 - 63783.75
conopia	Ethiopia to LME#32. Arabian Sea Ethiopia to LME#33. Red Sea		0 - 11584.08 0 - 10705.35	27,881.15 0 - 27881.15	9,870.96 0 - 20868.85	58,945.34 0 - 58945.34
France	France to LME#22. North Sea		0 - 8741.58	21,195.67 0 - 21195.67	7,504.06 0 - 15864.81	44,811.14 0 - 44811.14
	France to LME#24. Celtic-Biscay Shelf		0 - 7198.42	17,453.98 0 - 17453.98	6,179.36 0 - 13064.19	36,900.59 0 - 36900.59
C	France to LME#26. Mediterranean	1,529.93		11,128.87 0 - 11128.87	3,940.04 0 - 8329.88	23,528.27 0 - 23528.27
Germany	Germany to LME#22. North Sea Germany to LME#23. Baltic Sea	4,562.65	0 - 9125.3 0 - 30730.29	21,195.67 0 - 21195.67 71,378.35 0 - 71378.35	7,504.06 0 - 15864.81 25.270.60 0 - 53426.21	44,811.14 0 - 44811.14 150,905.61 0 - 150905.61
Guatemala	Guatemala to LME#11. Pacific Central-American		0 - 1302.48	2,123.90 0 - 2123.9	751.94 0 - 1589.72	4,490.26 0 - 4490.26
	Guatemala to LME#12. Caribbean Sea	356.69	0 - 713.38	1,163.28 0 - 1163.28	411.84 0 - 870.71	2,459.37 0 - 2459.37
India	India to LME#32. Arabian Sea	6,332.80		30,169.71 0 - 30169.71	10,681.20 0 - 22581.83	63,783.75 0 - 63783.75
leses	India to LME#34. Bay of Bengal	4,443.22		21,167.69 0 - 21167.69 12,450.11 0 - 12450.11	7,494.15 0 - 15843.87	44,752.00 0 - 44752
Japan	Japan to LME#47. East China Sea Japan to LME#49. Kuroshio Current	1,138.15 491.17		5,372.88 0 - 5372.88	4,407.80 0 - 9318.82 1,902.20 0 - 4021.57	26,321.58 0 - 26321.58 11,359.16 0 - 11359.16
	Japan to LME#50. Sea of Japan/East Sea	1,811.28		19,813.46 0 - 19813.46	7,014.70 0 - 14830.24	41,888.91 0 - 41888.91
	Japan to LME#51. Oyashio Current		0 - 1140.85	2,495.94 0 - 2495.94	883.65 0 - 1868.19	5,276.82 0 - 5276.82
Development in Development in Street	Japan to LME#52. Sea of Okhotsk		0 - 5492.78	12,016.99 0 - 12016.99	4,254.46 0 - 8994.64	25,405.91 0 - 25405.91
Democratic People's Republic of Korea	Democratic People's Republic of Korea to LME#47. East China Sea Democratic People's Republic of Korea to LME#48. Yellow Sea		0 - 5847.53 0 - 15866.89	12,450.11 0 - 12450.11 33,782.51 0 - 33782.51	4,407.80 0 - 9318.82 11,960.27 0 - 25285.98	26,321.58 0 - 26321.58 71,421.80 0 - 71421.8
	Democratic People's Republic of Korea to LME#50. Sea of Japan/East Sea		0 - 9305.93	19,813.46 0 - 19813.46	7,014.70 0 - 14830.24	41,888.91 0 - 41888.91
Republic of Korea	Republic of Korea to LME#47. East China Sea		0 - 6393.67	12,450.11 0 - 12450.11	4,407.80 0 - 9318.82	26,321.58 0 - 26321.58
	Republic of Korea to LME#48. Yellow Sea		0 - 17348.78	33,782.51 0 - 33782.51	11,960.27 0 - 25285.98	71,421.80 0 - 71421.8
Malayria	Republic of Korea to LME#50. Sea of Japan/East Sea		0 - 10175.07	19,813.46 0 - 19813.46	7,014.70 0 - 14830.24	41,888.91 0 - 41888.91
Malaysia	Malaysia to LME#34. Bay of Bengal Malaysia to LME#35. Gulf of Thailand	5,758.44	0 - 11275.32 0 - 229.04	21,167.69 0 - 21167.69 429.98 0 - 429.98	7,494.15 0 - 15843.87 152.23 0 - 321.84	44,752.00 0 - 44752 909.05 0 - 909.05
	Malaysia to LME#36. South China Sea	2,425.58		13,660.98 0 - 13660.98	4,836.50 0 - 10225.15	28,881.56 0 - 28881.56
Mali	Mali to LME#27. Canary Current	914.58		3,826.67 0 - 3826.67	1,354.78 0 - 2864.24	8,090.22 0 - 8090.22
	Mali to LME#28. Guinea Current	4,968.83		20,790.05 0 - 20790.05	7,360.45 0 - 15561.21	43,953.59 0 - 43953.59
Mexico	Mexico to LME#3. California Current Mexico to LME#4. Gulf of California	247.74	0 - 743.22 0 - 7110.82	1,645.78 0 - 1645.78 15,746.08 0 - 15746.08	582.67 0 - 1231.85 5,574.70 0 - 11785.83	3,479.44 0 - 3479.44 33,289.80 0 - 33289.8
	Mexico to LME#4. Guil of Camorina Mexico to LME#5. Gulf of Mexico	2,377.19		15,792.03 0 - 15792.03	5,590.97 0 - 11820.23	33,386.96 0 - 33386.96
Morocco	Morocco to LME#26. Mediterranean		0 - 5734.82	11,128.87 0 - 11128.87	3,940.04 0 - 8329.88	23,528.27 0 - 23528.27
	Morocco to LME#27. Canary Current	985.96		3,826.67 0 - 3826.67	1,354.78 0 - 2864.24	8,090.22 0 - 8090.22
Nicaragua	Nicaragua to LME#11. Pacific Central-American Nicaragua to LME#12. Caribbean Sea	691.81		2,123.90 0 - 2123.9	751.94 0 - 1589.72 411.84 0 - 870.71	4,490.26 0 - 4490.26 2,459.37 0 - 2459.37
Norway	Nicaragua to LME#12. Caribbean Sea Norway to LME#21. Norwegian Sea	378.91	0 - 757.82 0 - 3057.16	1,163.28 0 - 1163.28 6,338.15 0 - 6338.15	411.84 0 - 870.71 2,243.94 0 - 4744.06	2,459.37 0 - 2459.37 13,399.88 0 - 13399.88
,	Norway to LME#22. North Sea	5,111.80		21,195.67 0 - 21195.67	7,504.06 0 - 15864.81	44,811.14 0 - 44811.14
Panama	Panama to LME#11. Pacific Central-American	736.68	0 - 1473.36	2,123.90 0 - 2123.9	751.94 0 - 1589.72	4,490.26 0 - 4490.26
Dhilippinge	Panama to LME#12. Caribbean Sea	403.49	0 - 806.97	1,163.28 0 - 1163.28	411.84 0 - 870.71	2,459.37 0 - 2459.37
Philippines	Philippines to LME#36. South China Sea Philippines to LME#37. Sulu-Celebes Sea		0 - 10195.91 0 - 12851.75	13,660.98 0 - 13660.98 17,219.40 0 - 17219.4	4,836.50 0 - 10225.15 6,096.31 0 - 12888.6	28,881.56 0 - 28881.56 36,404.65 0 - 36404.65
Russian Federation	Russian Federation to LME#20. Barents Sea		0 - 1414.03	4,956.31 0 - 4956.31	1,754.72 0 - 3709.76	10,478.46 0 - 10478.46
	Russian Federation to LME#54. Chukchi Sea	88.56	0 - 974.14	3,414.44 0 - 3414.44	1,208.84 0 - 2555.69	7,218.69 0 - 7218.69
	Russian Federation to LME#56. East Siberian Sea		0 - 509.42	1,785.58 0 - 1785.58	632.16 0 - 1336.49	3,775.00 0 - 3775
	Russian Federation to LME#57. Laptev Sea Russian Federation to LME#58. Kara Sea		0 - 1935.9 0 - 1481.07	6,785.50 0 - 6785.5 5,191.29 0 - 5191.29	2,402.32 0 - 5078.9 1,837.91 0 - 3885.65	14,345.67 0 - 14345.67 10,975.25 0 - 10975.25
	Russian Federation to LME#58. Kara Sea Russian Federation to LME#62. Black Sea		0 - 1481.07 0 - 11868.04	5,191.29 0 - 5191.29 41,598.53 0 - 41598.53	1,837.91 0 - 3885.65 14,727.43 0 - 31136.22	10,975.25 0 - 10975.25 87,946.16 0 - 87946.16
	Russian Federation to LME#64. Arctic Ocean	6.09		234.71 0 - 234.71	83.09 0 - 175.68	496.21 0 - 496.21
	Russian Federation to LME#50. Sea of Japan/East Sea		0 - 5652.77	19,813.46 0 - 19813.46	7,014.70 0 - 14830.24	41,888.91 0 - 41888.91
	Russian Federation to LME#51. Oyashio Current		0 - 712.09	2,495.94 0 - 2495.94	883.65 0 - 1868.19	5,276.82 0 - 5276.82
	Russian Federation to LME#52. Sea of Okhotsk Russian Federation to LME#53. West Bering Sea		0 - 3428.44 0 - 465.66	12,016.99 0 - 12016.99 1,632.19 0 - 1632.19	4,254.46 0 - 8994.64 577.86 0 - 1221.68	25,405.91 0 - 25405.91 3,450.72 0 - 3450.72
Saudi Arabia	Saudi Arabia to LME#32. Arabian Sea		0 - 11368.02	30,169.71 0 - 30169.71	10,681.20 0 - 22581.83	63,783.75 0 - 63783.75
	Saudi Arabia to LME#33. Red Sea	5,252.84	0 - 10505.69	27,881.15 0 - 27881.15	9,870.96 0 - 20868.85	58,945.34 0 - 58945.34
			0 - 16876.05	41,598.53 0 - 41598.53	14,727.43 0 - 31136.22	87,946.16 0 - 87946.16
Serbia	Serbia to LME#62. Black Sea			11,128.87 0 - 11128.87	3,940.04 0 - 8329.88	23,528.27 0 - 23528.27
	Serbia to LME#26. Mediterranean	2,257.43			772 22 0 4624 22	4 617 02 0 4647 00
Serbia Somalia	Serbia to LME#26. Mediterranean Somalia to LME#31. Somali Coastal Current	538.42	0 - 1076.83	2,184.28 0 - 2184.28	773.32 0 - 1634.92 10.681.20 0 - 22581.83	
	Serbia to LME#26. Mediterranean	538.42 7,436.70			773.32 0 - 1634.92 10,681.20 0 - 22581.83 1,633.44 0 - 3453.36	63,783.75 0 - 63783.75
Somalia	Serbia to LME#26. Mediterranean Somalia to LME#31. Somali Coastal Current Somalia to LME#32. Arabian Sea South Africa to LME#29. Benguela Current South Africa to LME#30. Aguihas Current	538.42 7,436.70 1,201.24 2,046.03	0 - 1076.83 0 - 14873.39 0 - 2402.48 0 - 4092.06	2,184.28 0 - 2184.28 30,169.71 0 - 30169.71 4,613.74 0 - 4613.74 7,858.44 0 - 7858.44	10,681.20 0 - 22581.83 1,633.44 0 - 3453.36 2,782.18 0 - 5881.99	63,783.75 0 - 63783.75 9,754.22 0 - 9754.22 16,614.04 0 - 16614.04
Somalia	Serbia to LME#26. Mediterranean Somalia to LME#31. Somali Coastal Current Somalia to LME#32. Arabian Sea South Africa to LME#29. Benguela Current South Africa to LME#30. Agulhas Current Spain to LME#25. Iberian Coastal	538.42 7,436.70 1,201.24 2,046.03 714.43	0 - 1076.83 0 - 14873.39 0 - 2402.48 0 - 4092.06 0 - 1428.87	2,184.28 0 - 2184.28 30,169.71 0 - 30169.71 4,613.74 0 - 4613.74 7,858.44 0 - 7858.44 2,682.17 0 - 2682.17	10,681.20         0 - 22581.83           1,633.44         0 - 3453.36           2,782.18         0 - 5881.99           949.59         0 - 2007.59	63,783.75         0 - 63783.75           9,754.22         0 - 9754.22           16,614.04         0 - 16614.04           5,670.55         0 - 5670.55
Somalia South Africa	Serbia to LME#26. Mediterranean Somalia to LME#31. Somali Coastal Current Somalia to LME#32. Arabian Sea South Africa to LME#29. Benguela Current South Africa to LME#30. Aguihas Current	538.42 7,436.70 1,201.24 2,046.03 714.43 2,964.33	0 - 1076.83 0 - 14873.39 0 - 2402.48 0 - 4092.06	2,184.28 0 - 2184.28 30,169.71 0 - 30169.71 4,613.74 0 - 4613.74 7,858.44 0 - 7858.44	10,681.20 0 - 22581.83 1,633.44 0 - 3453.36 2,782.18 0 - 5881.99	4,617.93         0 - 4617.93           63,783.75         0 - 63783.75           9,754.22         0 - 9754.22           16,614.04         0 - 16614.04           5,670.55         0 - 5670.55           23,528.27         0 - 23528.27           150,905.61         0 - 150905.61





1	50	
-		

Switzerland	Switzerland to LME#22. North Sea	2,711.07 0 - 8133.21	21,195.67 0 - 21195.67	7,504.06 0 - 15864.81	44,811.14	0 - 44811.14
	Switzerland to LME#26. Mediterranean	1,423.46 0 - 4270.37	11,128.87 0 - 11128.87	3,940.04 0 - 8329.88	23,528.27	0 - 23528.27
	Switzerland to LME#62. Black Sea	5,320.73 0 - 15962.2	41,598.53 0 - 41598.53	14,727.43 0 - 31136.22	87,946.16	0 - 87946.16
United Kingdom of GB and NI	United Kingdom of GB and NI to LME#22. North Sea	5,874.84 0 - 11749.68	21,195.67 0 - 21195.67	7,504.06 0 - 15864.81	44,811.14	0 - 44811.14
	United Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf	4,837.75 0 - 9675.5	17,453.98 0 - 17453.98	6,179.36 0 - 13064.19	36,900.59	0 - 36900.59
United States	United States to LME#1. East Bering Sea	339.36 0 - 3393.55	11,406.01 0 - 11406.01	4,038.15 0 - 8537.32	24,114.20	0 - 24114.2
	United States to LME#2. Gulf of Alaska	99.95 0 - 999.53	3,359.50 0 - 3359.5	1,189.39 0 - 2514.56	7,102.53	0 - 7102.53
	United States to LME#3. California Current	48.97 0 - 489.66	1,645.78 0 - 1645.78	582.67 0 - 1231.85	3,479.44	0 - 3479.44
	United States to LME#4. Gulf of California	468.48 0 - 4684.82	15,746.08 0 - 15746.08	5,574.70 0 - 11785.83	33,289.80	0 - 33289.8
	United States to LME#5. Gulf of Mexico	469.85 0 - 4698.49	15,792.03 0 - 15792.03	5,590.97 0 - 11820.23	33,386.96	0 - 33386.96
	United States to LME#6. Southeast U.S. Continental Shelf	60.10 0 - 600.98	2,019.95 0 - 2019.95	715.14 0 - 1511.92	4,270.51	0 - 4270.51
	United States to LME#7. Northeast U.S. Continental Shelf	194.64 0 - 1946.37	6,541.93 0 - 6541.93	2,316.09 0 - 4896.59	13,830.72	0 - 13830.72
	United States to LME#10. Insular Pacific-Hawaiian	16.63 0 - 166.28	558.87 0 - 558.87	197.86 0 - 418.31	1,181.53	0 - 1181.53
	United States to LME#54. Chukchi Sea	101.59 0 - 1015.87	3,414.44 0 - 3414.44	1,208.84 0 - 2555.69	7,218.69	0 - 7218.69
	United States to LME#55. Beaufort Sea	142.75 0 - 1427.48	4,797.87 0 - 4797.87	1,698.62 0 - 3591.17	10,143.49	0 - 10143.49
n=34	n=105					



**Table 3.33:** Calculation of the uncertainty range for the combined change in the terms governing the marine-N loss rate (sedimentation rate, denitrification rate, and residence time) of the FF.

	emission route:		N to Air			N to sfw			N to gw			N to mw	
		Estimated CF	Var range		Estimated CF	Varrange		Estimated CF	Varrange		Estimated CF	Var range	
# Country-to-LME	unit:	PAF.m3.d/kgN	PAF.m3.d/kgN	%var	PAF.m3.d/kgN	PAF.m3.d/kgN	%var	PAF.m3.d/kgN	PAF.m3.d/kgN	%var	PAF.m3.d/kgN	PAF.m3.d/kgN	%va
s Albania to LME#26. Mediterranean		7,606.07	3655.27 - 7673.89	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.06	0.5
2 Algeria to LME#26. Mediterranean 4 Angola to LME#29. Benguela Current		7,211.38 2,490.13	3465.59 - 7275.68 1242.79 - 12088.99	0.53 4.36	11,128.87 4,613.74	5348.23 - 11228.1 2302.67 - 22398.63	0.53 4.36	3,940.04 1,633.44	1893.47 - 3975.17 815.23 - 7929.95	0.53 4.36	23,528.27 9,754.22	11307.04 - 23738.06 4868.22 - 47354.39	0.5 4.3
Argentina to LME#14. Patagonian Shelf		4,416.45	2204.2 - 21440.8	4.30	5,793.14	2891.29 - 28124.32	4.30	2.050.99	1023.62 - 9957.06	4.36	12.247.66	4808.22 - 47334.39 6112.66 - 59459.45	4.3
Australia to LME#39. North Australia		154.64	77.18 - 750.75	4.36	3,094.40	1544.38 - 15022.58	4.36	1,095.53	546.77 - 5318.55	4.36	6,542.07	3265.07 - 31760.21	4.3
Australia to LME#40. Northeast Australia		48.29	7.65 - 234.46	4.70	966.37	153.05 - 4691.52	4.70	342.13	54.19 - 1660.97	4.70	2,043.07	323.58 - 9918.64	4.7
Australia to LME#41. East-Central Australia		52.72	26.31 - 255.95	4.36	1,054.97	526.52 - 5121.61	4.36	373.50	186.41 - 1813.24	4.36	2,230.37	1113.15 - 10827.92	4.3
Australia to LME#42. Southeast Australia		81.68	40.77 - 396.54	4.36	1,634.43	815.73 - 7934.78	4.36	578.65	288.8 - 2809.21	4.36	3,455.46	1724.58 - 16775.44	4.3
Australia to LME#43. Southwest Australia		78.27	39.06 - 379.99	4.36	1,566.22	781.68 - 7603.64	4.36	554.50	276.75 - 2691.97	4.36	3,311.26	1652.61 - 16075.35	4.3
Australia to LME#44. West-Central Australia		59.76	29.83 - 290.14	4.36 4.36	1,195.88	596.85 - 5805.7	4.36 4.36	423.39	211.31 - 2055.44	4.36 4.36	2,528.28	1261.84 - 12274.22	4.3
Australia to LME#45. Northwest Australia Austria to LME#26. Mediterranean		75.31	37.59 - 365.6 2876.95 - 6039.89	4.36	1,506.92 11.128.87	752.09 - 7315.74 5348.23 - 11228.1	4.36	533.51 3.940.04	266.27 - 2590.05 1893.47 - 3975.17	4.30	3,185.88 23.528.27	1590.04 - 15466.69 11307.04 - 23738.06	4.3
Bahamas to LME#12. Caribbean Sea		1,490.85	744.29 - 1783.97	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.91	0.7
Bangladesh to LME#34. Bay of Bengal		11,107.20	4096.71 - 12181.63	0.73	21,167.69	7807.36 - 23215.31	0.73	7,494.15	2764.09 - 8219.08	0.73	44,752.00	16506.04 - 49080.99	0.7
6 Belgium to LME#22. North Sea		14,146.99	2658.3 - 17327.65	1.04	21,195.67	3982.79 - 25961.09	1.04	7,504.06	1410.06 - 9191.19	1.04	44,811.14	8420.27 - 54886.02	1.0
Bhutan to LME#34. Bay of Bengal		9,743.61	3593.77 - 10686.14	0.73	21,167.69	7807.36 - 23215.31	0.73	7,494.15	2764.09 - 8219.08	0.73	44,752.00	16506.04 - 49080.99	0.7
8 Bolivia to LME#13. Humboldt Current		214.72	106.85 - 1636.23	7.12	422.52	210.26 - 3219.68	7.12	149.59	74.44 - 1139.89	7.12	893.27	444.52 - 6806.93	7.:
Bosnia and Herzegovina to LME#26. Mediterranean Botswana to LME#30. Agulhas Current		6,433.01 4.689.03	3091.53 - 6490.37 881.1 - 5743.27	0.53 1.04	11,128.87 7.858.44	5348.23 - 11228.1 1476.65 - 9625.25	0.53	3,940.04 2.782.18	1893.47 - 3975.17 522.79 - 3407.7	0.53	23,528.27 16.614.04	11307.04 - 23738.06 3121.87 - 20349.37	0.5
6 Brazil to LME#15. South Brazil Shelf		280.94	140.21 - 1363.9	4.36	2,212.79	1104.38 - 10742.55	4.36	783.41	390.99 - 3803.26	4.36	4,678.20	2334.83 - 22711.53	4.3
Brazil to LME#16. East Brazil Shelf		122.26	61.02 - 593.55	4.36	962.97	480.61 - 4674.98	4.36	340.93	170.15 - 1655.12	4.36	2,035.87	1016.08 - 9883.68	4.
Brazil to LME#17. North Brazil Shelf		571.46	34.12 - 819.27	1.37	4,500.99	268.72 - 6452.86	1.37	1,593.52	95.14 - 2284.55	1.37	9,515.83	568.12 - 13642.42	1.
Belize to LME#12. Caribbean Sea		1,097.00	547.67 - 1312.69	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.91	0.
2 Virgin Islands (British) to LME#12. Caribbean Sea		1,692.38	844.9 - 2025.12	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.91	0.7
Bulgaria to LME#26. Mediterranean		2,330.43	1119.94 - 2351.21	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.06	0.
Bulgaria to LME#62. Black Sea Myanmar to LME#34. Bay of Bengal		8,710.90 12.033.02	4186.22 - 8788.57 4438.18 - 13197.01	0.53	41,598.53 21.167.69	19991.12 - 41969.45 7807.36 - 23215.31	0.53	14,727.43	7077.6 - 14858.75 2764.09 - 8219.08	0.53	87,946.16 44,752.00	42264.52 - 88730.33 16506.04 - 49080.99	0.
z Belarus to LME#23. Baltic Sea		29,863.38	15340.83 - 30645.2	0.75	71,378.35	36667.1 - 73247.03	0.75	25,270.60	12981.52 - 25932.18	0.75	150,905.61	77520.3 - 154856.3	0.
6 Cambodia to LME#23. Baltic Sea		29,863.38	15340.83 - 30645.2 592.7 - 5765.38	4.36	1,645.78	821.39 - 7989.85	4.36	582.67	290.8 - 2828.71	4.36	3,479.44	1736.55 - 16891.86	4.
Cameroon to LME#28. Guinea Current		10,509.35	5763.78 - 12323.14	0.62	20,790.05	11402.16 - 24378.19	0.62	7,360.45	4036.79 - 8630.79	0.62	43,953.59	24106.04 - 51539.51	0.
Canada to LME#2. Gulf of Alaska		216.39	108 - 1050.52	4.36	3,359.50	1676.69 - 16309.55	4.36	1,189.39	593.61 - 5774.19	4.36	7,102.53	3544.79 - 34481.09	4.
Canada to LME#63. Hudson Bay		524.41	220.26 - 654.96	0.83	8,141.68	3419.66 - 10168.43	0.83	2,882.46	1210.69 - 3600	0.83	17,212.84	7229.73 - 21497.73	0.
Canada to LME#9. Newfoundland-Labrador Shelf		157.96	78.83 - 766.84	4.36	2,452.32	1223.92 - 11905.42	4.36	868.21	433.31 - 4214.96	4.36	5,184.60	2587.58 - 25170.01	4.
Canada to LME#8. Scotian Shelf		1,060.60	527.56 - 1811.52	1.21	16,466.06	8190.5 - 28124.32	1.21	5,829.60	2899.74 - 9957.06	1.21	34,811.98	17316.08 - 59459.45	1.
Canada to LME#64. Arctic Ocean Sri Lanka to LME#34. Bay of Bengal		15.12 25,932.46	5.66 - 16.84 9564.76 - 28440.98	0.74	234.71 21,167.69	87.9 - 261.38 7807.36 - 23215.31	0.74	83.09 7,494.15	31.12 - 92.54 2764.09 - 8219.08	0.74	496.21 44,752.00	185.84 - 552.6 16506.04 - 49080.99	0.
		25,932.46 369.57	183.91 - 2816.18	7.12	422.52	210.26 - 3219.68	7.12	7,494.15	2764.09 - 8219.08 74.44 - 1139.89	7.12	44,752.00 893.27	444.52 - 6806.93	7.
Chile to LME#13. Humboldt Current China, People's Republic of to LME#36. South China Sea		1,810.54	608.89 - 1935.35	0.73	13,660.98	4594.21 - 14602.69	0.73	4,836.50	1626.52 - 5169.89	0.73	28,881.56	9712.93 - 30872.48	0.
China, People's Republic of to LME#47. East China Sea		1,650.06	740.44 - 1945.07	0.73	12,450.11	5586.79 - 14675.97	0.73	4,407.80	1977.93 - 5195.84	0.73	26,321.58	11811.4 - 31027.42	0.
China, People's Republic of to LME#48. Yellow Sea		4,477.33	1952.54 - 4823.82	0.64	33,782.51	14732.39 - 36396.82	0.64	11,960.27	5215.82 - 12885.83	0.64	71,421.80	31146.7 - 76948.87	0.
Colombia to LME#11. Pacific Central-American		523.34	261.19 - 2540.68	4.36	2,123.90	1060.01 - 10311	4.36	751.94	375.28 - 3650.48	4.36	4,490.26	2241.04 - 21799.16	4.
Colombia to LME#12. Caribbean Sea		286.64	143.1 - 342.99	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.91	0.
Congo to LME#28. Guinea Current		10,781.75	5913.17 - 12642.56	0.62	20,790.05	11402.16 - 24378.19	0.62	7,360.45	4036.79 - 8630.79	0.62	43,953.59	24106.04 - 51539.51	0.
Democratic Republic of the Congo to LME#28. Guinea Current Costa Rica to LME#11. Pacific Central-American		8,817.57 744.33	4835.94 - 10339.39 371.48 - 3613.52	0.62	20,790.05 2,123.90	11402.16 - 24378.19 1060.01 - 10311	0.62	7,360.45	4036.79 - 8630.79 375.28 - 3650.48	0.62	43,953.59 4,490.26	24106.04 - 51539.51 2241.04 - 21799.16	0.
Costa Rica to LME#11. Facilite Central-American		407.68	203.53 - 487.83	0.70	1.163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.91	0.
Croatia to LME#26. Mediterranean		6,318.80	3036.64 - 6375.15	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.06	0.
2 Cuba to LME#12. Caribbean Sea		1,445.79	721.79 - 1730.05	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.91	0.
G Cyprus to LME#26. Mediterranean		8,841.96	4249.2 - 8920.8	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.06	0.
3 Czech Republic to LME#22. North Sea		10,857.65	2040.21 - 13298.77	1.04	21,195.67	3982.79 - 25961.09	1.04	7,504.06	1410.06 - 9191.19	1.04	44,811.14	8420.27 - 54886.02	1.
Benin to LME#28. Guinea Current		13,077.95	7172.51 - 15335.06	0.62	20,790.05	11402.16 - 24378.19	0.62	7,360.45	4036.79 - 8630.79	0.62	43,953.59	24106.04 - 51539.51	0.
Denmark to LME#22. North Sea		3,117.37	585.77 - 3818.25	1.04	21,195.67	3982.79 - 25961.09	1.04	7,504.06	1410.06 - 9191.19	1.04	44,811.14	8420.27 - 54886.02	1
Denmark to LME#23. Baltic Sea Denmark to LME#60. Faroe Plateau		10,498.03 188.33	5392.85 - 10772.87 93.99 - 914.29	4.36	71,378.35 1.280.49	36667.1 - 73247.03 639.08 - 6216.46	0.51 4.36	25,270.60 453.34	12981.52 - 25932.18 226.26 - 2200.86	0.51 4.36	150,905.61 2.707.16	77520.3 - 154856.3 1351.11 - 13142.63	0.
4 Dominican Republic to LME#12. Caribbean Sea		1,545.87	771.75 - 1849.8	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.91	0.
8 Ecuador to LME#11. Pacific Central-American		1,521.96	759.59 - 7388.73	4.36	2,123.90	1060.01 - 10311	4.36	751.94	375.28 - 3650.48	4.36	4,490.26	2241.04 - 21799.16	4
El Salvador to LME#11. Pacific Central-American		2,097.28	1046.73 - 10181.8	4.36	2,123.90	1060.01 - 10311	4.36	751.94	375.28 - 3650.48	4.36	4,490.26	2241.04 - 21799.16	4
6 Equatorial Guinea to LME#28. Guinea Current		14,004.93	7680.91 - 16422.03	0.62	20,790.05	11402.16 - 24378.19	0.62	7,360.45	4036.79 - 8630.79	0.62	43,953.59	24106.04 - 51539.51	0
1 Ethiopia to LME#32. Arabian Sea		5,792.04	2442.91 - 6373.84	0.68	30,169.71	12724.66 - 33200.21	0.68	10,681.20	4505.01 - 11754.11	0.68	63,783.75	26902.04 - 70190.72	0
Ethiopia to LME#33. Red Sea		5,352.68	2486.52 - 5488.49	0.56	27,881.15	12951.84 - 28588.6	0.56	9,870.96	4585.43 - 10121.43	0.56	58,945.34	27382.32 - 60441.02	0
Eritrea to LME#33. Red Sea Estonia to LME#23. Baltic Sea		15,412.99 38,535,67	7159.91 - 15804.08 19795.8 - 39544.53	0.56 0.51	27,881.15 71.378.35	12951.84 - 28588.6 36667.1 - 73247.03	0.56	9,870.96 25.270.60	4585.43 - 10121.43 12981.52 - 25932.18	0.56	58,945.34 150.905.61	27382.32 - 60441.02 77520.3 - 154856.3	0
s Falkland Islands (Malvinas) to LME#14. Patagonian Shelf		9,187.22	4585.24 - 44601.77	4.36	5,793.14	2891.29 - 28124.32	4.36	2,050.99	1023.62 - 9957.06	4.36	12,247.66	6112.66 - 59459.45	4
Finland to LME#23. Baltic Sea		38,643.28	19851.08 - 39654.96	0.51	71,378.35	36667.1 - 73247.03	0.51	25,270.60	12981.52 - 25932.18	0.51	150,905.61	77520.3 - 154856.3	0
France to LME#22. North Sea		2,913.86	547.53 - 3568.98	1.04	21,195.67	3982.79 - 25961.09	1.04	7,504.06	1410.06 - 9191.19	1.04	44,811.14	8420.27 - 54886.02	1
France to LME#24. Celtic-Biscay Shelf		2,399.47	450.87 - 2938.95	1.04	17,453.98	3279.7 - 21378.16	1.04	6,179.36	1161.14 - 7568.66	1.04	36,900.59	6933.83 - 45196.95	1
France to LME#26. Mediterranean		1,529.93	735.24 - 1543.58	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.06	0
2 Djibouti to LME#32. Arabian Sea		18,417.86	7768.09 - 20267.9	0.68	30,169.71	12724.66 - 33200.21	0.68	10,681.20	4505.01 - 11754.11	0.68	63,783.75	26902.04 - 70190.72	0
Gabon to LME#28. Guinea Current		13,043.97	7153.88 - 15295.22	0.62	20,790.05	11402.16 - 24378.19	0.62	7,360.45	4036.79 - 8630.79	0.62	43,953.59	24106.04 - 51539.51	0
e Georgia to LME#62. Black Sea Gambia to LME#28. Guinea Current		17,264.22 19,658.43	8296.71 - 17418.16 10781.53 - 23051.26	0.53 0.62	41,598.53 20,790.05	19991.12 - 41969.45 11402.16 - 24378.19	0.53	14,727.43 7,360.45	7077.6 - 14858.75 4036.79 - 8630.79	0.53	87,946.16 43,953.59	42264.52 - 88730.33 24106.04 - 51539.51	0
Germany to LME#22. North Sea		4,562.65	857.35 - 5588.47	1.04	21,195.67	3982.79 - 25961.09	1.04	7,504.06	1410.06 - 9191.19	1.04	44,811.14	8420.27 - 54886.02	1
Germany to LME#23. Baltic Sea		15,365.15	7893.08 - 15767.4	0.51	71,378.35	36667.1 - 73247.03	0.51	25,270.60	12981.52 - 25932.18	0.51	150,905.61	77520.3 - 154856.3	0
Ghana to LME#28. Guinea Current		14,639.52	8028.94 - 17166.14	0.62	20,790.05	11402.16 - 24378.19	0.62	7,360.45	4036.79 - 8630.79	0.62	43,953.59	24106.04 - 51539.51	0
Greece to LME#26. Mediterranean		8,120.22	3902.35 - 8192.62	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.06	C
Guatemala to LME#11. Pacific Central-American		651.24	325.03 - 3161.61	4.36	2,123.90	1060.01 - 10311	4.36	751.94	375.28 - 3650.48	4.36	4,490.26	2241.04 - 21799.16	- 4
Guatemala to LME#12. Caribbean Sea		356.69	178.07 - 426.82	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82		2,459.37	1227.81 - 2942.91	0
Guinea to LME#28. Guinea Current Guyana to LME#17. North Brazil Shelf		16,406.40	8997.97 - 19237.97	0.62	20,790.05	11402.16 - 24378.19	0.62	7,360.45	4036.79 - 8630.79		43,953.59	24106.04 - 51539.51	0
a Guyana to LME#17. North Brazil Shelf Haiti to LME#12. Caribbean Sea		3,889.58	232.22 - 5576.32 757.74 - 1816.22	1.37 0.70	4,500.99 1,163.28	268.72 - 6452.86 580.75 - 1392	1.37 0.70	1,593.52 411.84	95.14 - 2284.55 205.61 - 492.82	1.37 0.70	9,515.83 2,459.37	568.12 - 13642.42 1227.81 - 2942.91	1
Honduras to I ME#12. Caribbean Sea		1,517.80 1.133.63	565.95 - 1356.52	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.91	
Hungary to LME#62. Black Sea		20,356.52	9782.79 - 20538.03	0.53	41,598.53	19991.12 - 41969.45	0.53	14,727.43	7077.6 - 14858.75	0.53	87,946.16	42264.52 - 88730.33	0
Iceland to LME#59. Iceland Shelf		1,402.27	699.86 - 6807.69	4.36	1,510.10	753.67 - 7331.16	4.36	534.63	266.83 - 2595.5	4.36	3,192.60	1593.39 - 15499.29	4
India to LME#32. Arabian Sea		6,332.80	2670.98 - 6968.92	0.68	30,169.71	12724.66 - 33200.21	0.68	10,681.20	4505.01 - 11754.11	0.68	63,783.75	26902.04 - 70190.72	(
India to LME#34. Bay of Bengal		4,443.22	1638.81 - 4873.03	0.73	21,167.69	7807.36 - 23215.31	0.73	7,494.15	2764.09 - 8219.08	0.73	44,752.00	16506.04 - 49080.99	C
Indonesia to LME#38. Indonesian Sea		6,011.18	3696.02 - 11528.25	1.30	5,930.87	3646.64 - 11374.23	1.30	2,099.75	1291.05 - 4026.9		12,538.84	7709.6 - 24046.99	
Iran, Islamic Republic of to LME#32. Arabian Sea		13,376.15	5641.65 - 14719.76	0.68	30,169.71	12724.66 - 33200.21	0.68	10,681.20	4505.01 - 11754.11		63,783.75	26902.04 - 70190.72	
Iraq to LME#32. Arabian Sea		12,920.81	5449.6 - 14218.68	0.68	30,169.71	12724.66 - 33200.21	0.68	10,681.20	4505.01 - 11754.11	0.68	63,783.75	26902.04 - 70190.72	
Ireland to LME#24. Celtic-Biscay Shelf Israel to LME#26. Mediterranean		17,768.49	3338.8 - 21763.37 2945.11 - 6182.97	1.04 0.53	17,453.98	3279.7 - 21378.16	1.04 0.53	6,179.36	1161.14 - 7568.66		36,900.59	6933.83 - 45196.95 11307.04 - 23738.06	1
Israel to LME#26. Mediterranean Italy to LME#26. Mediterranean		6,128.33 7,754.52	2945.11 - 6182.97 3726.61 - 7823.66	0.53 0.53	11,128.87 11,128.87	5348.23 - 11228.1 5348.23 - 11228.1	0.53	3,940.04 3,940.04	1893.47 - 3975.17 1893.47 - 3975.17	0.53	23,528.27 23,528.27	11307.04 - 23738.06 11307.04 - 23738.06	
Italy to LME#26. Mediterranean Kosovo to LME#26. Mediterranean		6,004.91	3726.61 - 7823.66 2885.8 - 6058.45	0.53	11,128.87 11,128.87	5348.23 - 11228.1 5348.23 - 11228.1	0.53	3,940.04 3,940.04	1893.47 - 3975.17 1893.47 - 3975.17	0.53	23,528.27 23,528.27	11307.04 - 23738.06 11307.04 - 23738.06	
Côte d'Ivoire to LME#28. Guinea Current		15,667.52	2003.0 - 0038.43 8592.74 - 18371.57	0.55	20,790.05	11402.16 - 24378.19	0.55	7,360.45	4036.79 - 8630.79		43,953.59	24106.04 - 51539.51	
Jamaica to LME#12. Caribbean Sea		1,571.02	784.31 - 1879.91	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.91	6
		1,138.15	510.73 - 1341.63	0.73	12,450.11	5586.79 - 14675.97	0.73	4,407.80	1977.93 - 5195.84	0.73	26,321.58	11811.4 - 31027.42	C
		491.17	243.26 - 593.18	0.71	5,372.88	2661.02 - 6488.75	0.71	1,902.20	942.1 - 2297.26	0.71	11,359.16	5625.83 - 13718.29	0
							0.73						
Japan to LME#47. East China Sea Japan to LME#49. Kuroshio Current Japan to LME#50. Sea of Japan/East Sea		1,811.28	609.14 - 1936.14	0.73	19,813.46	6663.31 - 21179.28		7,014.70	2359.06 - 7498.25	0.73	41,888.91	14087.33 - 44776.49	
a Japan to LME#47. East China Sea Japan to LME#49. Kuroshio Current Japan to LME#450. Sea of Japan/East Sea Japan to LME#51. Oyashio Current		1,811.28 228.17	113.88 - 1107.71	4.36	19,813.46 2,495.94	1245.69 - 12117.17	4.36	883.65	441.02 - 4289.93	4.36	5,276.82	2633.6 - 25617.69	4.
2 Japan to LME#47. East China Sea Japan to LME#49. Kuroshio Current Japan to LME#50. Sea of Japan/East Sea		1,811.28			19,813.46								4.





emocratic People's Republic of Korea to LME#47. East China Sea emocratic People's Republic of Korea to LME#48. Yellow Sea	1,949.18 5,288.96	874.66 - 2297.66 2306.49 - 5698.26	0.73 0.64	12,450.11 33,782.51	5586.79 - 14675.97 14732.39 - 36396.82	0.73 0.64	4,407.80 11,960.27	1977.93 - 5195.84 5215.82 - 12885.83	0.64	26,321.58 71,421.80	11811.4 - 31027.42 31146.7 - 76948.87
emocratic People's Republic of Korea to LME#50. Sea of Japan/East Sea epublic of Korea to LME#47. East China Sea	3,101.98 2,131.22	1043.2 - 3315.81 956.35 - 2512.25	0.73	19,813.46 12,450.11	6663.31 - 21179.28 5586.79 - 14675.97	0.73	7,014.70	2359.06 - 7498.25 1977.93 - 5195.84	0.73	41,888.91 26,321.58	14087.33 - 44776.49 11811.4 - 31027.42
epublic of Korea to LME#48. Yellow Sea	5,782.93	2521.91 - 6230.45	0.75	33,782.51	14732.39 - 36396.82	0.75	11,960.27	5215.82 - 12885.83	0.64	71,421.80	31146.7 - 76948.87
epublic of Korea to LME#50. Sea of Japan/East Sea	3,391.69	1140.63 - 3625.49 3044.11 - 9675.69	0.73	19,813.46	6663.31 - 21179.28 4594.21 - 14602.69	0.73	7,014.70	2359.06 - 7498.25 1626.52 - 5169.89	0.73	41,888.91	14087.33 - 44776.49 9712.93 - 30872.48
ao People's Democratic Republic to LME#36. South China Sea abanon to LME#26. Mediterranean	9,051.71 6,439.34	3094.57 - 6496.76	0.73 0.53	13,660.98 11,128.87	4594.21 - 14602.69 5348.23 - 11228.1	0.73	4,836.50 3,940.04	1893.47 - 3975.17	0.73	28,881.56 23,528.27	11307.04 - 23738.06
tvia to LME#23. Baltic Sea	35,828.36	18405.05 - 36766.35	0.51	71,378.35	36667.1 - 73247.03	0.51	25,270.60	12981.52 - 25932.18	0.51	150,905.61	77520.3 - 154856.3
beria to LME#28. Guinea Current byan Arab Jamahiriya to LME#26. Mediterranean	18,505.35 6.311.36	10149.13 - 21699.17 3033.07 - 6367.64	0.62	20,790.05 11.128.87	11402.16 - 24378.19 5348.23 - 11228.1	0.62	7,360.45 3.940.04	4036.79 - 8630.79 1893.47 - 3975.17	0.62	43,953.59 23.528.27	24106.04 - 51539.51 11307.04 - 23738.06
thuania to LME#23. Baltic Sea	33,510.99	17214.61 - 34388.3	0.51	71,378.35	36667.1 - 73247.03	0.51	25,270.60	12981.52 - 25932.18	0.51	150,905.61	77520.3 - 154856.3
adagascar to LME#30. Agulhas Current	6,968.10	1309.35 - 8534.74	1.04	7,858.44	1476.65 - 9625.25	1.04	2,782.18	522.79 - 3407.7	1.04	16,614.04	3121.87 - 20349.37
alaysia to LME#34. Bay of Bengal alaysia to LME#35. Gulf of Thailand	3,758.44 76.35	1386.24 - 4122.01 38.16 - 2226.49	0.73 28.66	21,167.69 429.98	7807.36 - 23215.31 214.92 - 12539.67	0.73 28.66	7,494.15	2764.09 - 8219.08 76.09 - 4439.51	0.73 28.66	44,752.00 909.05	16506.04 - 49080.99 454.39 - 26510.94
alaysia to LME#36. South China Sea	2,425.58	815.73 - 2592.79	0.73	13,660.98	4594.21 - 14602.69	0.73	4,836.50	1626.52 - 5169.89	0.73	28,881.56	9712.93 - 30872.48
ali to LME#27. Canary Current ali to LME#28. Guinea Current	914.58 4.968.83	456.45 - 4440.05 2725.12 - 5826.4	4.36	3,826.67 20,790.05	1909.85 - 18577.58 11402.16 - 24378.19	4.36 0.62	1,354.78 7,360.45	676.16 - 6577.15 4036.79 - 8630.79	4.36	8,090.22 43,953.59	4037.73 - 39276.06 24106.04 - 51539.51
auritania to LME#27. Canary Current	2,965.74	1480.16 - 14397.94	4.36	3,826.67	1909.85 - 18577.58	4.36	1,354.78	676.16 - 6577.15	4.36	8,090.22	4037.73 - 39276.06
exico to LME#3. California Current	247.74	123.64 - 1202.72	4.36	1,645.78	821.39 - 7989.85	4.36	582.67	290.8 - 2828.71	4.36	3,479.44	1736.55 - 16891.86
exico to LME#4. Gulf of California exico to LME#5. Gulf of Mexico	2,370.27 2,377.19	527.14 - 2805.36 145.82 - 2418.22	0.96	15,746.08 15,792.03	3501.89 - 18636.43 968.69 - 16064.63	0.96	5,574.70 5,590.97	1239.8 - 6597.99 342.95 - 5687.48	0.96	33,289.80 33,386.96	7403.58 - 39400.48 2047.97 - 33963.27
oldova to LME#62. Black Sea	19,732.66	9482.98 - 19908.61	0.53	41,598.53	19991.12 - 41969.45	0.53	14,727.43	7077.6 - 14858.75	0.53	87,946.16	42264.52 - 88730.33
ontenegro to LME#26. Mediterranean	6,004.91	2885.8 - 6058.45	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.0
orocco to LME#26. Mediterranean orocco to LME#27. Canary Current	2,867.41 985.96	1378 - 2892.98 492.08 - 4786.61	0.53	11,128.87 3,826.67	5348.23 - 11228.1 1909.85 - 18577.58	0.53	3,940.04 1,354.78	1893.47 - 3975.17 676.16 - 6577.15	0.53	23,528.27 8,090.22	11307.04 - 23738.0 4037.73 - 39276.0
ozambique to LME#30. Agulhas Current	5,012.94	941.96 - 6140	1.04	7,858.44	1476.65 - 9625.25	1.04	2,782.18	522.79 - 3407.7	1.04	16,614.04	3121.87 - 20349.3
man to LME#32. Arabian Sea	21,274.65	8973 - 23411.65	0.68	30,169.71	12724.66 - 33200.21	0.68	10,681.20	4505.01 - 11754.11	0.68	63,783.75	26902.04 - 70190.7
amibia to LME#29. Benguela Current epal to LME#34. Bay of Bengal	3,124.29 9.178.18	1559.29 - 15167.66 3385.22 - 10066.02	4.36 0.73	4,613.74 21.167.69	2302.67 - 22398.63 7807.36 - 23215.31	4.36 0.73	1,633.44 7.494.15	815.23 - 7929.95 2764.09 - 8219.08	4.36 0.73	9,754.22 44,752.00	4868.22 - 47354.3 16506.04 - 49080.9
etherlands to LME#22. North Sea	14,615.34	2746.31 - 17901.3	1.04	21,195.67	3982.79 - 25961.09	1.04	7,504.06	1410.06 - 9191.19	1.04	44,811.14	8420.27 - 54886.0
ew Caledonia to LME#40. Northeast Australia ew Zealand to LME#46. New Zealand Shelf	1,692.66 2,518.46	268.08 - 8217.47 1256.93 - 12226.52	4.70 4.36	966.37 1,871.56	153.05 - 4691.52 934.07 - 9085.97	4.70 4.36	342.13 662.60	54.19 - 1660.97 330.7 - 3216.77	4.70 4.36	2,043.07 3,956.78	323.58 - 9918.6 1974.78 - 19209.2
icaragua to LME#11. Pacific Central-American	691.81	345.27 - 3358.57	4.36	2,123.90	1060.01 - 10311	4.36	751.94	375.28 - 3650.48	4.36	4,490.26	2241.04 - 21799.1
caragua to LME#12. Caribbean Sea	378.91	189.17 - 453.41	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.9
ger to LME#28. Guinea Current geria to LME#28. Guinea Current	10,873.93 11,375.19	5963.73 - 12750.65 6238.65 - 13338.43	0.62	20,790.05 20,790.05	11402.16 - 24378.19 11402.16 - 24378.19	0.62	7,360.45 7,360.45	4036.79 - 8630.79 4036.79 - 8630.79	0.62	43,953.59 43,953.59	24106.04 - 51539.5 24106.04 - 51539.5
prvay to LME#21. Norwegian Sea	1,528.58	287.23 - 3098.22	1.84	6,338.15	1190.97 - 12846.52	1.84	2,243.94	4036.79 - 8630.79 421.65 - 4548.15	1.84	43,953.59	2517.92 - 27159.6
prway to LME#22. North Sea	5,111.80	960.54 - 6261.08	1.04	21,195.67	3982.79 - 25961.09	1.04	7,504.06	1410.06 - 9191.19	1.04	44,811.14	8420.27 - 54886.0
kistan to LME#32. Arabian Sea nama to LME#11. Pacific Central-American	13,556.88 736.68	5717.88 - 14918.65 367.67 - 3576.4	0.68	30,169.71 2,123.90	12724.66 - 33200.21 1060.01 - 10311	0.68	10,681.20 751.94	4505.01 - 11754.11 375.28 - 3650.48	0.68	63,783.75 4,490.26	26902.04 - 70190.7 2241.04 - 21799.1
nama to LME#12. Caribbean Sea	403.49	201.44 - 482.82	0.70	1,163.28	580.75 - 1392	0.70	411.84	205.61 - 492.82	0.70	2,459.37	1227.81 - 2942.9
araguay to LME#14. Patagonian Shelf	3,331.12	1662.52 - 16171.79	4.36	5,793.14	2891.29 - 28124.32	4.36	2,050.99	1023.62 - 9957.06 74.44 - 1139.89	4.36	12,247.66	6112.66 - 59459.4 444.52 - 6806.9
eru to LME#13. Humboldt Current nilippines to LME#36. South China Sea	301.05 5,097.96	149.81 - 2294.06 1714.45 - 5449.38	7.12 0.73	422.52 13,660.98	210.26 - 3219.68 4594.21 - 14602.69	7.12 0.73	149.59 4,836.50	74.44 - 1139.89 1626.52 - 5169.89	7.12 0.73	893.27 28,881.56	444.52 - 6806.9 9712.93 - 30872.4
ilippines to LME#37. Sulu-Celebes Sea	6,425.88	2161.04 - 6623	0.69	17,219.40	5790.92 - 17747.64	0.69	6,096.31	2050.2 - 6283.33	0.69	36,404.65	12242.96 - 37521.4
land to LME#23. Baltic Sea rtugal to LME#25. Iberian Coastal	35,107.62 2,497.74	18034.81 - 36026.74 1246.59 - 12125.94	0.51 4.36	71,378.35 2,682.17	36667.1 - 73247.03 1338.64 - 13021.3	0.51 4.36	25,270.60 949.59	12981.52 - 25932.18 473.93 - 4610.03	0.51 4.36	150,905.61 5,670.55	77520.3 - 154856. 2830.11 - 27529.1
uinea-Bissau to LME#28. Guinea Current	18,512.85	10153.24 - 21707.97	0.62	20,790.05	11402.16 - 24378.19	0.62	7,360.45	4036.79 - 8630.79	0.62	43,953.59	24106.04 - 51539.5
mor-Leste to LME#38. Indonesian Sea	8,710.92	5355.98 - 16705.81	1.30	5,930.87	3646.64 - 11374.23	1.30	2,099.75	1291.05 - 4026.9	1.30	12,538.84	7709.6 - 24046.9
erto Rico to LME#12. Caribbean Sea mania to LME#62. Black Sea	1,612.49 20,602.61	805.01 - 1929.52 9901.05 - 20786.31	0.70 0.53	1,163.28 41,598.53	580.75 - 1392 19991.12 - 41969.45	0.70	411.84 14,727.43	205.61 - 492.82 7077.6 - 14858.75	0.70	2,459.37 87,946.16	1227.81 - 2942.9 42264.52 - 88730.3
issian Federation to LME#20. Barents Sea	128.55	24.15 - 260.55	1.84	4,956.31	931.32 - 10045.74	1.84	1,754.72	329.72 - 3556.57	1.84	10,478.46	1968.96 - 21238.3
ussian Federation to LME#54. Chukchi Sea	88.56	40.99 - 104.16	0.71	3,414.44	1580.39 - 4015.92	0.71	1,208.84	559.52 - 1421.79	0.71	7,218.69	3341.2 - 8490.3
ussian Federation to LME#56. East Siberian Sea ussian Federation to LME#57. Laptev Sea	46.31 175.99	21.44 - 54.47 81.46 - 206.99	0.71	1,785.58 6,785.50	826.46 - 2100.12 3140.69 - 7980.83	0.71 0.71	632.16 2,402.32	292.6 - 743.52 1111.92 - 2825.51	0.71 0.71	3,775.00 14,345.67	1747.27 - 444 6639.94 - 16872.7
ussian Federation to LME#58. Kara Sea	134.64	62.32 - 158.36	0.71	5,191.29	2402.81 - 6105.79	0.71	1,837.91	850.68 - 2161.68	0.71	10,975.25	5079.94 - 12908.6
ussian Federation to LME#62. Black Sea	1,078.91	518.5 - 1088.53	0.53	41,598.53	19991.12 - 41969.45	0.53	14,727.43	7077.6 - 14858.75	0.53	87,946.16	42264.52 - 88730.3
ussian Federation to LME#64. Arctic Ocean ussian Federation to LME#50. Sea of Japan/East Sea	6.09 513.89	2.28 - 6.78 172.82 - 549.31	0.74 0.73	234.71 19,813.46	87.9 - 261.38 6663.31 - 21179.28	0.74 0.73	83.09 7,014.70	31.12 - 92.54 2359.06 - 7498.25	0.74 0.73	496.21 41,888.91	185.84 - 552.0 14087.33 - 44776.4
ussian Federation to LME#51. Oyashio Current	64.74	32.31 - 314.27	4.36	2,495.94	1245.69 - 12117.17	4.36	883.65	441.02 - 4289.93	4.36	5,276.82	2633.6 - 25617.6
ussian Federation to LME#52. Sea of Okhotsk ussian Federation to LME#53. West Bering Sea	311.68 42.33	58.57 - 631.72 21.13 - 205.52	1.84 4.36	12,016.99 1,632.19	2258.06 - 24356.75 814.61 - 7923.89	1.84 4.36	4,254.46 577.86	799.44 - 8623.2 288.4 - 2805.35	1.84 4.36	25,405.91 3,450.72	4773.92 - 51494.1 1722.21 - 16752.4
audi Arabia to LME#32. Arabian Sea	5,684.01	2397.34 - 6254.96	0.68	30,169.71	12724.66 - 33200.21	0.68	10,681.20	4505.01 - 11754.11	0.68	63,783.75	26902.04 - 70190.73
audi Arabia to LME#33. Red Sea	5,252.84	2440.14 - 5386.13	0.56	27,881.15	12951.84 - 28588.6	0.56	9,870.96	4585.43 - 10121.43	0.56	58,945.34	27382.32 - 60441.0
enegal to LME#27. Canary Current erbia to LME#62. Black Sea	3,391.52 8,438.03	1692.67 - 16465.02 4055.09 - 8513.26	4.36 0.53	3,826.67 41,598.53	1909.85 - 18577.58 19991.12 - 41969.45	4.36 0.53	1,354.78	676.16 - 6577.15 7077.6 - 14858.75	4.36 0.53	8,090.22 87,946.16	4037.73 - 39276.0 42264.52 - 88730.3
erbia to LME#26. Mediterranean	2,257.43	1084.86 - 2277.56	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.0
erra Leone to LME#28. Guinea Current	17,638.63	9673.79 - 20682.87	0.62	20,790.05	11402.16 - 24378.19	0.62	7,360.45	4036.79 - 8630.79	0.62	43,953.59	24106.04 - 51539.5
ovakia to LME#62. Black Sea iet Nam to LME#36. South China Sea	19,961.73 10.915.28	9593.06 - 20139.72 3670.83 - 11667.72	0.53 0.73	41,598.53 13,660.98	19991.12 - 41969.45 4594.21 - 14602.69	0.53	14,727.43 4,836.50	7077.6 - 14858.75 1626.52 - 5169.89	0.53 0.73	87,946.16 28,881.56	42264.52 - 88730.3 9712.93 - 30872.4
ovenia to LME#26. Mediterranean	6,616.68	3179.8 - 6675.68	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.0
omalia to LME#31. Somali Coastal Current	538.42	268.72 - 2613.88	4.36	2,184.28	1090.15 - 10604.16	4.36	773.32	385.95 - 3754.27	4.36	4,617.93	2304.75 - 22418.9
malia to LME#32. Arabian Sea uth Africa to LME#29. Benguela Current	7,436.70 1,201.24	3136.57 - 8183.7 599.52 - 5831.73	0.68	30,169.71 4,613.74	12724.66 - 33200.21 2302.67 - 22398.63	0.68	10,681.20 1,633.44	4505.01 - 11754.11 815.23 - 7929.95	0.68	63,783.75 9,754.22	26902.04 - 70190.7 4868.22 - 47354.3
uth Africa to LME#30. Agulhas Current	2,046.03	384.46 - 2506.04	1.04	7,858.44	1476.65 - 9625.25	1.04	2,782.18	522.79 - 3407.7	1.04	16,614.04	3121.87 - 20349.3
mbabwe to LME#30. Agulhas Current ain to LME#25. Iberian Coastal	4,303.58 714.43	808.67 - 5271.15 356.57 - 3468.41	1.04 4.36	7,858.44 2,682.17	1476.65 - 9625.25 1338.64 - 13021.3	1.04 4.36	2,782.18 949.59	522.79 - 3407.7 473.93 - 4610.03	1.04	16,614.04 5,670.55	3121.87 - 20349.3 2830.11 - 27529.1
pain to LME#26. Mediterranean	2,964.33	1424.58 - 2990.76	0.53	11,128.87	5348.23 - 11228.1	4.50	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.0
udan to LME#33. Red Sea	11,750.93	5458.75 - 12049.1	0.56	27,881.15	12951.84 - 28588.6	0.56	9,870.96	4585.43 - 10121.43	0.56	58,945.34	27382.32 - 60441.0
vaziland to LME#30. Agulhas Current veden to LME#23. Baltic Sea	5,466.38 16,311.16	1027.16 - 6695.38 8379.05 - 16738.18	1.04 0.51	7,858.44 71,378.35	1476.65 - 9625.25 36667.1 - 73247.03	1.04 0.51	2,782.18 25,270.60	522.79 - 3407.7 12981.52 - 25932.18	1.04	16,614.04 150,905.61	3121.87 - 20349.3 77520.3 - 154856.
veden to LME#22. North Sea	4,843.57	910.13 - 5932.55	1.04	21,195.67	3982.79 - 25961.09	1.04	7,504.06	1410.06 - 9191.19	1.04	44,811.14	8420.27 - 54886.0
vitzerland to LME#22. North Sea	2,711.07	509.43 - 3320.6 684.07 - 1436.15	1.04	21,195.67	3982.79 - 25961.09 5348.23 - 11228.1	1.04	7,504.06	1410.06 - 9191.19 1893.47 - 3975.17	1.04	44,811.14	8420.27 - 54886.0
vitzerland to LME#26. Mediterranean vitzerland to LME#62. Black Sea	1,423.46 5,320.73	684.07 - 1436.15 2557 - 5368.17	0.53	11,128.87 41,598.53	5348.23 - 11228.1 19991.12 - 41969.45	0.53	3,940.04 14,727.43	1893.47 - 3975.17 7077.6 - 14858.75	0.53	23,528.27 87,946.16	11307.04 - 23738.0 42264.52 - 88730.3
rian Arab Republic to LME#26. Mediterranean	5,188.23	2493.32 - 5234.49	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.0
ailand to LME#34. Bay of Bengal ogo to LME#28. Guinea Current	13,886.51 14,057.36	5121.81 - 15229.79 7709.66 - 16483.51	0.73	21,167.69 20,790.05	7807.36 - 23215.31 11402.16 - 24378.19	0.73	7,494.15 7,360.45	2764.09 - 8219.08 4036.79 - 8630.79	0.73	44,752.00 43,953.59	16506.04 - 49080.9 24106.04 - 51539.5
hited Arab Emirates to LME#32. Arabian Sea	20,715.44	8737.14 - 22796.27	0.62	30,169.71	12724.66 - 33200.21	0.62	10,681.20	4030.79 - 8030.79 4505.01 - 11754.11	0.62	43,933.39	26902.04 - 70190.7
nisia to LME#26. Mediterranean	7,601.66	3653.15 - 7669.44	0.53	11,128.87	5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.0
rkey to LME#26. Mediterranean sanda to LME#26. Mediterranean	5,982.32 4,814.88	2874.94 - 6035.66 2313.9 - 4857.81	0.53 0.53	11,128.87 11,128.87	5348.23 - 11228.1 5348.23 - 11228.1	0.53	3,940.04 3,940.04	1893.47 - 3975.17 1893.47 - 3975.17	0.53	23,528.27 23,528.27	11307.04 - 23738.0 11307.04 - 23738.0
raine to LME#62. Black Sea	18,287.34	8788.4 - 18450.4	0.53	41,598.53	19991.12 - 41969.45	0.53	14,727.43	7077.6 - 14858.75	0.53	87,946.16	42264.52 - 88730.3
e FYR of Macedonia to LME#26. Mediterranean	6,534.89	3140.49 - 6593.16	0.53	11,128.87	5348.23 - 11228.1 5348.23 - 11228.1	0.53	3,940.04	1893.47 - 3975.17	0.53	23,528.27	11307.04 - 23738.0 11307.04 - 23738.0
ypt to LME#26. Mediterranean hited Kingdom of GB and NI to LME#22. North Sea	5,560.13 5,874.84	2672.05 - 5609.71 1103.92 - 7195.68	0.53	11,128.87 21,195.67	5348.23 - 11228.1 3982.79 - 25961.09	0.53	3,940.04 7,504.06	1893.47 - 3975.17 1410.06 - 9191.19	0.53	23,528.27 44,811.14	11307.04 - 23738.0 8420.27 - 54886.0
nited Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf	4,837.75	909.04 - 5925.42	1.04	17,453.98	3279.7 - 21378.16	1.04	6,179.36	1161.14 - 7568.66	1.04	36,900.59	6933.83 - 45196.9
hited Republic of Tanzania: Mainland to LME#30. Agulhas Current	4,084.75	767.55 - 5003.13 63.77 - 687.82	1.04	7,858.44	1476.65 - 9625.25	1.04	2,782.18	522.79 - 3407.7	1.04	16,614.04	3121.87 - 20349.3
nited States to LME#1. East Bering Sea nited States to LME#2. Gulf of Alaska	339.36 99.95	49.89 - 485.25	1.84	11,406.01 3,359.50	2143.26 - 23118.38 1676.69 - 16309.55	1.84 4.36	4,038.15 1,189.39	758.79 - 8184.77 593.61 - 5774.19	1.84 4.36	24,114.20 7,102.53	4531.2 - 48876.0 3544.79 - 34481.0
hited States to LME#3. California Current	48.97	24.44 - 237.72	4.36	1,645.78	821.39 - 7989.85	4.36	582.67	290.8 - 2828.71	4.36	3,479.44	1736.55 - 16891.8
	468.48	104.19 - 554.48	0.96	15,746.08	3501.89 - 18636.43	0.96	5,574.70	1239.8 - 6597.99	0.96	33,289.80	7403.58 - 39400.4
nited States to LME#4. Gulf of California	469.85	28.82 - 477.96 29.99 - 291.76	0.96 4.36	15,792.03 2,019.95	968.69 - 16064.63 1008.14 - 9806.39	0.96 4.36	5,590.97 715.14	342.95 - 5687.48 356.92 - 3471.83	0.96 4.36	33,386.96 4,270.51	2047.97 - 33963.2 2131.36 - 20732.3
nited States to LME#4. Gulf of California nited States to LME#5. Gulf of Mexico	60.10				3265 - 31759.5	4.36	2,316.09	1155.93 - 11244.05	4.36	13,830.72	6902.75 - 67144.8
nited States to LME#4. Gulf of California nited States to LME#5. Gulf of Mexico nited States to LME#6. Southeast U.S. Continental Shelf nited States to LME#7. Northeast U.S. Continental Shelf	194.64	97.14 - 944.92	4.36	6,541.93							
nited States to LMEH4. Gulf of California Inted States to LMEH5. Gulf of Mexico nited States to LMEH6. Southeast U.S. Continental Shelf nited States to LMEH7. Northasst U.S. Continental Shelf nited States to LMEH70. Insular Pacific-Hawaiian	194.64 16.63	8.3 - 80.72	4.36	558.87	278.92 - 2713.16	4.36	197.86	98.75 - 960.56	4.36	1,181.53	
nited States to LME#4. Gulf of California nited States to LME#5. Gulf of Mexico nited States to LME#6. Southeast U.S. Continental Shelf nited States to LME#7. Northeast U.S. Continental Shelf	194.64					4.36 0.71 0.71	197.86 1,208.84 1,698.62	98.75 - 960.56 559.52 - 1421.79 786.21 - 1997.85	4.36 0.71 0.71	1,181.53 7,218.69 10,143.49	589.69 - 5736.06 3341.2 - 8490.33 4694.95 - 11930.35
nited States to LME#4. Gulf of California nited States to LME#6. Gulf of Mexico nited States to LME#7. Southeast U.S. Continental Shelf nited States to LME#7. Northeast U.S. Continental Shelf nited States to LME#10. Insular Pardiff-Hawaiian nited States to LME#10. Insular Pardiff-Hawaiian nited States to LME#5. Beaufort Sea nited States to LME#55. Beaufort Sea	194.64 16.63 101.59 142.75 4,786.56	8.3 - 80.72 47.02 - 119.48 66.07 - 167.89 2388.92 - 23237.6	4.36 0.71 0.71 4.36	558.87 3,414.44 4,797.87 5,793.14	278.92 - 2713.16 1580.39 - 4015.92 2220.71 - 5643.06 2891.29 - 28124.32	0.71 0.71 4.36	1,208.84 1,698.62 2,050.99	559.52 - 1421.79 786.21 - 1997.85 1023.62 - 9957.06	0.71 0.71 4.36	7,218.69 10,143.49 12,247.66	3341.2 - 8490.3 4694.95 - 11930.3 6112.66 - 59459.45
hted States to LMEH4. Guff of California htted States to LMEH5. Guff of Mexico htted States to LMEH6. Subthast U.S. Continental Shelf hited States to LMEH61. Insular Pacific-Hawaiian htted States to LMEH61. Insular Pacific-Hawaiian htted States to LMEH63. Chuckhi Sea htted States to LMEH65. Beaudord Sea	194.64 16.63 101.59 142.75	8.3 - 80.72 47.02 - 119.48 66.07 - 167.89	4.36 0.71 0.71	558.87 3,414.44 4,797.87	278.92 - 2713.16 1580.39 - 4015.92 2220.71 - 5643.06	0.71 0.71	1,208.84 1,698.62	559.52 - 1421.79 786.21 - 1997.85	0.71 0.71	7,218.69 10,143.49	3341.2 - 8490.3 4694.95 - 11930.3



**Table 3.34:** Calculation of the uncertainty range for the available BGE data values (del Giorgio & Cole 1998) influencing the oxygen comsumption with the degradation of organic matter, expressed in the XF.

	emission route:		N to Air			N to sfw			N to gw			N to mw	
	r	Estimated CF	Var range		Estimated CF	Varrange		Estimated CF	Var range		Estimated CF	Var range	7
Country-to-LME	unit:	PAF.m3.d/kgN	PAF.m3.d/kgN	%var	PAF.m3.d/kgN	PAF.m3.d/kgN	%var	PAF.m3.d/kgN	PAF.m3.d/kgN	%var	PAF.m3.d/kgN	PAF.m3.d/kgN	%
Albania to LME#26. Mediterranean Algeria to LME#26. Mediterranean		7,606.07 7.211.38	3189.73 - 10186.56 3024.21 - 9657.96	0.92 0.92	11,128.87 11.128.87	4667.07 - 14904.53 4667.07 - 14904.53	0.92 0.92	3,940.04 3.940.04	1652.32 - 5276.76 1652.32 - 5276.76	0.92	23,528.27 23.528.27	9866.96 - 31510.63 9866.96 - 31510.63	
Angola to LME#20. Reguela Current		2,490.13	1044.28 - 3334.95	0.92	4,613.74	1934.85 - 6179.03	0.92	1,633.44	685.01 - 2187.61	0.92	9,754.22	4090.59 - 13063.5	5 O.
Argentina to LME#14. Patagonian Shelf		4,416.45	1852.11 - 5914.8	0.92	5,793.14	2429.45 - 7758.56	0.92	2,050.99	860.12 - 2746.82	0.92	12,247.66	5136.26 - 16402.88	3 0.
Australia to LME#39. North Australia		154.64	64.85 - 207.11	0.92	3,094.40	1297.69 - 4144.23	0.92	1,095.53	459.43 - 1467.21	0.92	6,542.07	2743.53 - 8761.58	8 0.
Australia to LME#40. Northeast Australia		48.29	20.25 - 64.68	0.92	966.37	405.26 - 1294.23	0.92	342.13	143.48 - 458.21	0.92	2,043.07	856.8 - 2736.22	2 0.
Australia to LME#41. East-Central Australia		52.72	22.11 - 70.61	0.92	1,054.97	442.42 - 1412.88	0.92	373.50	156.63 - 500.21	0.92	2,230.37	935.34 - 2987.06	
Australia to LME#42. Southeast Australia Australia to LME#43. Southwest Australia		81.68 78.27	34.25 - 109.39 32.82 - 104.83	0.92	1,634.43 1,566.22	685.43 - 2188.94 656.82 - 2097.59	0.92	578.65 554.50	242.67 - 774.97 232.54 - 742.63	0.92	3,455.46 3,311.26	1449.1 - 4627.78 1388.63 - 4434.65	3 O. 5 O.
Australia to LME#45. Southwest Australia Australia to LME#44. West-Central Australia		59.76	25.06 - 80.04	0.92	1,300.22	501.51 - 1601.6	0.92	423.39	177.55 - 567.03	0.92	2.528.28	1060.28 - 3386.05	
Australia to LME#45. Northwest Australia		75.31	31.58 - 100.86	0.92	1,506.92	631.95 - 2018.17	0.92	533.51	223.73 - 714.51	0.92	3,185.88	1336.05 - 4266.74	0.
Austria to LME#26. Mediterranean		5,986.51	2510.54 - 8017.54	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	B 0.
Bahamas to LME#12. Caribbean Sea		1,490.85	625.21 - 1996.65	0.92	1,163.28	487.84 - 1557.94	0.92	411.84	172.71 - 551.57	0.92	2,459.37	1031.38 - 3293.75	6 0.
Bangladesh to LME#34. Bay of Bengal		11,107.20	4657.98 - 14875.5	0.92	21,167.69	8877.02 - 28349.19	0.92	7,494.15	3142.8 - 10036.67	0.92	44,752.00	18767.48 - 59934.86	
Belgium to LME#22. North Sea		14,146.99	5932.77 - 18946.59 4086.14 - 13049.3	0.92	21,195.67	8888.75 - 28386.65	0.92	7,504.06	3146.95 - 10049.93	0.92	44,811.14	18792.28 - 60014.07	
Bhutan to LME#34. Bay of Bengal Bolivia to LME#13. Humboldt Current		9,743.61 214.72	4086.14 - 13049.3 90.05 - 287.57	0.92 0.92	21,167.69 422.52	8877.02 - 28349.19 177.19 - 565.86	0.92 0.92	7,494.15 149.59	3142.8 - 10036.67 62.73 - 200.34	0.92	44,752.00 893.27	18767.48 - 59934.86 374.61 - 1196.33	5 0. 3 0.
Bosnia and Herzegovina to LME#26. Mediterranean		6,433.01	2697.79 - 8615.52	0.92	422.32	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	s 0.
Botswana to LME#30. Agulhas Current		4,689.03	1966.42 - 6279.86	0.92	7,858.44	3295.57 - 10524.55	0.92	2,782.18	1166.75 - 3726.08	0.92	16,614.04	6967.37 - 22250.63	3 0.
Brazil to LME#15. South Brazil Shelf		280.94	117.82 - 376.25	0.92	2,212.79	927.97 - 2963.51	0.92	783.41	328.54 - 1049.19	0.92	4,678.20	1961.88 - 6265.35	5 O.
Brazil to LME#16. East Brazil Shelf		122.26	51.27 - 163.74	0.92	962.97	403.84 - 1289.67	0.92	340.93	142.97 - 456.59	0.92	2,035.87	853.78 - 2726.58	3 0
Brazil to LME#17. North Brazil Shelf		571.46	239.65 - 765.33	0.92	4,500.99	1887.56 - 6028.02	0.92	1,593.52	668.27 - 2134.14	0.92	9,515.83	3990.62 - 12744.23	
Belize to LME#12. Caribbean Sea		1,097.00	460.05 - 1469.18	0.92	1,163.28	487.84 - 1557.94	0.92	411.84	172.71 - 551.57	0.92	2,459.37	1031.38 - 3293.75	
Virgin Islands (British) to LME#12. Caribbean Sea		1,692.38	709.73 - 2266.54	0.92	1,163.28	487.84 - 1557.94	0.92	411.84	172.71 - 551.57	0.92	2,459.37	1031.38 - 3293.75	5 0
Bulgaria to LME#26. Mediterranean Bulgaria to LME#62. Black Sea		2,330.43 8,710.90	977.3 - 3121.07 3653.06 - 11666.21	0.92 0.92	11,128.87 41,598.53	4667.07 - 14904.53 17445.02 - 55711.53	0.92	3,940.04 14,727.43	1652.32 - 5276.76 6176.19 - 19723.96	0.92	23,528.27 87,946.16	9866.96 - 31510.63 36881.66 - 117783.35	8 0. 5 0.
Myanmar to LME#34. Bay of Bengal		12,033.02	5046.24 - 16115.42	0.92	21,167.69	8877.02 - 28349.19	0.92	7,494.15	3142.8 - 10036.67	0.92	44,752.00	18767.48 - 59934.86	5 0
Belarus to LME#23. Baltic Sea		29,863.38	12523.69 - 39995.02	0.92	71,378.35	29933.68 - 95594.65	0.92	25,270.60	10597.64 - 33844.07	0.92	150,905.61	63284.73 - 202102.85	
Cambodia to LME#3. California Current		1,187.57	498.03 - 1590.48	0.92	1,645.78	690.18 - 2204.13	0.92	582.67	244.35 - 780.35	0.92	3,479.44	1459.16 - 4659.9	e c
Cameroon to LME#28. Guinea Current		10,509.35	4407.27 - 14074.82	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	3 0
Canada to LME#2. Gulf of Alaska		216.39	90.75 - 289.8	0.92	3,359.50	1408.86 - 4499.26	0.92	1,189.39	498.79 - 1592.91	0.92	7,102.53	2978.56 - 9512.18	3 0
Canada to LME#63. Hudson Bay		524.41	219.92 - 702.33	0.92	8,141.68	3414.34 - 10903.87	0.92	2,882.46	1208.81 - 3860.38	0.92	17,212.84	7218.49 - 23052.59	9 0
Canada to LME#9. Newfoundland-Labrador Shelf		157.96	66.24 - 211.55	0.92	2,452.32	1028.42 - 3284.31	0.92	868.21	364.1 - 1162.77	0.92	5,184.60	2174.25 - 6943.57	0
Canada to LME#8. Scotian Shelf		1,060.60	444.78 - 1420.42	0.92	16,466.06	6905.31 - 22052.45 98.43 - 314.33	0.92	5,829.60	2444.74 - 7807.39 34.85 - 111.29	0.92	34,811.98	14598.97 - 46622.52 208.09 - 664.55	2 0
Canada to LME#64. Arctic Ocean Sri Lanka to LME#34. Bay of Bengal		15.12 25,932.46	6.34 - 20.25 10875.2 - 34730.48	0.92	234.71 21,167.69	98.43 - 314.33 8877.02 - 28349.19	0.92	83.09 7,494.15	34.85 - 111.29 3142.8 - 10036.67	0.92	496.21 44,752.00	208.09 - 664.55 18767.48 - 59934.86	5 0
Chile to LME#13. Humboldt Current		25,932.46 369.57	10875.2 - 34730.48 154.98 - 494.95	0.92	422.52	177.19 - 565.86	0.92	149.59	62.73 - 200.34	0.92	44,752.00 893.27	374.61 - 1196.33	
China, People's Republic of to LME#36. South China Sea		1,810.54	759.28 - 2424.8	0.92	13,660.98	5728.95 - 18295.69	0.92	4,836.50	2028.26 - 6477.36	0.92	28,881.56	12111.95 - 38680.11	LO
China, People's Republic of to LME#47. East China Sea		1,650.06	691.98 - 2209.87	0.92	12,450.11	5221.15 - 16674.01	0.92	4,407.80	1848.48 - 5903.22	0.92	26,321.58	11038.38 - 35251.61	
China, People's Republic of to LME#48. Yellow Sea		4,477.33	1877.64 - 5996.34	0.92	33,782.51	14167.25 - 45243.79	0.92	11,960.27	5015.73 - 16017.99	0.92	71,421.80	29951.9 - 95652.84	0
Colombia to LME#11. Pacific Central-American		523.34	219.47 - 700.89	0.92	2,123.90	890.69 - 2844.46	0.92	751.94	315.34 - 1007.05	0.92	4,490.26	1883.07 - 6013.66	5 0
Colombia to LME#12. Caribbean Sea		286.64	120.21 - 383.88	0.92	1,163.28	487.84 - 1557.94	0.92	411.84	172.71 - 551.57	0.92	2,459.37	1031.38 - 3293.75	5 (
Congo to LME#28. Guinea Current		10,781.75	4521.5 - 14439.64	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	3 0
Democratic Republic of the Congo to LME#28. Guinea Current		8,817.57	3697.79 - 11809.08 312.14 - 996.85	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	
Costa Rica to LME#11. Pacific Central-American Costa Rica to LME#12. Caribbean Sea		744.33 407.68	312.14 - 996.85 170.97 - 545.99	0.92 0.92	2,123.90 1,163.28	890.69 - 2844.46 487.84 - 1557.94	0.92	751.94 411.84	315.34 - 1007.05 172.71 - 551.57	0.92	4,490.26 2,459.37	1883.07 - 6013.66 1031.38 - 3293.75	5 0
Croatia to LME#26. Mediterranean		6,318.80	2649.89 - 8462.56	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	3 0
Cuba to LME#12. Caribbean Sea		1,445.79	606.32 - 1936.3	0.92	1,163.28	487.84 - 1557.94	0.92	411.84	172.71 - 551.57	0.92	2,459.37	1031.38 - 3293.75	5 0
Cyprus to LME#26. Mediterranean		8,841.96	3708.02 - 11841.74	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	3 (
Czech Republic to LME#22. North Sea		10,857.65	4553.33 - 14541.28	0.92	21,195.67	8888.75 - 28386.65	0.92	7,504.06	3146.95 - 10049.93	0.92	44,811.14	18792.28 - 60014.07	7 (
Benin to LME#28. Guinea Current		13,077.95	5484.45 - 17514.86	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	3 (
Denmark to LME#22. North Sea		3,117.37	1307.32 - 4174.99	0.92	21,195.67	8888.75 - 28386.65	0.92	7,504.06	3146.95 - 10049.93	0.92	44,811.14	18792.28 - 60014.07	
Denmark to LME#23. Baltic Sea Denmark to LME#60. Faroe Plateau		10,498.03 188.33	4402.52 - 14059.66 78.98 - 252.22	0.92	71,378.35 1,280.49	29933.68 - 95594.65 536.99 - 1714.92	0.92	25,270.60 453.34	10597.64 - 33844.07 190.12 - 607.14	0.92	150,905.61 2,707.16	63284.73 - 202102.85 1135.29 - 3625.61	
Dominican Republic to LME#12. Caribbean Sea		1,545.87	648.28 - 2070.33	0.92	1,163.28	487.84 - 1557.94	0.92	433.34	172.71 - 551.57	0.92	2,459.37	1031.38 - 3293.75	5 (
Ecuador to LME#11. Pacific Central-American		1,521.96	638.26 - 2038.3	0.92	2.123.90	890.69 - 2844.46	0.92	751.94	315.34 - 1007.05	0.92	4,490,26	1883.07 - 6013.66	
El Salvador to LME#11. Pacific Central-American		2,097.28	879.53 - 2808.82	0.92	2,123.90	890.69 - 2844.46	0.92	751.94	315.34 - 1007.05	0.92	4,490.26	1883.07 - 6013.66	
Equatorial Guinea to LME#28. Guinea Current		14,004.93	5873.2 - 18756.33	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	3
Ethiopia to LME#32. Arabian Sea		5,792.04	2428.99 - 7757.08	0.92	30,169.71	12652.16 - 40405.29	0.92	10,681.20	4479.34 - 14304.98	0.92	63,783.75	26748.76 - 85423.45	5
Ethiopia to LME#33. Red Sea		5,352.68	2244.73 - 7168.66	0.92	27,881.15	11692.41 - 37340.29	0.92	9,870.96	4139.55 - 13219.85	0.92	58,945.34	24719.69 - 78943.53	
ritrea to LME#33. Red Sea		15,412.99	6463.69 - 20642.1	0.92	27,881.15	11692.41 - 37340.29	0.92	9,870.96	4139.55 - 13219.85	0.92	58,945.34	24719.69 - 78943.53	3
Estonia to LME#23. Baltic Sea Falkland Islands (Malvinas) to LME#14. Patagonian Shelf		38,535.67 9.187.22	16160.56 - 51609.54 3852.81 - 12304.14	0.92 0.92	71,378.35 5.793.14	29933.68 - 95594.65 2429.45 - 7758.56	0.92 0.92	25,270.60 2.050.99	10597.64 - 33844.07 860.12 - 2746.82	0.92	150,905.61 12,247.66	63284.73 - 202102.85 5136.26 - 16402.88	3
Finland to LME#23. Baltic Sea		38,643.28	16205.69 - 51753.66	0.92	71,378.35	29933.68 - 95594.65	0.92	25,270.60	10597.64 - 33844.07	0.92	150,905.61	63284.73 - 202102.85	5
France to LME#22. North Sea		2,913.86	1221.97 - 3902.44	0.92	21,195.67	8888.75 - 28386.65	0.92	7,504.06	3146.95 - 10049.93	0.92	44,811.14	18792.28 - 60014.07	7
France to LME#24. Celtic-Biscay Shelf		2,399.47	1006.26 - 3213.54	0.92	17,453.98	7319.61 - 23375.53	0.92	6,179.36	2591.42 - 8275.81	0.92	36,900.59	15474.87 - 49419.73	3
France to LME#26. Mediterranean		1,529.93	641.6 - 2048.99	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	3
Djibouti to LME#32. Arabian Sea		18,417.86	7723.83 - 24666.43	0.92	30,169.71	12652.16 - 40405.29	0.92	10,681.20	4479.34 - 14304.98	0.92	63,783.75	26748.76 - 85423.45	
Gabon to LME#28. Guinea Current		13,043.97	5470.2 - 17469.36	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	
Georgia to LME#62. Black Sea Sambia to LME#28. Guinea Current		17,264.22 19.658.43	7240.03 - 23121.4 8244.08 - 26327.88	0.92 0.92	41,598.53 20,790.05	17445.02 - 55711.53 8718.65 - 27843.42	0.92 0.92	14,727.43 7.360.45	6176.19 - 19723.96 3086.73 - 9857.61	0.92	87,946.16 43.953.59	36881.66 - 117783.35 18432.66 - 58865.58	3
Germany to LME#22. North Sea		4,562.65	1913.42 - 6110.61	0.92	21,195.67	8888.75 - 28386.65	0.92	7,500.45	3146.95 - 10049.93	0.92	45,955.59	18792.28 - 60014.07	7
Germany to LME#23. Baltic Sea		15.365.15	6443.62 - 20578.03	0.92	71,378.35	29933.68 - 95594.65	0.92	25.270.60	10597.64 - 33844.07	0.92	150,905.61	63284.73 - 202102.85	5
Ghana to LME#28. Guinea Current		14,639.52	6139.32 - 19606.22	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	3
Greece to LME#26. Mediterranean		8,120.22	3405.35 - 10875.13	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	3
Suatemala to LME#11. Pacific Central-American		651.24	273.11 - 872.18	0.92	2,123.90	890.69 - 2844.46	0.92	751.94	315.34 - 1007.05	0.92	4,490.26	1883.07 - 6013.66	5
Suatemala to LME#12. Caribbean Sea		356.69	149.58 - 477.7	0.92	1,163.28	487.84 - 1557.94	0.92	411.84	172.71 - 551.57	0.92	2,459.37	1031.38 - 3293.75	5
Suinea to LME#28. Guinea Current		16,406.40	6880.29 - 21972.54	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	
Suyana to LME#17. North Brazil Shelf		3,889.58	1631.16 - 5209.18	0.92	4,500.99	1887.56 - 6028.02	0.92	1,593.52	668.27 - 2134.14	0.92	9,515.83	3990.62 - 12744.23	
laiti to LME#12. Caribbean Sea Ionduras to LME#12. Caribbean Sea		1,517.80 1,133.63	636.51 - 2032.73 475.41 - 1518.23	0.92 0.92	1,163.28 1,163.28	487.84 - 1557.94 487.84 - 1557.94	0.92 0.92	411.84 411.84	172.71 - 551.57 172.71 - 551.57	0.92	2,459.37 2,459.37	1031.38 - 3293.75 1031.38 - 3293.75	
ungary to LME#12. Canbbean sea		20,356.52	475.41 - 1518.23 8536.84 - 27262.81	0.92	41.598.53	487.84 - 1557.94 17445.02 - 55711.53	0.92	411.84 14,727.43	6176.19 - 19723.96	0.92	2,459.37 87,946.16		
eland to LME#59. Iceland Shelf		1,402.27	588.07 - 1878.01	0.92	1,510.10	633.28 - 2022.42	0.92	534.63	224.21 - 716.01	0.92	3,192.60	1338.87 - 4275.74	
ndia to LME#32. Arabian Sea		6,332.80	2655.76 - 8481.31	0.92	30,169.71	12652.16 - 40405.29	0.92	10,681.20	4479.34 - 14304.98	0.92	63,783.75	26748.76 - 85423.45	
ndia to LME#34. Bay of Bengal		4,443.22	1863.34 - 5950.66	0.92	21,167.69	8877.02 - 28349.19	0.92	7,494.15	3142.8 - 10036.67	0.92	44,752.00	18767.48 - 59934.86	
donesia to LME#38. Indonesian Sea		6,011.18	2520.89 - 8050.58	0.92	5,930.87	2487.21 - 7943.02	0.92	2,099.75	880.56 - 2812.12	0.92	12,538.84	5258.37 - 16792.85	
an, Islamic Republic of to LME#32. Arabian Sea		13,376.15	5609.51 - 17914.23	0.92	30,169.71	12652.16 - 40405.29	0.92	10,681.20	4479.34 - 14304.98	0.92	63,783.75	26748.76 - 85423.45	
aq to LME#32. Arabian Sea		12,920.81	5418.55 - 17304.41	0.92	30,169.71	12652.16 - 40405.29	0.92	10,681.20	4479.34 - 14304.98	0.92	63,783.75	26748.76 - 85423.45	
reland to LME#24. Celtic-Biscay Shelf srael to LME#26. Mediterranean		17,768.49 6.128.33	7451.5 - 23796.74 2570.02 - 8207.47	0.92 0.92	17,453.98 11,128.87	7319.61 - 23375.53 4667.07 - 14904.53	0.92 0.92	6,179.36 3,940.04	2591.42 - 8275.81 1652.32 - 5276.76	0.92	36,900.59 23.528.27	15474.87 - 49419.73 9866.96 - 31510.63	
aly to LME#26. Mediterranean		6,128.33 7,754.52	3251.98 - 10385.36	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27 23,528.27	9866.96 - 31510.63	
osovo to LME#26. Mediterranean		6,004.91	2518.26 - 8042.18	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	
ôte d'Ivoire to LME#28. Guinea Current		15,667.52	6570.43 - 20982.99	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	
		1,571.02	658.83 - 2104.02	0.92	1,163.28	487.84 - 1557.94	0.92	411.84	172.71 - 551.57	0.92	2,459.37	1031.38 - 3293.75	5
amaica to LME#12. Caribbean Sea		1,138.15	477.3 - 1524.28	0.92	12,450.11	5221.15 - 16674.01	0.92	4,407.80	1848.48 - 5903.22	0.92	26,321.58	11038.38 - 35251.61	L
		491.17	205.98 - 657.81	0.92	5,372.88	2253.21 - 7195.72	0.92	1,902.20	797.72 - 2547.55	0.92	11,359.16	4763.65 - 15212.95	
apan to LME#47. East China Sea		491.17	203.30 037.01										
apan to LME#47. East China Sea apan to LME#49. Kuroshio Current apan to LME#50. Sea of Japan/East Sea		1,811.28	759.59 - 2425.79	0.92	19,813.46	8309.1 - 26535.5	0.92	7,014.70	2941.73 - 9394.56	0.92	41,888.91	17566.8 - 56100.43	3
lapan to LME#47. East China Sea Japan to LME#49. Kuroshio Current Japan to LME#50. Sea of Japan/East Sea Japan to LME#51. Oyashio Current		1,811.28 228.17	759.59 - 2425.79 95.69 - 305.58	0.92	19,813.46 2,495.94	1046.71 - 3342.72	0.92	883.65	370.57 - 1183.45	0.92	5,276.82	17566.8 - 56100.43 2212.92 - 7067.07	3
Jamaica to LUME#12. Caribbean Sea Japan to LUME#12. Eart China Sea Japan to LUME#49. Eart China Sea Japan to LUME#50. Sea of Japan/East Sea Japan to LUME#50. Oyashio Current Japan to LUME#51. Oyashio Current Japan to LUME#52. Sea of Okhotsk Jordan to LUME#32. Red Sea		1,811.28	759.59 - 2425.79		19,813.46							17566.8 - 56100.43	3





Democratic People's Republic of Korea to LME#47. East China Sea Democratic People's Republic of Korea to LME#48. Yellow Sea	1,949.18 5,288.96	817.42 - 2610.47 2218.01 - 7083.33	0.92	12,450.11 33,782.51	5221.15 - 16674.01 14167.25 - 45243.79	0.92	4,407.80 11,960.27	1848.48 - 5903.22 5015.73 - 16017.99	0.92	26,321.58 71.421.80	11038.38 - 35251.61 29951.9 - 95652.84	
Democratic People's Republic of Korea to LME#50. Sea of Japan/East Sea	3,101.98	1300.87 - 4154.38	0.92	19,813.46	8309.1 - 26535.5	0.92	7,014.70	2941.73 - 9394.56	0.92	41,888.91	17566.8 - 56100.43	з
Republic of Korea to LME#47. East China Sea Republic of Korea to LME#48. Yellow Sea	2,131.22 5,782.93	893.76 - 2854.27 2425.16 - 7744.88	0.92	12,450.11 33,782.51	5221.15 - 16674.01 14167.25 - 45243.79	0.92	4,407.80 11,960.27	1848.48 - 5903.22 5015.73 - 16017.99	0.92	26,321.58 71,421.80	11038.38 - 35251.61 29951.9 - 95652.84	
Republic of Korea to LME#50. Sea of Japan/East Sea Lao People's Democratic Republic to LME#36. South China Sea	3,391.69 9.051.71	1422.36 - 4542.38 3795.98 - 12122.66	0.92	19,813.46 13.660.98	8309.1 - 26535.5 5728.95 - 18295.69	0.92	7,014.70	2941.73 - 9394.56 2028.26 - 6477.36	0.92	41,888.91 28.881.56	17566.8 - 56100.43 12111.95 - 38680.11	
Lao People's Democratic Republic to EME#36. South China Sea Lebanon to LME#26. Mediterranean	6,439.34	2700.44 - 8624	0.92	13,660.98	4667.07 - 14904.53	0.92	4,836.50 3,940.04	2028.26 - 6477.36 1652.32 - 5276.76	0.92	28,881.56	9866.96 - 31510.63	
Latvia to LME#23. Baltic Sea	35,828.36	15025.21 - 47983.73	0.92	71,378.35	29933.68 - 95594.65	0.92	25,270.60	10597.64 - 33844.07	0.92	150,905.61	63284.73 - 202102.85	
Liberia to LME#28. Guinea Current Libyan Arab Jamahiriya to LME#26. Mediterranean	18,505.35 6,311.36	7760.52 - 24783.59 2646.77 - 8452.6	0.92	20,790.05 11,128.87	8718.65 - 27843.42 4667.07 - 14904.53	0.92 0.92	7,360.45 3,940.04	3086.73 - 9857.61 1652.32 - 5276.76	0.92 0.92	43,953.59 23,528.27	18432.66 - 58865.58 9866.96 - 31510.63	
Lithuania to LME#23. Baltic Sea	33,510.99	14053.38 - 44880.15	0.92	71,378.35	29933.68 - 95594.65	0.92	25,270.60	10597.64 - 33844.07	0.92	150,905.61	63284.73 - 202102.85	
Madagascar to LME#30. Agulhas Current Malaysia to LME#34. Bay of Bengal	6,968.10 3,758.44	2922.19 - 9332.15 1576.16 - 5033.55	0.92	7,858.44 21,167.69	3295.57 - 10524.55 8877.02 - 28349.19	0.92	2,782.18	1166.75 - 3726.08 3142.8 - 10036.67	0.92	16,614.04 44,752.00	6967.37 - 22250.63 18767.48 - 59934.86	
Malaysia to LME#35. Gulf of Thailand	76.35	32.02 - 102.25	0.92	429.98	180.32 - 575.86	0.92	152.23	63.84 - 203.88	0.92	909.05	381.22 - 1217.46	6
Malaysia to LME#36. South China Sea Mali to LME#27. Canary Current	2,425.58 914.58	1017.21 - 3248.5 383.54 - 1224.86	0.92	13,660.98 3,826.67	5728.95 - 18295.69 1604.78 - 5124.93	0.92	4,836.50	2028.26 - 6477.36 568.15 - 1814.42	0.92	28,881.56 8,090.22	12111.95 - 38680.11 3392.76 - 10834.96	
Mali to LME#28. Guinea Current	4,968.83	2083.76 - 6654.59	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	8
Mauritania to LME#27. Canary Current Mexico to LME#3. California Current	2,965.74 247.74	1243.73 - 3971.91 103.89 - 331.79	0.92	3,826.67	1604.78 - 5124.93 690.18 - 2204.13	0.92	1,354.78 582.67	568.15 - 1814.42 244.35 - 780.35	0.92	8,090.22 3,479.44	3392.76 - 10834.96 1459.16 - 4659.9	
Mexico to LME#4. Gulf of California	2,370.27	994.01 - 3174.43	0.92	15,746.08	6603.37 - 21088.19	0.92	5,574.70	2337.84 - 7466.01	0.92	33,289.80	13960.62 - 44583.92	2
Mexico to LME#5. Gulf of Mexico Moldova to LME#62. Black Sea	2,377.19 19,732.66	996.91 - 3183.69 8275.21 - 26427.3	0.92	15,792.03 41,598.53	6622.65 - 21149.74 17445.02 - 55711.53	0.92	5,590.97 14,727.43	2344.66 - 7487.8 6176.19 - 19723.96	0.92	33,386.96 87,946.16	14001.37 - 44714.05 36881.66 - 117783.35	
Montenegro to LME#26. Mediterranean	6,004.91	2518.26 - 8042.18	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	3
Morocco to LME#26. Mediterranean Morocco to LME#27. Canary Current	2,867.41 985.96	1202.5 - 3840.23 413.48 - 1320.47	0.92	11,128.87 3.826.67	4667.07 - 14904.53 1604.78 - 5124.93	0.92	3,940.04 1,354.78	1652.32 - 5276.76 568.15 - 1814.42	0.92	23,528.27 8,090.22	9866.96 - 31510.63 3392.76 - 10834.96	
Mozambique to LME#30. Agulhas Current	5,012.94	2102.26 - 6713.67	0.92	7,858.44	3295.57 - 10524.55	0.92	2,782.18	1166.75 - 3726.08	0.92	16,614.04	6967.37 - 22250.63	3
Oman to LME#32. Arabian Sea Namibia to LME#29. Benguela Current	21,274.65 3,124.29	8921.87 - 28492.43 1310.22 - 4184.25	0.92	30,169.71 4,613.74	12652.16 - 40405.29 1934.85 - 6179.03	0.92	10,681.20 1,633.44	4479.34 - 14304.98 685.01 - 2187.61	0.92 0.92	63,783.75 9,754.22	26748.76 - 85423.45 4090.59 - 13063.5	
Nepal to LME#34. Bay of Bengal	9,178.18	3849.02 - 12292.03	0.92	21,167.69	8877.02 - 28349.19	0.92	7,494.15	3142.8 - 10036.67	0.92	44,752.00	18767.48 - 59934.86	
Netherlands to LME#22. North Sea New Caledonia to LME#40. Northeast Australia	14,615.34 1,692.66	6129.18 - 19573.83 709.85 - 2266.93	0.92	21,195.67 966.37	8888.75 - 28386.65 405.26 - 1294.23	0.92 0.92	7,504.06 342.13	3146.95 - 10049.93 143.48 - 458.21	0.92 0.92	44,811.14 2,043.07	18792.28 - 60014.07 856.8 - 2736.22	
New Zealand to LME#46. New Zealand Shelf	2,518.46	1056.16 - 3372.89	0.92	1,871.56	405.26 - 1294.23 784.87 - 2506.52	0.92	662.60	277.87 - 887.4	0.92	3,956.78	1659.34 - 5299.19	
Nicaragua to LME#11. Pacific Central-American	691.81	290.12 - 926.52	0.92	2,123.90	890.69 - 2844.46	0.92	751.94	315.34 - 1007.05	0.92	4,490.26	1883.07 - 6013.66	6
Nicaragua to LME#12. Caribbean Sea Niger to LME#28. Guinea Current	378.91 10,873.93	158.9 - 507.46 4560.16 - 14563.09	0.92	1,163.28 20,790.05	487.84 - 1557.94 8718.65 - 27843.42	0.92	411.84 7,360.45	172.71 - 551.57 3086.73 - 9857.61	0.92	2,459.37 43,953.59	1031.38 - 3293.75 18432.66 - 58865.58	
Nigeria to LME#28. Guinea Current	11,375.19	4770.37 - 15234.42	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	8
Norway to LME#21. Norwegian Sea Norway to LME#22. North Sea	1,528.58 5,111.80	641.04 - 2047.18 2143.72 - 6846.06	0.92	6,338.15 21,195.67	2658 - 8488.47 8888.75 - 28386.65	0.92	2,243.94 7,504.06	941.03 - 3005.23 3146.95 - 10049.93	0.92 0.92	13,399.88 44,811.14	5619.46 - 17946.02 18792.28 - 60014.07	
Pakistan to LME#32. Arabian Sea	13,556.88	5685.3 - 18156.28	0.92	30,169.71	12652.16 - 40405.29	0.92	10,681.20	4479.34 - 14304.98	0.92	63,783.75	26748.76 - 85423.45	5
Panama to LME#11. Pacific Central-American Panama to LME#12. Caribbean Sea	736.68 403.49	308.94 - 986.61 169.21 - 540.38	0.92	2,123.90 1,163.28	890.69 - 2844.46 487.84 - 1557.94	0.92	751.94 411.84	315.34 - 1007.05 172.71 - 551.57	0.92	4,490.26 2,459.37	1883.07 - 6013.66 1031.38 - 3293.75	
Paraguay to LME#14. Patagonian Shelf	3,331.12	1396.96 - 4461.26	0.92	5,793.14	2429.45 - 7758.56	0.92	2,050.99	860.12 - 2746.82	0.92	12,247.66	5136.26 - 16402.88	8
Peru to LME#13. Humboldt Current Philippines to LME#36. South China Sea	301.05	126.25 - 403.18 2137.91 - 6827.52	0.92	422.52 13.660.98	177.19 - 565.86	0.92	149.59 4.836.50	62.73 - 200.34 2028.26 - 6477.36	0.92	893.27 28.881.56	374.61 - 1196.33 12111.95 - 38680.11	-
Philippines to LME#37. Sulu-Celebes Sea	6,425.88	2694.8 - 8605.96	0.92	17,219.40	7221.24 - 23061.37	0.92	6,096.31	2556.59 - 8164.58	0.92	36,404.65	15266.88 - 48755.54	
Poland to LME#23. Baltic Sea	35,107.62	14722.95 - 47018.47	0.92	71,378.35	29933.68 - 95594.65	0.92	25,270.60	10597.64 - 33844.07	0.92	150,905.61	63284.73 - 202102.85	
Portugal to LME#25. Iberian Coastal Guinea-Bissau to LME#28. Guinea Current	2,497.74 18,512.85	1047.47 - 3345.14 7763.67 - 24793.64	0.92	2,682.17 20,790.05	1124.81 - 3592.14 8718.65 - 27843.42	0.92 0.92	949.59 7,360.45	398.23 - 1271.75 3086.73 - 9857.61	0.92 0.92	5,670.55 43,953.59	2378.04 - 7594.38 18432.66 - 58865.58	
Timor-Leste to LME#38. Indonesian Sea	8,710.92	3653.07 - 11666.25	0.92	5,930.87	2487.21 - 7943.02	0.92	2,099.75	880.56 - 2812.12	0.92	12,538.84	5258.37 - 16792.85	
Puerto Rico to LME#12. Caribbean Sea Romania to LME#62. Black Sea	1,612.49 20,602.61	676.22 - 2159.55 8640.04 - 27592.39	0.92	1,163.28 41,598.53	487.84 - 1557.94 17445.02 - 55711.53	0.92	411.84 14,727.43	172.71 - 551.57 6176.19 - 19723.96	0.92 0.92	2,459.37 87,946.16	1031.38 - 3293.75 36881.66 - 117783.35	
Russian Federation to LME#20. Barents Sea	128.55	53.91 - 172.16	0.92	4,956.31	2078.51 - 6637.82	0.92	1,754.72	735.87 - 2350.04	0.92	10,478.46	4394.31 - 14033.45	
Russian Federation to LME#54. Chukchi Sea Russian Federation to LME#56. East Siberian Sea	88.56 46.31	37.14 - 118.6 19.42 - 62.02	0.92	3,414.44 1,785.58	1431.9 - 4572.85 748.81 - 2391.36	0.92	1,208.84 632.16	506.95 - 1618.96 265.11 - 846.63	0.92	7,218.69 3,775.00	3027.28 - 9667.75 1583.11 - 5055.73	
Russian Federation to LME#56. East Siderian Sea	46.31	19.42 - 62.02 73.8 - 235.7	0.92	6,785.50	2845.61 - 9087.59	0.92	2,402.32	265.11 - 846.63 1007.45 - 3217.35	0.92	14,345.67	6016.09 - 19212.67	
Russian Federation to LME#58. Kara Sea	134.64	56.46 - 180.32	0.92	5,191.29	2177.05 - 6952.53	0.92	1,837.91	770.76 - 2461.45	0.92	10,975.25	4602.65 - 14698.79	9
Russian Federation to LME#62. Black Sea Russian Federation to LME#64. Arctic Ocean	1,078.91 6.09	452.46 - 1444.95 2.55 - 8.15	0.92	41,598.53 234.71	17445.02 - 55711.53 98.43 - 314.33	0.92	14,727.43 83.09	6176.19 - 19723.96 34.85 - 111.29	0.92	87,946.16 496.21	36881.66 - 117783.35 208.09 - 664.55	
Russian Federation to LME#50. Sea of Japan/East Sea	513.89	215.51 - 688.23	0.92	19,813.46	8309.1 - 26535.5	0.92	7,014.70	2941.73 - 9394.56	0.92	41,888.91	17566.8 - 56100.43	3
Russian Federation to LME#51. Oyashio Current Russian Federation to LME#52. Sea of Okhotsk	64.74 311.68	27.15 - 86.7 130.71 - 417.42	0.92	2,495.94 12,016.99	1046.71 - 3342.72 5039.52 - 16093.96	0.92	883.65 4,254.46	370.57 - 1183.45 1784.18 - 5697.86	0.92	5,276.82 25,405.91	2212.92 - 7067.07 10654.38 - 34025.28	
Russian Federation to LME#53. West Bering Sea	42.33	17.75 - 56.7	0.92	1,632.19	684.49 - 2185.94	0.92	577.86	242.33 - 773.9	0.92	3,450.72	1447.11 - 4621.43	3
Saudi Arabia to LME#32. Arabian Sea Saudi Arabia to LME#33. Red Sea	5,684.01 5,252.84	2383.68 - 7612.41 2202.87 - 7034.96	0.92 0.92	30,169.71 27,881.15	12652.16 - 40405.29 11692.41 - 37340.29	0.92 0.92	10,681.20 9,870.96	4479.34 - 14304.98 4139.55 - 13219.85	0.92 0.92	63,783.75 58,945.34	26748.76 - 85423.45 24719.69 - 78943.53	
Senegal to LME#27. Canary Current	3,391.52	1422.29 - 4542.15	0.92	3,826.67	1604.78 - 5124.93	0.92	1,354.78	568.15 - 1814.42	0.92	8,090.22	3392.76 - 10834.96	
Serbia to LME#62. Black Sea Serbia to LME#26. Mediterranean	8,438.03 2,257.43	3538.62 - 11300.77 946.69 - 3023.3	0.92	41,598.53 11.128.87	17445.02 - 55711.53 4667.07 - 14904.53	0.92	14,727.43 3.940.04	6176.19 - 19723.96 1652.32 - 5276.76	0.92	87,946.16 23.528.27	36881.66 - 117783.35 9866.96 - 31510.63	
Sierra Leone to LME#28. Guinea Current	17,638.63	7397.05 - 23622.83	0.92	20,790.05	8718.65 - 27843.42	0.92	7,360.45	3086.73 - 9857.61	0.92	43,953.59	18432.66 - 58865.58	
Slovakia to LME#62. Black Sea	19,961.73	8371.28 - 26734.07	0.92	41,598.53	17445.02 - 55711.53	0.92	14,727.43	6176.19 - 19723.96	0.92	87,946.16	36881.66 - 117783.35	
Viet Nam to LME#36. South China Sea Slovenia to LME#26. Mediterranean	10,915.28 6,616.68	4577.5 - 14618.47 2774.81 - 8861.5	0.92	13,660.98 11.128.87	5728.95 - 18295.69 4667.07 - 14904.53	0.92	4,836.50 3.940.04	2028.26 - 6477.36 1652.32 - 5276.76	0.92 0.92	28,881.56 23,528.27	12111.95 - 38680.11 9866.96 - 31510.63	
Somalia to LME#31. Somali Coastal Current	538.42	225.79 - 721.08	0.92	2,184.28	916.01 - 2925.33	0.92	773.32	324.3 - 1035.68	0.92	4,617.93	1936.6 - 6184.64	
Somalia to LME#32. Arabian Sea South Africa to LME#29. Benguela Current	7,436.70 1,201.24	3118.7 - 9959.72 503.76 - 1608.78	0.92	30,169.71 4,613.74	12652.16 - 40405.29 1934.85 - 6179.03	0.92	10,681.20 1,633.44	4479.34 - 14304.98 685.01 - 2187.61	0.92	63,783.75 9,754.22	26748.76 - 85423.45 4090.59 - 13063.5	
South Africa to LME#30. Agulhas Current	2,046.03	858.04 - 2740.18	0.92	7,858.44	3295.57 - 10524.55	0.92	2,782.18	1166.75 - 3726.08	0.92	16,614.04	6967.37 - 22250.63	
Zimbabwe to LME#30. Agulhas Current	4,303.58	1804.78 - 5763.64	0.92	7,858.44	3295.57 - 10524.55	0.92	2,782.18	1166.75 - 3726.08	0.92	16,614.04	6967.37 - 22250.63	
Spain to LME#25. Iberian Coastal Spain to LME#26. Mediterranean	714.43 2,964.33	299.61 - 956.82 1243.14 - 3970.03	0.92	2,682.17 11,128.87	1124.81 - 3592.14 4667.07 - 14904.53	0.92	949.59 3,940.04	398.23 - 1271.75 1652.32 - 5276.76	0.92	5,670.55 23,528.27	2378.04 - 7594.38 9866.96 - 31510.63	
Sudan to LME#33. Red Sea	11,750.93	4927.95 - 15737.63	0.92	27,881.15	11692.41 - 37340.29	0.92	9,870.96	4139.55 - 13219.85	0.92	58,945.34	24719.69 - 78943.53	3
Swaziland to LME#30. Agulhas Current Sweden to LME#23. Baltic Sea	5,466.38 16,311.16	2292.41 - 7320.94 6840.35 - 21844.99	0.92	7,858.44	3295.57 - 10524.55 29933.68 - 95594.65	0.92	2,782.18 25,270.60	1166.75 - 3726.08 10597.64 - 33844.07	0.92	16,614.04 150,905.61	6967.37 - 22250.63 63284.73 - 202102.85	
Sweden to LME#22. North Sea	4,843.57	2031.23 - 6486.83	0.92	21,195.67	8888.75 - 28386.65	0.92	7,504.06	3146.95 - 10049.93	0.92	44,811.14	18792.28 - 60014.07	17
Switzerland to LME#22. North Sea Switzerland to LME#26. Mediterranean	2,711.07 1,423.46	1136.93 - 3630.84 596.95 - 1906.39	0.92	21,195.67 11,128.87	8888.75 - 28386.65 4667.07 - 14904.53	0.92	7,504.06 3,940.04	3146.95 - 10049.93 1652.32 - 5276.76	0.92	44,811.14 23,528.27	18792.28 - 60014.07 9866.96 - 31510.63	
Switzerland to LME#20. Neureranean Switzerland to LME#62. Black Sea	5,320.73	2231.34 - 7125.88	0.92	41,598.53	17445.02 - 55711.53	0.92	14,727.43	6176.19 - 19723.96	0.92	87,946.16	36881.66 - 117783.35	
Syrian Arab Republic to LME#26. Mediterranean	5,188.23	2175.77 - 6948.42	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	
Thailand to LME#34. Bay of Bengal Togo to LME#28. Guinea Current	13,886.51 14,057.36	5823.53 - 18597.74 5895.18 - 18826.56	0.92	21,167.69 20,790.05	8877.02 - 28349.19 8718.65 - 27843.42	0.92 0.92	7,494.15 7,360.45	3142.8 - 10036.67 3086.73 - 9857.61	0.92 0.92	44,752.00 43,953.59	18767.48 - 59934.86 18432.66 - 58865.58	
United Arab Emirates to LME#32. Arabian Sea	20,715.44	8687.36 - 27743.5	0.92	30,169.71	12652.16 - 40405.29	0.92	10,681.20	4479.34 - 14304.98	0.92	63,783.75	26748.76 - 85423.45	5
Tunisia to LME#26. Mediterranean Turkey to LME#26. Mediterranean	7,601.66 5,982.32	3187.88 - 10180.65 2508.78 - 8011.92	0.92	11,128.87 11,128.87	4667.07 - 14904.53 4667.07 - 14904.53	0.92	3,940.04 3,940.04	1652.32 - 5276.76 1652.32 - 5276.76	0.92 0.92	23,528.27 23,528.27	9866.96 - 31510.63 9866.96 - 31510.63	
Uganda to LME#26. Mediterranean	4,814.88	2019.2 - 6448.41	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	3
Ukraine to LME#62. Black Sea The FYR of Macedonia to LME#26. Mediterranean	18,287.34 6,534.89	7669.09 - 24491.63 2740.51 - 8751.97	0.92	41,598.53 11.128.87	17445.02 - 55711.53 4667.07 - 14904.53	0.92	14,727.43 3.940.04	6176.19 - 19723.96 1652.32 - 5276.76	0.92 0.92	87,946.16 23.528.27	36881.66 - 117783.35 9866.96 - 31510.63	
Egypt to LME#26. Mediterranean	5,560.13	2331.73 - 7446.5	0.92	11,128.87	4667.07 - 14904.53	0.92	3,940.04	1652.32 - 5276.76	0.92	23,528.27	9866.96 - 31510.63	з
United Kingdom of GB and NI to LME#22. North Sea United Kingdom of GB and NI to LME#24. Celtic-Biscay Shelf	5,874.84 4,837.75	2463.71 - 7867.98 2028.79 - 6479.04	0.92	21,195.67 17,453.98	8888.75 - 28386.65 7319.61 - 23375.53	0.92	7,504.06 6,179.36	3146.95 - 10049.93 2591.42 - 8275.81	0.92	44,811.14 36,900.59	18792.28 - 60014.07 15474.87 - 49419.73	
United Republic of Tanzania: Mainland to LME#30. Agulhas Current	4,084.75	1713.01 - 5470.57	0.92	7,858.44	3295.57 - 10524.55	0.92	2,782.18	1166.75 - 3726.08	0.92	16,614.04	6967.37 - 22250.63	3
United States to LME#1. East Bering Sea United States to LME#2. Gulf of Alaska	339.36 99.95	142.31 - 454.49 41.92 - 133.86	0.92	11,406.01 3,359.50	4783.3 - 15275.69 1408.86 - 4499.26	0.92	4,038.15 1,189.39	1693.47 - 5408.17 498.79 - 1592.91	0.92	24,114.20 7,102.53	10112.68 - 32295.34 2978.56 - 9512.18	
United States to LME#3. California Current	99.95 48.97	41.92 - 133.86 20.53 - 65.58	0.92	3,359.50 1,645.78	1408.86 - 4499.26 690.18 - 2204.13	0.92	1,189.39 582.67	498.79 - 1592.91 244.35 - 780.35	0.92	7,102.53 3,479.44	1459.16 - 4659.9	9
United States to LME#4. Gulf of California	468.48	196.47 - 627.42	0.92	15,746.08	6603.37 - 21088.19	0.92	5,574.70	2337.84 - 7466.01	0.92	33,289.80	13960.62 - 44583.92	2
United States to LME#5. Gulf of Mexico United States to LME#6. Southeast U.S. Continental Shelf	469.85 60.10	197.04 - 629.25 25.2 - 80.49	0.92	15,792.03 2,019.95	6622.65 - 21149.74 847.1 - 2705.26	0.92	5,590.97 715.14	2344.66 - 7487.8 299.91 - 957.76	0.92	33,386.96 4,270.51	14001.37 - 44714.05 1790.91 - 5719.36	
United States to LME#7. Northeast U.S. Continental Shelf	194.64	81.62 - 260.67	0.92	6,541.93	2743.46 - 8761.39	0.92	2,316.09	971.29 - 3101.86	0.92	13,830.72	5800.14 - 18523.02	12
United States to LME#10. Insular Pacific-Hawaiian	16.63 101 59	6.97 - 22.27	0.92	558.87 3 414 44	234.37 - 748.47 1431 9 - 4572 85	0.92	197.86 1 208 84	82.98 - 264.99 506 95 - 1618 96	0.92	1,181.53	495.5 - 1582.39	
United States to LME#54. Chukchi Sea United States to LME#55. Beaufort Sea	101.59 142.75	42.6 - 136.05 59.86 - 191.18	0.92	3,414.44 4,797.87	1431.9 - 4572.85 2012.07 - 6425.63	0.92	1,208.84 1,698.62	506.95 - 1618.96 712.35 - 2274.91	0.92	7,218.69 10,143.49	3027.28 - 9667.75 4253.84 - 13584.84	
Uruguay to LME#14. Patagonian Shelf	4,786.56	2007.32 - 6410.48	0.92	5,793.14	2429.45 - 7758.56	0.92	2,050.99	860.12 - 2746.82	0.92	12,247.66	5136.26 - 16402.88	8
Venezuela (Bolivarian Republic of) to LME#12. Caribbean Sea	874.99	366.94 - 1171.84 7779.86 - 24845.36	0.92	1,163.28	487.84 - 1557.94 12652.16 - 40405.29	0.92 0.92	411.84 10,681.20	172.71 - 551.57 4479.34 - 14304.98	0.92 0.92	2,459.37 63,783.75	1031.38 - 3293.75 26748.76 - 85423.45	
Yemen to LME#32. Arabian Sea	18,551.47			30,169.71								