



Regulations affecting recreational fishing and hunting of marine species and maritime traffic in Øresund

Jorgensen, Anna; Lusseau, David

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Anna Jorgensen and David Lusseau

DTU Aqua Report no. 417-2023



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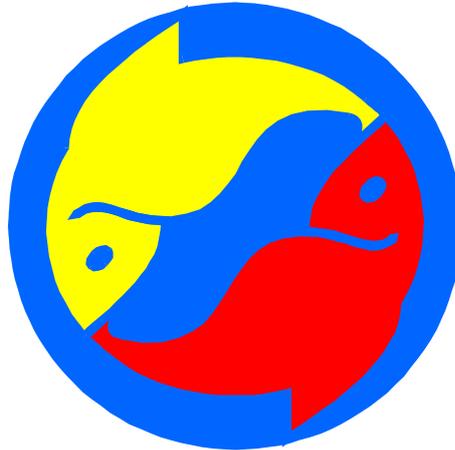
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Preface

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DTU Aqua, Kgs. Lyngby
January 2023

Anna Jorgensen and David Lusseau

Contents

Summary	5
1. Introduction.....	6
1.1 Objectives	7
2. Methods.....	8
2.1 Retrieving legal documents	8
2.2 Management instruments	8
3. Results	9
3.1 Retrieval of texts.....	9
3.2 Government Department Categorization.....	10
3.3 Management Instruments.....	12
3.3.1 Recreational fisheries.....	12
3.3.2 Commercial fisheries.....	20
3.3.3 Maritime Traffic.....	21
3.3.4 Controlling seal populations	21
3.3.5 Bird Hunting regulations	24
4. Discussion	27
4.1 The importance of the policy context in which management instruments are applied	27
4.2 National implementation of European legislation	27
4.3 Similar EU interpretations.....	28
4.4 Applying regulations: the governance and management context.....	28
5. Conclusion.....	30
6. Reference.....	31
7. Acknowledgements	37
8. Appendix	38

Summary

Executing environmental ambitions and targets determined by a complex set of laws and rules can be challenging. This challenge is further complicated in border regions where management actions need to account for rules and laws emerging in multiple countries. Denmark and Sweden are two countries that face these types of challenges, where their maritime boundary meets within the Øresund strait. They are also member States of the European Union and therefore EU legislation influences national legislation governing marine activities. This shared legislative framework can create opportunities to harmonise environmental management actions in this border region, but that will depend on how EU legislation is interpreted nationally. Here we aim to investigate how Danish and Swedish legal acts pertaining to the fisheries, hunting, and maritime sectors, compare in terms of similar or different management instruments in addition to how they interact with EU legislation. Using keyword search queries and citation networks, we found differences and similarities in how countries interpret international agreements for their own national policies. Difference may be related to different management approaches to regulate marine activities, with Denmark having a more centralized approach and Sweden diverging in management based on private and public land and waters. There are differences in the governing bodies implementing the same EU legislation between the two countries possibly leading to different interpretations and thus hurdles to harmonisation. Both countries use similar instruments to manage marine activities, but with differing targets. Particularly, we find there can be differences in recreational fishing minimum catch sizes and closed fishing periods, along with variations in bird hunting seasons in the Øresund region. While the differences may be small, the policy argumentative context in which they take place might lead to complications for those to be harmonised. This is because how governing authorities manage and set targets (i.e., habitat restoration, population sizes, environmental markers etc.) can differ across borders even when they interpret the same European legislation. Finally, Sweden has legal opportunities to use territorial user rights schemes for fisheries which Denmark seems to lack. This places a difference in fisheries management approaches that can be achieved simultaneously between the two countries. We identify challenges and opportunities to jointly reach international environmental agreements and targets in this border region.

1. Introduction

Managing marine activities requires the coordination of complex interactions between multiple governing authorities at multiple scales (national, regional, and municipal) [1]. Importantly the argumentation settling how and by whom marine activities are managed will be shaped by the legal tradition of a country. This means that similar ambitions might end up being governed and managed in different manners in different nations and at times in different regions [2].

The EU Commission's Communication on "Boosting growth and cohesion in EU border regions" highlights the importance of countries to focus on collaboration to build "good practices" across national borders [3]. Specifically, this communication focuses heavily on cross-border transportation infrastructure, health care, tax, and employment agreements. It does also acknowledge joint environmental action, especially since some EU environmental legal acts explicitly state the need for cooperation between countries to achieve for example European biodiversity ambitions [3]. Since species, environmental pollution, and ecosystem health is not confined by the borders of countries, understanding how countries' policies operate for environmental management and monitoring in border regions is crucial to achieve Europe-wide Good Environmental Status.

Denmark and Sweden share a boundary region lying within the Øresund strait. The Øresund region has had great success with infrastructure investment. This is due to both governments cooperation in building the Øresund bridge across the strait, which in turn, has greatly boosted economic productivity [4]. Over the years, as industrialization, recreational activities, and community infrastructure on both sides of the border expanded, environmental pressure and challenges have followed [5]. At the same time, the large shipping volume in the narrow strait as reduced opportunities for bottom-trawling commercial fisheries and therefore reduced a key pressure altering benthic habitats in other parts of Europe. As both countries aim to develop a comprehensive unified approach to manage human activities to maintain the socioeconomic potential of the region while addressing biodiversity restoration and conservation objectives, it is important to understand how those activities are regulated in each nation. Understanding differences in regulations is a first step though. If a unified cross-border environmental management plan is to be developed, we must understand the legislative and regulatory context from which management actions emerge [2]. Understanding this regulatory context is needed to develop a theory of change on the best approach to change current management actions to those that can be applied on both side of the border [6, 7]. Differences in government set up, legislation, and management could place hurdles on the development of a border region environmental management plan. Much of the national regulations for human activities that can affect Øresund strait's environmental status are influenced by European Directives and Regulations [1]. Therefore, a first step to understand how Danish and Swedish legal acts might interact in regulating common human activities is to understand similarities and differences in national management and how European legislation is integrated in the laws and regulations of both countries. Here we aim to map out the legislative differences and similarities between Denmark and Sweden as it pertains to three major activities found within the region of the Øresund strait. These activities include fisheries, hunting, and maritime traffic. We aim to develop the foundation for a theory of change for Øresund by estimating the legal context from which current management instruments emerge on both sides of the border. This legal context

is needed to understand how instruments can be changed to increase their coherence and whether governance, regulatory or legislative barriers exist that would impede change.

To do so, we performed keyword search queries within Danish and Swedish legislations along with estimating how European decisions are cited in legal decisions of both countries. By constructing a network of shared citation among Danish and Swedish legal decisions, this 'quantitative jurisprudence' approach [8], can help elucidate how legal argumentation to regulate human activities pervades in the two nations based on commonly agreed legal decisions (European decisions). These database searches and networks can provide an approach to assess whether the shape and form of legal interactions is conducive to developing synergies between the two nations, or whether conflicts might arise because of legal constraints in one nation or the other. Importantly, this approach provides an avenue to identify the more important European decisions to shape national regulations in both countries, and therefore identify whether literal legal common ground exist for each of these activities to develop joint and unified management actions.

1.1 Objectives

Our focus is to:

1. Find key legislations that discuss regulations around different focal activities which may occur in the Øresund region (commercial and recreational fisheries, bird hunting, seal hunting/culls, maritime traffic).
2. Highlight key current differences and commonalities in management approaches (instruments) for the focal activities.
3. Assess which EU legislations these country legislations highly interact with
4. Appraise how those interactions possibly create opportunities to meet both Danish and Swedish regulatory ambitions and where ambitions differ.

Overall, understanding the similarities and differences between environmental related legislation is important for building and adjusting management strategies for progress toward achieving joint environmental targets

2. Methods

2.1 Retrieving legal documents

We used the Danish Civil Service Agency's legal database website, Restinformation [9], and the Swedish Parliament's database [10] to retrieve legal acts and regulations. Additionally, we needed to use the Swedish database's Application Programming Interface (API) to obtain text selection [11]. Within each database we performed three search queries to retrieve documents that pertain to fisheries, hunting, and maritime traffic (Table 1).

Table 1: Search terms in their language counterpart

	Danish	Swedish
Fisheries	Fiskeri	Fiske
Hunting	Jagt	Jakt
Maritime Traffic	Søtrafik	Sjöfart

To further categorize the documents, we detected if the text contained certain terms (Table 2). In addition, we extracted what EU legal acts the country legislations are cited. For further detailed information text and citation extraction methodology, reference Appendix A: Methods Notes.

Table 2: Additional categorizing terms searched

		Danish	Swedish
Fisheries	Commercial	kommercielt fisk	yrkesfisk
		erhvervsmæssigt fisk	
	Recreational	erhvervsfisk	
		lystfiske	fritidsfisk
fritidsfiske		spöfiske	
Harpoon/spear fishing	rekreativt fisk	handredskapsfiske	
	rekreative fisk	husbehovfisk	
		fiske för husbehov	
	harpun	harpoon	
Hunting	bird	undervandsfisk	undervattensjakt
		unkdervandsjagt	
	seal	fugle	fågel
		sæljagt	säljakt
Maritime Traffic	boat traffic	sæl	säl
		sæler	sälar
		bådtrafik	båttrafik

2.2 Management instruments

Once the key governance bodies, and when available the Delegated Authorities, were identified through the Legal context estimation in both countries, we could query their websites to find the management instruments used in Denmark and Sweden to manage the activities.

3. Results

3.1 Retrieval of texts

The fisheries query resulted in 1,012 Danish and 105 Swedish legal texts. The hunting query resulted in 347 Danish legal texts and 35 Swedish legal texts. The marine traffic query resulted in eight Danish and 125 Swedish legal texts. The Danish legislation titled, "Ligningsvejledning 2000 E. Erhvervsdrivende", appeared in both the fisheries and hunting queries. However, it has a faulty webpage/url and thus we were unable to extract any text data for this result. Therefore, this document was removed in the further analysis and not counted within the table below (Table 3). The number of legislations mentioning additional description terms varies across the counties and terms (Table 3)

Table 3: Query and additional terms search results for Danish and Swedish legislation. *The same document can be pulled for multiple search queries. Thus, the total is not the sum of the bolded numbers.

Query	Relation to	Danish	No. Docs	Swedish	No. Docs	
Fisheries	Commercial	fiskeri	1011	fiske	105	
		kommercielt fisk	3	yrkesfisk	12	
		erhvervsmæssigt	55			
		fisk	97			
	Recreational	erhvervsfisk	61			
		lystfiske	10	fritidsfisk	3	
		fritidsfiske	10	spöfiske	1	
		rekreativt fisk	3	hundredskapsfiske	1	
	Harpoon/spear fishing	rekreative fisk			husbehovfisk	0
		harpun	3	harpun	fiske för husbehov	0
		undervandsfisk	2	undervattensjakt	0	
		unkdervandsjagt	0			
Hunting	bird	jagt	346	jakt	35	
		fugle	175	fågel	3	
	seal	sæljagt	0	säljakt	1	
		sæl	6	säl	3	
		sæler	8	sälar	1	
Maritime Traffic	boat traffic	søtrafik	8	sjofart	125	
		bådtraffik	0	båttrafik	0	
Total*			1211		223	

3.2 Linkage to EU legislation

211 Danish legislations reference an EU legislation, totaling to 243 unique EU legislations cited. We found 92 Swedish legislations reference an EU legislation, totaling to 301 unique EU legislations cited.

3.3 Government Department Categorization

We find that governance responsibility for the country legal texts varies between the countries. In total, Danish legal texts related to fisheries are categorized into 19 different governmental units, hunting into 14, and maritime traffic into three (Figure 1). For Sweden, fisheries legal texts are categorized into 12 governmental units, hunting into 6 units, and 10 units for maritime traffic (Figure 1). We see particularly Sweden has categorized their ministries to cover broader scope of government topics, such that in 2023 the Ministry of Enterprise and Innovation was merged with the Ministry of the Environment to be now called the Ministry of Climate and Enterprise. In addition, this new department has proportionally a larger remit in governing fisheries and hunting activity in Sweden. While Denmark has more specific ministries, such that Denmark has three distinct ministries which could encompass the Swedish Ministry of climate and enterprise. These are the Ministry of the Environment, Ministry of Climate, Energy and Supply, and Ministry of Business and Industry. In addition, the managing authorities for Danish and Swedish legislation varies greatly as well between the search queries. We see Denmark has many more managing authorities associated across the three topics (Denmark = 101, Sweden = 38). Furthermore, we see that in Denmark fisheries related legal acts have a larger breadth of managing authorities than the other two queries (Figure 2).

Table 4: Departments/ministries with the highest proportion of legislations within each search query.

Query	Country	Ministry (English translation)	Proportion of Legislation
Fisheries	Denmark	Ministry of Food, Agriculture, and Fisheries	0.353
	Sweden	Ministry of the Climate and Business	0.438
Hunting	Denmark	Ministry of the Environment	0.367
	Sweden	Ministry of the Climate and Business	0.571
Maritime traffic	Denmark	Ministry of Taxation	0.50
	Sweden	Ministry of Finance	0.552

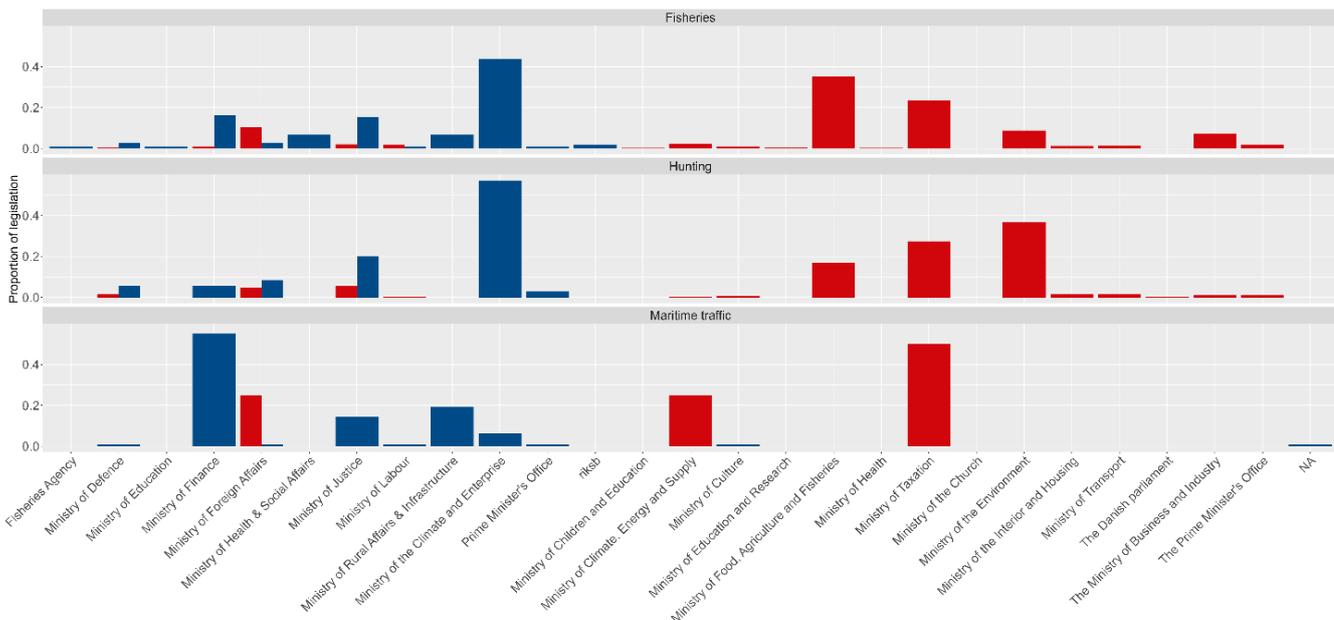
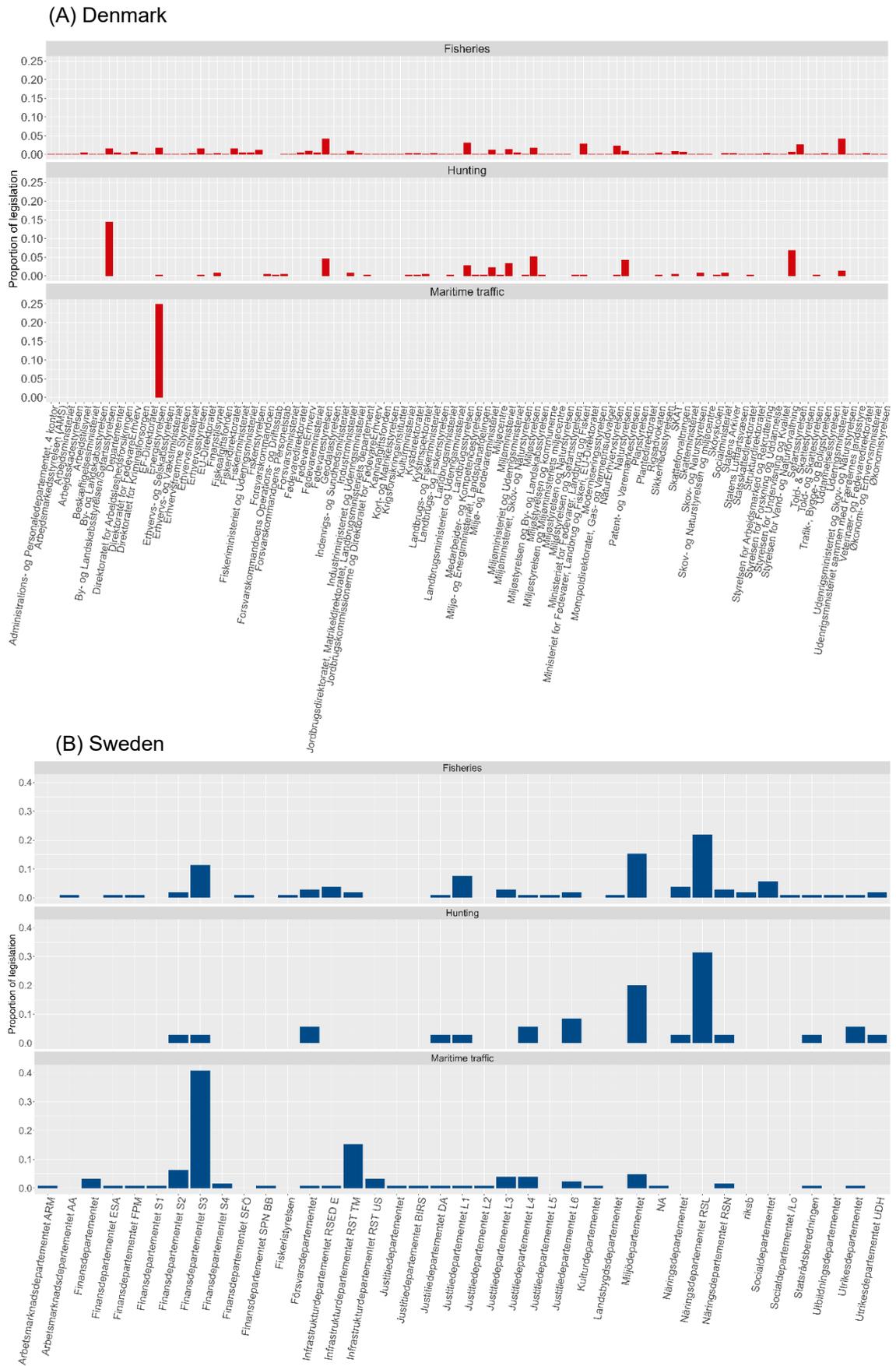


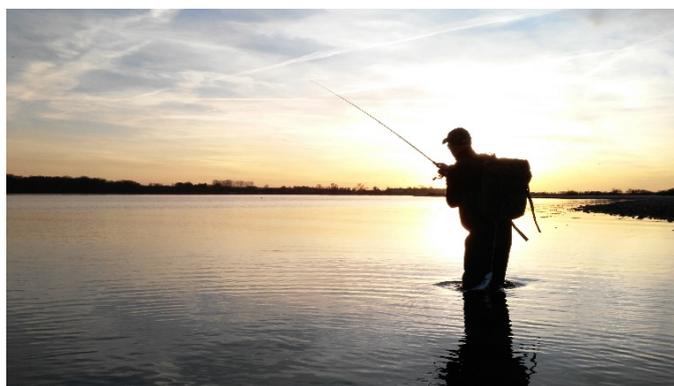
Figure 1: Proportion of search query legislation within Danish (Red) and Swedish (Blue) ministries. It was unclear which ministry the Swedish fisheries agency lies within so it has its own categorization.



3.4 Management Instruments

3.4.1 Recreational fisheries

Denmark has two forms of fishing licences, an angler (lystfisker) or recreational (fitidsfisker) license [12]. These differ based on which type of gear a fisherman will use. An angler license is needed when one uses a fishing rod or other types of hand gear (active gear), while a recreational licence is needed for the use of nets, traps, or similar gear (passive gear) [12]. When fishing at sea, one must have a lystfisker license, if they are above the age of 18 (until one has received public pension) [12]. There is an option of obtaining a lystfisker license for either one day, one week, or one year depending on one's needs [12]. There are other forms of exemptions to a lystfisker licences with regards to freshwater fishing, such as fishing on one's own property or within stocked fish lakes (put-and-take fishing) [12]. On the other hand, a fitidsfisker license has no age or pension exemptions and those under the age of 12 cannot participate in the activity [12]. Additionally, there is only one fitidsfisker license option, with a validity of one year but it also covers as a lystfisker license as well [12].



Left photo is an example of recreational (fitidsfisker) fishing gear (nets). Right photo depicts a fisherman with a rod and reel (lystfisker). Photos: Finn Sivebæk.

In Sweden, on all public waters recreational fishermen do not need a license. However, a licence is required on private waters (except for the five largest Lakes in Sweden) and if one fishes with nets, trolling, or ice fishing [13]. In Sweden, the coastal waters of the Øresund are public, but there are three fisheries management areas (FVOFs), thus private waters, where their waters flow into the Øresund strait [14]. Therefore, a fishing licence is required if one wants to fish in these waters that open into the Øresund. These fishing properties are Rååns FVOF, Höje å FVOF, and Kävlingeån and Löddeån FVOF. Permits within these private areas come with specific rules for those private waters. For instance, in Rååns FVOF, all salmon catch must be released [15]. However, in Höje å FVOF catch size for salmon is a minimum of 60cm, same as the national regulations ([16]; Table 8).

In both countries recreational fishing catch regulations can differ by the waters and target species. Especially in Sweden where recreational fisheries is not centrally managed, due the distinguishment between private and public ownership of waters. Some regulations within

species vary between the countries (Table 8). For instance, sea trout minimum sizes and certain size exceptions for gear types (Table 8). Individual nation's recreational fishing regulations can support or be more stringent than EU legislations. However, the European Union can override national rulings to help conserve specific stocks due to the Common Fisheries Policy [17, 18]. We see this in Table 8, where for cod and salmon recreational catch limits and conservation periods for 2022 changed due to EU Council Regulation (EU) 2021/1888 [18].

While there are differences and similarities between Minimum Conservation Reference Size (MCRS) and conservation periods, there is a distinct difference between Sweden and Denmark around spear gun fishing. In Denmark, a spear gun is considered "light hand gear" [19] and thus legal to fish with if one obtains a fishing licence [19]. Furthermore Danish, spear gun fishing regulations (i.e. the time of day and gear type), follow EU Regulation (EU) 2019/1241 [19,20]. However, in Sweden their legislation around harpoon fishing is stricter than EU regulations, since a spear gun is categorized as a weapon [21] and thus needs a weapon licence and is illegal to fish with one [22].

Within the Øresund there are protected nature areas on both sides of the sound [23]. However, in addition to these areas, there are specific areas with special fisheries regulations in both Denmark and Sweden. Denmark has designated conservation belts, areas that flow into saltwater (i.e., streams/rivers), where additional fishing restrictions occur [24]. Within the Danish side of the Øresund, there are 24 conservation belts (Table 5). 12 of these are closed for fishing all year (Table 5; red text), eight of them are closed for fishing from 16th of September to 15th of March (Table 5; blue text), and five of them have specific rules which apply to them (Table 5; green text) [24]. More information on the conservation belts and their specific regulations can be found in Danish regulation number 1413 of 23rd June 2021 [25] and a map of the conservation belts can be found on The Ministry of Food, Agriculture, and Fisheries' website [24]. In Sweden there are similar areas that are designated as conservation areas, with specific fishing regulations. On the Swedish side of the Øresund there are 18 conservation areas (Table 6; [26; 27]).

Table 5: List of conservation belts on the Danish side of the Øresund strait. Numbers in parentheses are the conservation belt ID numbers. Red text: closed for fishing all year. Blue text: closed for fishing from 16th of September to 15th of March. Green text: specific rules.

Information from [24].

Esrum Å (69)	Pandehave Å (288)
Nivå (265)	Vesterbæk (865)
Skensved Å (323)	Østerbæk (752)
Køge Å (Havn) (216)	Egebæk (753)
Køge Havn (709)	Olsbæk (761)
Køge Havn (710)	Karlstrup Møllebæk (763)
Køge Havn (692)	Solrød Bæk (765)
Køge Havn (688)	Møllerende (766)
Vedskølle Å/Sortebækken (442)	Køge Å (655) *
Tryggevælde Å	Køge Havn (657) **
Ll. Vejle Å (689)	Køge Havn (656) *
Ll. Vejle Å (691)	Kikhanerende (185) §
Ll. Vejle Å (672)	Søborg Kanal§
Additional notes:	
* Catch limit restrictions	
** Fishing restrictions	
§ From 16th March to 15th September: one can fish with a rod or spearfishing/light hand gear	

Table 6: List of conservation areas that are on the Swedish side of the Øresund strait where there are various fishing regulations [26].

Marbäcken*	Råån*
Säbyholmsbäcken*	Saxån*
Bernstorpsbäcken*	Lundåkrabukten***
Gessiebäcken*	Foteviken***
Barsebäck**	Norra Öresund§
Rydebäcken*	Södra Kattegatt sydöstra området**
Segeån*	Södra Kattegatta västra området§§
Höjeån*	Sydvästskånes Utsjövatten inre ⁺
Löddeån Kävlingeån*	Nordvästra Skånes havsområde Nationell**
Additional notes:	
*From the 15 th September – 30 th April fishing is not allowed.	
**Closed to fishing all year round	
***Closed to fishing all year round with an exception for hand gear (i.e. rods) <i>without</i> using a boat	
§1 st Feb – 31 st March no fishing allowed. Exceptions to this regulation are (1) fishing with hand gear except fishing for cod (2) fishing for crayfish, crabs, or lobster with a cage gear (3) for lump fish (<i>Cyclopterus lumpus</i>) if one uses a net with a meshsize of 220 millimeters or less.	
§§1 st Jan – 31 st March fishing is not allowed with the same exceptions as §	
⁺ 1 st November – 30 th April fishing with nets as gear is not allowed. Other times nets are allowed if a pinger is present	
**From 1 st Oct. – 31 st March fishing with hand gear in water less than 3 meters is not allowed. Additional restrictions for commercial fishing gear.	

Table 7: Danish and Swedish legislations which managing bodies reference to look at for further information on recreation fishing regulations. Table extends to the next two pages.

Country	Legislation Number	Title	Ministry	EU linkage*	Mentions	Sections	Link
Denmark	§LBK. Nr. 261/2019	Bekendtgørelse af lov om fiskeri og fiskeopdræt (fiskeriloven)	Ministeriet for Fødevarer, Landbrug, og Fiskeri	(1) 31979L0409 (2) 31992L0043 (3) 32004L0035			https://www.retsinformation.dk/eli/ta/2019/261
	§BEK. nr. 769/2004	Bekendtgørelse om fredningsbælter og om ophævelse af lov om saltvandsfiskeri	Ministeriet for Fødevarer, Landbrug, og Fiskeri	None			https://www.retsinformation.dk/eli/ta/2004/769
	§BEK. nr. 791/2018	Bekendtgørelse om mindstemål for fisk og krebsdyr i saltvand	Ministeriet for Fødevarer, Landbrug, og Fiskeri	(1) 31998R0850 (2) 32005R2187			https://www.retsinformation.dk/eli/ta/2018/791
	§EU Regulation (EU) 2019/1241 **	Conservation of fisheries resources and protection of marine ecosystems	European Parliament, Council of the European Union	N/A	Spear/harpoon fishing		https://eur-lex.europa.eu/eli/reg/2019/1241/oj
	§BEK. Nr. 1473/2016	Bekendtgørelse om fredningstder for fisk og krebsdyr i saltvand	Ministeriet for Fødevarer, Landbrug, og Fiskeri	None			https://www.retsinformation.dk/eli/ta/2016/1473
	§BEK. Nr. 1615/2015	Bekendtgørelse om rekreativt fiskeri i salt og ferskvand samt redskabsfiskeri mv. i ferskvand	Ministeriet for Fødevarer, Landbrug, og Fiskeri	None			https://www.retsinformation.dk/eli/ta/2015/1615

	§BEK nr. 1413/2021	Bekendtgørelse om fiskeri og fredningsbælter omkring sjælland	Ministeriet for Fødevarer, Landbrug, og Fiskeri	None	Spear/harpoon fishing	Section 6 part 3 Pertains to waters: Søborg Kanal (Gilleleje Havn) and Kikhanerende (Vedbæk Havn) with in the Øresund region	https://www.retsinformation.dk/eli/ta/2021/1413
Sweden	§SFS-1993-787	Fiskelag (1993:787)	Näringsdepartementet	(1) 32013R1380 (2) 32011R0404 (3) 32008R1005	commercial fisheries		https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/fiskelag-1993787_sfs-1993-787
	§SFS-2022-384	Forordning (1994:1716) om fisket, vattenbruket og fiskerinäringen	Näringsdepartementet	(1) 32013R1380 (2) 32016R0429 (3) 32017R2403 (4) 32021R1888 (5) 32021R1417 (6) 32014R0508 (7) 32013R1303 (8) 32003H0361 (9) 32002R0178 (10) 32017R1004 (11) 32011R0404 (12) 32010R0201 (13) 32016R1627 (14) 31999R0728 (15) 32016R2336 (16) 32010R1236 (17) 32017R0127 (18) 31996R2406 (19) 32009R1010	Commercial & recreational fisheries		https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-19941716-om-fisket-vattenbruket_sfs-1994-1716
	§Collection of regulations from Havs- och vattens myndigheten /HVMFS) (maritime and water authority) [26]						

Additional notes: *EU link titles (full, condensed, or summary titles)

31979L0409: Conservation of wild birds(Birds Directive)

31992L0043: Protecting Europe's biodiversity (Natura 2000) (Habitats Directive)

32004L0035: The polluter-pays principle and environmental liability

31998R0850: Conservation of fishery resources through technical measures for the protection of juveniles of marine organisms

32005R2187: Conservation of fishery resources in the Baltic Sea and Danish Belts repealed by EU Regulation (EU) 2019/1241 **

32013R1380: EU's common fisheries policy (CFP)

32011R0404: Establishing a community control system for ensuring compliance with the rules of the Common Fisheries Policy

32008R1005: Eliminating illegal, unreported and unregulated fishing

32016R0429: The EU animal health law

32017R2403: Sustainable management of external fishing fleets

32021R1888: Fishing opportunities in the Baltic Sea (2022)

32021R1417: Concerning the specifications for the landing obligation as regards salmon in the Baltic Sea for the period 2021-2023

32014R0508: European Maritime and Fisheries Fund (2014–2020)

32013R1303: laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006

32003H0361: Micro-, small- and medium-sized enterprises: definition and scope

32002R0178: laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety

32017R1004: Collecting data to assist in fisheries sector management

32011R0404: Establishing a community control system for ensuring compliance with the rules of the Common Fisheries Policy

32010R0201: laying down detailed rules for the implementation of Council Regulation (EC) No 1006/2008 concerning authorisations for fishing activities of Community fishing vessels outside Community waters and the access of third country vessels to Community waters

32016R1627: Multiannual recovery plan for bluefin tuna

31999R0728: a notification period for Community fishing vessels carrying on fishing activities in the Baltic Sea, the Skagerrak and the Kattegat

32016R2336: Fishing in the north-east Atlantic - rules on deep-sea stocks and international waters

32010R1236: Future international cooperation in north-east Atlantic fisheries

32017R0127: the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters

31996R2406: Council Regulation (EC) No 2406/96 of 26 November 1996 laying down common marketing standards for certain fishery products

32009R1010: Commission Regulation (EC) No 1010/2009 of 22 October 2009 laying down detailed rules for the implementation of Council Regulation (EC) No 1005/2008 establishing a community system to prevent, deter and eliminate illegal, unreported and unregulated fishing

Table 8: Fishing regulation in Sweden and Denmark specifically pertaining to waters within/overlapping the Øresund strait region. These are for recreational fisheries. Some exceptions may be made for commercial fisheries which are not stated here. Green rows indicate fish species that have the same regulations across Sweden and Denmark. Table extends to the next page. Information from [28, 29, 30, 31, 32]. For Sweden, when fishing with a rod in coastal waters the minimum sizes only applies to pike, pike perch, salmon, trout and cod [31].- These regulations are based on year 2022 and some may have changed for 2023.

Fish	Country	Conservation Periods (Fishing is not allowed)	Minimum catch sizes	Notes
Pike	Denmark Sweden	1 st April – 15 th May None stated	60cm 40cm*	
Sea Trout	Denmark Sweden	16 th November – 15 th May** 15 th September – 31 st December ***	40cm 50cm	
Common Whitefish	Denmark Sweden	1 st November – 31 st January 12 th November- 15 th December	36cm None	
Salmon	Denmark Sweden	16 th November – 15 th January** 15 th September – 31 st December ***	60cm 60cm	<p>This is an EU-determined size limit. The EU also decided on a catch limit of one salmon per person per day ONLY if the salmon's adipose fin is clipped/removed (small fin between the dorsal fin and the tail of the fish). The fish must be taken home whole.</p>  <p>Fish missing an adipose fin. Photo: Finn Sivebæk</p>
Cod	Denmark Sweden	15 th January – 31 st of March 2022 15 th January – 31 st March 2022	35cm 38cm	This is an EU-determined take limit and conservation period. In subarea 23: one cod per person per day. In subarea 24: fishing must take place within 6 nautical miles of the baseline (point where internal waters meet territorial waters).
European Eel	Denmark Sweden	1 st November 2022 – 31 st January 2023 ^{\$\$} Recreational fishing for eels has been banned since 2007 *		
European Perch	Denmark Sweden	None Stated None Stated	29 cm None	

European Lobster	Denmark	None Stated	21cm (total length)	Cannot catch lobster with roe
	Sweden [§]	First Monday after September 20 th at 7am till November 30th.	9cm (carapace length)	
Norway Lobster	Denmark	None Stated	10.5 (full length), 3.2 cm (Carapace length), 5.9cm (Lobster tails)	
	Sweden	None stated	10.5 cm (total length) 3.2 cm (carapace length)	
Turbot	Denmark	None Stated	30cm	
	Sweden [§]	None Stated	30cm	
European Plaice	Denmark	None Stated	25 cm	
	Sweden [§]	None Stated	25cm ****	
European Flounder	Denmark	None Stated	23cm	
	Sweden [§]	None Stated	23cm ****	
Brill	Denmark	None Stated	30cm	
	Sweden [§]	None Stated	30 cm	

Additional notes and exceptions:

* All gear types this is the minimum. Expect for hand gear there is a 75cm maximum catch size limit.

** In this conservation period if a fish is caught it can only be taken home if it is completely shiny with loose scales. However, fish with colour, are those that have reproductive potential, and must be immediately released.

*** Only in coastal waters between Kullen's lighthouse and Torhamns Cape.

**** Doesn't apply to hand gear.

***** for hand gear there is a maximum size of 60cm

[§] within Västra Kullaberg cannot catch benthic animals, except for the bycatch of shore crabs and fish.

^{§§} Refer to Danish Regulation number 844 of 13/06/2022 (BEK nr 844 af 13/06/2022) for more detailed information [33]

* There are certain exceptions to this ban. Particularly in freshwater areas thus not directly linked to the Øresund strait

3.4.2 Commercial fisheries

Given that the scope of this work is to help identify commonalities and differences between Sweden and Denmark, we include here all instruments used in both countries to manage fisheries. That is, some of these approaches may not be currently applied in Øresund fisheries, however their future use is not precluded. In both countries the Common Fisheries Policy sets Total Allowable Catches, with set allocations to each member state, as well as landing obligations, and Technical Conservation Measures which influences mesh size and minimum fish size limits. Additional management instruments at the disposal of member States are defined by the Common Fisheries Policy. The principal difference between Denmark and Sweden is a longer tradition of individual quotas in the former, and a longer tradition of effort regulation in the latter. Sweden extends private property to coastal waters which opens the scope for privatisation of fishing rights in private waters and the development of co-management approaches in public waters (Table 9).

Table 9: Management instruments used to manage commercial fisheries in Denmark and Sweden. Green rows indicate where Sweden and Denmark use the same management approaches for commercial fisheries.

Management approach	Instrument	Denmark	Sweden
Fishing Rights	Individual Quotes	Individual quotas and Individual Transferable Quotas	Individual Quotas and Individual Transferable Quotas
Fishing Rights	Territorial use rights for Fisheries (TURF)	N/A	Privatization of fishing rights on property
Fishing Rights	Territorial use rights for Fisheries (TURF)	N/A	Small-scale fisheries co-management in public waters
Fishing Rights	Non-transferrable licenses	N/A	Limited permits
Closures		proposals	No-take areas
Closures		Areas with gear restrictions	Areas with gear restrictions
Closures		Temporary closures	Temporary (spawning) closures
Closures			Permanent fishing bans
Marine Protected Areas (MPAs)		Natura 2000	Natura 2000
Marine Protected Areas (MPAs)		OSPAR	OSPAR
Marine Protected Areas (MPAs)		HELCOM	HELCOM

3.4.3 Maritime Traffic

In Denmark jet skis and other Personal Watercrafts (PWC) are not permitted within 300 meters from the coast, except to reach that offshore zone on a perpendicular path to the coast travelling at less than 5 knots (Table 10: BEK no 23 of 06/01/2012 [34], BEK no 663 of 20/05/2020 [35]). In Sweden, PWC are not nationally restricted other than ensuring that their operation does not disturb people on the shore. County boards can issue restrictions for operations of PWC outside navigation channels (Table 10: SFS 1993:1053 [36], SFS (1986:300) [37], SFS 1994:1009 [38]). In both countries, they are also banned in Natura 2000 sites, game reserves and other protected areas.

The globally agreed no-wake speed apply to vessels in harbor waters in both countries. It is interpreted to be 3 knots. Sweden has various additional speed limits for boats which are indicated with signage in coastal water when they occur.

Table 10: Maritime related legislations for Denmark and Sweden.

Country	Code	Title	Ministry	Link
Denmark	BEK no 23 of 06/01/2012	Bekendtgørelse om regulering af ikke-erhvervsmæssig sejlad på søterritoriet med vandscootere m.v.1)	Miljøministeriet	https://www.retsinformation.dk/eli/ta/2012/23
	BEK no 663 of 20/05/2020	Bekendtgørelse om beviskrav til førere af visse motordrevne fritidsfartøjer med en skroglængde under 4 meter (vandscooterførerbekendtgørelsen)	Erhvervsministeriet	https://www.retsinformation.dk/eli/ta/2020/663
Sweden	SFS 1993:1053	Förordning (1993:1053) om användning av vattenskoter	Miljödepartementet	https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-19931053-om-anvandning-av_sfs-1993-1053
	SFS 1994:1009	Sjölag (1994:1009)	Justitiedepartementet	https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/sjolag-19941009_sfs-1994-1009
	SFS 1986:300	Sjötrafikförordning (1986:300),	Infrastrukturdepartementet	https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/sjotrafikforordning-1986300_sfs-1986-300

3.4.4 Controlling seal populations

In both countries, seal hunting for sport is illegal, however, controlled hunting (cull) can be permitted when seals become harmful (i.e., fishing gear interactions and stealing catch). In Sweden a cull can be issued [39, 40] and given out if the Swedish EPA initiates a cull or based on individual's applications to the Swedish EPA [39]. In addition, all seals killed must be reported to the Swedish EPA (Table 11: Jaktförordning (1987:905) section 5C and 6 [40]). A license to hunt grey seals is not needed only if a seal interacts with fishing gear or takes catches [41]. In Denmark, the Danish Nature Agency must give permission to regulation seal populations. For harbor seals, permission can be granted between 1st August to the 30th of April, only when they become an issue with fishing gear or within in streams or conservation belts for the conservation of fish stocks (Table 11; Decree on game damage; [42,43]). For Grey seals, from 1st of May to 30th of November, the Danish Nature Agency must give permission when they are an issue within 100 meters of fishing gear or for the conservation of specific fish stocks (Table 11; Decree on game damage; [42,43]).

Table 11: Danish and Swedish legislations which mention seal/s or seal hunting and within which sections. Additional legislation information such as EU linkage and the ministry are also given,

Country	Code	Title	English title	Ministry	Section	EU links* (Celex Numbers)	Link
Sweden	SFS-2007-845	Artskyddsförordning (2007:845)	Species Protection Ordinance (2007:845)	Miljödepartementet	Section 34 Appendix 1	32009L0147 31992L0043 32006L0105 32006R0865	https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/artskyddsförordning-2007845_sfs-2007-845
	sfs-1987-905	Jaktförordning (1987:905)	Hunting Ordinance (1987:905)	Näringsdepartementet	Section 5c, 6, 20, 23b/g, 24, 29	32019R0515 32009R1107	https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/jaktförordning-1987905_sfs-1987-905
	sfs-1938-279	Kungl. Maj:ts Jaktstadga (1938:279)	Royal May's Hunting Statute (1938:279)	Jordbruksdepartementet	Section 4a, 10	None	https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/kungl-majts-jaktstadga-1938279_sfs-1938-279
	sfs-1987-259	Jaktlag (1987:259)	Hunting Law (1987:259)	Näringsdepartementet	Section 23	None	https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/jaktlag-1987259_sfs-1987-259
Denmark	BEK nr 1016 af 14/06/2020 recently amended to BEK nr 1408 af 03/10/2022	Bekendtgørelse om vildtskader	Decree on game damage	Miljøministeriet	Section 24 – spotted seals Section 25 – Grey seals	31992L0043 32009L0147	https://www.retsinformation.dk/eli/ta/2022/1408
	LBK nr 265 af 21/03/2019	Bekendtgørelse af lov om jagt og vildtforvaltning	Promulgation of the Act on hunting and game management	Miljøministeriet	Section 9a	31992L0043 32004L0035 32009L0147	https://www.retsinformation.dk/eli/ta/2019/265
	BEK nr 2091 af 12/11/2021	Bekendtgørelse om udpegning og administration af internationale	Order on the designation and administration of international	Miljøministeriet	Appendix 5	31992L0043 32009L0147	https://www.retsinformation.dk/eli/ta/2021/2091

		naturbeskyttelsesområder samt beskyttelse af visse arter	nature conservation areas and the protection of certain species				
	BKI nr 84 af 15/09/1986	Bekendtgørelse af konvention af 23. juni 1979 om beskyttelse af migrerende arter af vilde dyr	Proclamation of the Convention of 23 June 1979 on the Protection of Migratory Species of Wild Animals	Udenrigsministeriet	Endangered Migratory Species List I	none	https://www.retsinformation.dk/eli/ltc/1986/84
	BEK nr 521 af 25/03/2021	Bekendtgørelse om fredning af visse dyre- og plantearter og pleje af tilskadekommet vildt	Order on the protection of certain animal and plant species and the care of injured game	Miljøministeriet	Appendix 6	31992L0043 32009L0147	https://www.retsinformation.dk/eli/ltc/2021/521
	VEJ nr 9439 af 02/07/2008	Miljøskadelovens Skadebegreb	The Environmental Damages Act's concept of damage	Miljøministeriet	Section 8.4.1.8	32004L0035	https://www.retsinformation.dk/eli/retsinfo/2008/9439
	BEK nr 971 af 21/06/2022	Bekendtgørelse om våben og ammunition der må anvendes til jagt m.v.	Decree on weapons and ammunition that may be used for hunting, etc.	Miljøministeriet	section 4 & annex 1	31992L0043 32009L0147	https://www.retsinformation.dk/eli/ltc/2022/971

3.4.5 Bird Hunting regulations

Denmark and Sweden have similarities and differences in the bird species hunted and the hunting seasons. In general, within both countries hunting seasons can vary depending on the county (Sweden) or municipality (Denmark) (Table 12). The hunting season for the ring-necked pheasant is the only season that is the same within the Øresund region between the two countries (Table 12). With regards to the Øresund strait in Danish territory, there is a good portion of the sound that is 'hunting free' [44]. These areas are in addition to nature/wildlife preserves within the strait. In Denmark there are also game reserves with designated motorboat hunting free areas, hunting free urban area, and hunting free holiday home areas [42]. Within Sweden, since the coast of the Øresund is public waters, one needs to have permission from the specific coastal county [40] (Skåne [45], Västra Götaland [46], or Halland [47]) to hunt on the waters. The hunting permit may vary between counties and be limited to a specific coastal area, time span, and/or target species [40]. In all three coastal counties, hunting cannot occur within 100 meters of property shoreline, or in other protected areas set out within other Swedish legislations (i.e Miljöbalk [48], Jaktlagen [39], and Jaktförordningen [40]).

Table 12. Bird species and their hunting seasons within the Øresund region of Denmark and Sweden. Green bolded text is the bird species with the same hunting period across Denmark and Sweden. Danish information came from [49] and Swedish information came from [50].

Country	Hunting	Bird Species	Notes
Denmark	1 st Sep. – 31 st Dec.	Mallard Ducks*, Garganey*, Eurasian teal*, Northern pintail*, Eurasian wigeon*, Northern shoveler*, Gadwall*, Common snipe	*Can also be hunted in fishing territories from 1 st Jan. – 31 st Jan
	1 st Sep. – 31 st Jan.	Greylag goose*, Eurasian magpie, hooded crow, Carrion crow, Egyptian goose (invasive species), Greater white-fronted goose, Canada Goose*, pink-footed goose	*Within circulation areas and greater than 300 meters from the wetlands they can also be hunted from 1 st Aug. – 31 st Aug.
	1 st Oct. – 31 st Jan.	Tufted duck, Greater scaup, Common goldeneye, Common eider* (only males), Common scoter, Eurasian coot, Eurasian woodcock	*Specially protected in certain bird protected areas see [51] for more details.
	1 st Nov. – 31 st Jan.	European herring gull	This is the local hunting season for the capital regions municipalities.
	11 th Nov. – 31 st Jan.	Common wood pigeon	
	16 th Sep. – 31 st Oct.	Grey partridge	
	1 st Oct. – 31 st Jan.	Ring-necked pheasant	
	No hunting seasons near Øresund region municipalities*	Bean goose	*Can only hunt bean goose in Vordingborg, Guldborgsund, and Lolland municipalities.
Sweden (Skåne county)	1 st Jul. – 30 th Jun.	Fieldfare ^{\$1} , Great black-backed gull ^{\$2} , Common raven ^{\$3} , Great cormorant ^{\$4} , Barnacle goose	
	21 st Aug. – 31 st Dec.	Eurasian wigeon, Mallard, Eurasian teal	
	1 st Oct. – 31 st Jan.	Greater white-fronted goose, Ring necked pheasant.	
	11 th Aug. – 28 th Feb.	Common gull	
	11 th Aug. – 31 st Dec	Greylag goose, Canada goose	
	1 st Aug. – 31 st Mar.	European herring gull	
	1 st Jul. – 15 th Apr.	Western jackdaw, hooded crow, Eurasian magpie	
	21 st Aug. -31 st Jan.	Common goldeneye, common merganser, tufted duck	
	11 th Sep. – 31 st Dec.	Eurasian woodcock	
	21 st Aug. – 10 th Mar.	Garrulus	
	Black grouse, Western capercaillie		

	1 st Jan. – 31 st Jan & 1 st Sep – 15 th Sep. 16 th Sep. – 30 th Nov. 16 th Aug. – 31 st Dec. 21 st Jul. – 31 st Jan. 21 st Sep. – 31 st Jan. 1 st Oct. – 31 st Mar. 21 st Apr. – 20 th Feb. 1 st Aug. – 30 th Sep. & 1 st Apr. – 30 th May	Grey partridge Common wood pigeon Rook Common scoter Whooper swan ^{\$5} Bean goose ^{\$5} Common crane	
Sweden (Halland & Västra Götalands county differences from Skåne)	1 st Jan – 31 st Dec. 21 st Aug. – 30 th Oct. 25 th Aug. – 30 th Sep & 1 st Jan – 31 st Jan.	Greater white-fronted goose Eurasian teal Black grouse, Western capercaillie	In Västra Götalands one cannot hunt for rook or bean goose. In Halland one cannot hunt for bean goose.
<p>^{\$}Protective hunting only. Number corresponds to instances below for protective hunting</p> <p>^{\$1} can hunt if they enter a farm or garden and hunters want to prevent injury/inconvenience, damage to crops, or municipal committee allows a special ruling for environmental and health protection.</p> <p>^{\$} can hunt if (1) they are at an airport OR (2) same as ^{\$1}</p> <p>^{\$3} can be hunted if (1) to protect breeding domestic animals' offspring including reindeer calves in reindeer husbandry areas. OR (1) same as ^{\$2} (3) same as ^{\$1}</p> <p>^{\$4} can be hunted if (1) they are at an airport. (2) if they interact with passive fishing gear (i.e., nets and traps) and at a 300-meter distance from the gear from 1st Aug. – 28^{th/29th} Feb. (3) seven days before and after stocking of fish in stocking areas and fish farms with a 300-meter distance from 1st Jul – 30th Jun. (4) in conservation areas from 1st Aug. – 28^{th/29th} Feb.</p> <p>^{\$5} only can be hunted if they appear in a flock with at least 5 birds and in a field with unharvested crops</p>			

4. Discussion

4.1 The importance of the policy context in which management instruments are applied

Understanding the regulatory landscape for particular activities is usually achieved in an ad-hoc manner. We can collate experiences of people actively involved in management and governance of those activities in structured or semi-structured interviews. However, this will ensure that we capture the “known knowns” of regulatory interactions which will be heavily dependent on the individuals interviewed and their experience. It is often sensitive to biases. Advances in the development of structured and electronic databases of laws and regulations that can be queried in a transparent and replicable manner increases the scope for unbiased estimates of regulatory landscapes [8]. These legislation wide appraisals of the regulatory landscape of human activities are needed when we want to enact changes in the way activities are managed. This is particularly the case when multiple human activities with complex effects on the natural habitat and its biodiversity coexist in a region. Here we show that the jurisprudence, the legal arguments, leading to the development of management instruments for fisheries, hunting, and marine traffic are interconnected. This is an important outcome as this means that discussing changes in the way one of these activities is managed can have implications for the other activities. These implications might be that a management change is not possible without for example deteriorating management approach for another activity, or in the best outcomes, management changes for one activity will open opportunities to ameliorate management for the other activities. We show also that, as expected, EU legislation forms a jurisprudence backbone of regulatory common ground between Denmark and Sweden. But this backbone is also complex with national legal arguments borrowing from multiple European decisions to arrive to management actions.

4.2 National implementation of European legislation

International agreements align legislative ambitions between Parties on environmental matters. However, regulatory implementation at a national level will vary depending on how countries' delegate policy management (i.e., state, municipality, regional level), which potentially can lead to conflict in border regions [52]. Specifically, in terms of the European Union (EU), the type of legislation (i.e., regulation, directives, decisions, recommendations) provides a degree of country compliance [53,54]. For example, EU directives allow member states to decide on how they will achieve the directive's goals, while regulations and decisions are binding in their entirety [53,54]. Therefore, there can be more freedom when working with an EU directive [53]. We can see this concept at play when investigating how Danish and Swedish legislation interacts with EU policies.

We found that Denmark has a large focus on the Habitats Directive in legislation pertaining to fisheries and hunting related legal texts (Appendix Results). In total the Habitats Directive is referenced in 82 legal Danish texts, while only three Swedish legislations reference the Habitats Directive (Appendix Results). In contrast, the General Data Protection Regulation (GDPR) Directive is the most cited in Swedish legislation, while it is not present in the Danish legislation (Appendix Results). Additionally, GDPR is discussed in legal texts relating to all three search queries (fisheries, hunting, and maritime traffic). This could possibly suggest that Sweden may have a larger focus on registrars when dealing with environmental-recreational management

due to the difference in public and private water management. This identifies a difference in implementation between Denmark and Sweden worth exploring early when developing a border region management plan. Swedish legislation may also be written with less sectorial specificity. For example, the Swedish regulation on property registers [55], has key specificities for property ownership, which generally applies to land rights, however they also include fisheries into this regulation mentioning independent fishing and fishing community fishing areas [55].

4.3 Similar EU interpretations

EU legislation is aimed to define common visions, ambitions and objectives in a way that leaves some flexibility to the way member nations can implement it in their own legislation. However, we find that between Denmark and Sweden there are eight similar topics which both countries discuss in their legislation pertaining to fisheries, hunting, and maritime traffic (Appendix Results, Figure B.3/4). Specifically, we see that both countries reference EU legislation discussing (1) species protection and biodiversity, (2) government aid, (3) Water management and protection, (4) Fisheries management, policy, and funding, (5) food quality, health, and safety, (6) vessel safety and environmental impact, (7) energy consumption, and (8) defense (Appendix Results, Figure B.4). The eight topics do differ in the number of country legal texts found in the community modules (Table Appendix Table B1), again highlighting possible differences in the sectorial specificity of legal acts between countries. These shared interpretations of EU legislation between countries are not surprising. For instance, two modules have a health and safety component (module five and six), but since these regulations pertain to protection of human life, policies usually set out clear and strict guidelines. Additionally, four of the modules also discuss topics around environmental issues, however these topics are heavily discussed in society today (GHGs, biodiversity, pollution, etc.) and are popular discussion topics in the public discourse. Therefore, since societal discussions influence policy agendas, it is unsurprising that these EU legislations are recurring and prevalent across countries.

4.4 Applying regulations: the governance and management context

It is clear that Sweden and Denmark delegate governing responsibilities to ministries differently, despite dealing with similar sectors (fisheries, hunting, and maritime traffic). For example, Denmark places a higher proportion of fisheries related legal acts into the Ministry of Food, Agriculture, and Fisheries. However, in Sweden the highest proportion of fisheries related acts are within the Ministry of the Climate and Business. In addition, starting in 2023, the Swedish government further consolidated the ministries, moving from 14 ministries to 10 [56]. Now the Ministry of the Environment and the Ministry of Enterprise are one ministry and the Ministry of Rural Affairs, and the Ministry of Infrastructure are merged to be one ministry. In addition, The Swedish ministries are a more generalized ministry, an umbrella term covering a larger scope of issues. For example, Sweden has one ministry focusing on all issues around the environment, climate, and energy, Ministry of the Climate and Business, while Denmark differentiates between a Ministry of the Environment, and a Ministry of Climate, Energy and Supply. The difference in ministries' generalization or specifications does not imply that one way is more efficient in policy formation and management, however, we highlight that this could lead to potential differing interpretation of common ambitions in the future when countries hope to collaborate. This is because the management is delegated by governing bodies with differing aims and remits. The translation of this governance aim is done by delegated authorities. While those can be identified readily in Denmark, there is no easily accessible information for

identifying Swedish ministries organizational codes into governing bodies. For example, The Ministry of Justice lays out the organizational units and their associated codes [57], however other ministries do not [58, 59, 60]. In Denmark, delegation can take place at all administrative levels with a slight focus towards retaining a centralized administration of marine activities.

These governance and administration differences set the context in which we find variance in the instruments used to manage marine activities. Recreational activities are managed differently. We see that fisheries restrictions (size limits and conservation periods) and hunting seasons in Denmark can differ from those across the strait in Sweden. These differences could be confusing for users who have freedom of movement in the border region. For example, a 3cm difference in the minimum size for cod fishing (Table 8) is unlikely to affect the success of fisheries management but likely to confuse users and lead to their contravention of the regulations simply by mistake. Taken outside its legal and regulatory context, it may seem that this instrument can be trivially homogenized between the two countries. However, the governance difference between the two countries for the regulations from which this management action emerges may place a different emphasis in the trade-off between exploitation and conservation in setting this instrument, and indeed even simply whether conservation is understood as population viability targets or population restoration targets. This work has provided an overview of this context which can help discussions to move forward in an informed manner [2].

Some management differences emerge from more profound legal divergence. For example, Sweden's argumentative approach to private property has opened an opportunity to develop co-management practices for management (TURF, Table 9) which are promising management tools [61,62]. There is not really a legal basis to do the same in Denmark. Despite shared EU legislation, the legal traditions of nations can still have a large influence on national implementation, here with a consequence that Sweden has more spatial management instruments at its disposal to implement EU legislation.

5. Conclusion

Governance and administrative differences between the two countries, as well as legal traditions, are eliciting differing management approaches for the same regulatory ambitions. However, EU ruling and legislation provides a common jurisprudence backbone (e.g., EU determined fisheries restrictions in Table 8) to find common grounds. Agreements on European technical measures in cross-border regions have been useful to manage common commercial fisheries in such complex context. It is therefore achievable to develop common technical approaches for the other marine activities, but this may require changes in governance for those activities. While an EU-level governance is one approach, polycentric governance is now known to be one of the most robust governance approaches to sustainably manage common resources across complex boundaries [63,64]. A polycentric governance is simply a governance system which has multiple centers of decisions. This approach ensures that rights and responsibilities are delegated together to the relevant level of governance. This may be through the constitution of a user group/collective in simple cases such as common water distribution management in agrarian land owned by multiple farms. It may be also through the constitution of a consortium representing user types in more complex situations where multiple use is made of a common area. This management group has semi-autonomous decision-making power in the management of the common resources. It is semi-autonomous because national institutions retain an arbitration right, hence the 'poly' (multiple) centric (seat of decisions) governance. Øresundsvandssamarbejdet corresponds to the kind of public institution collective that is identified as key to successfully managing common goods in this large body of work. The States could explore avenues to delegate to Øresundsvandssamarbejdet some of the authorities needed to develop a unified management plan, with inputs from stakeholders, for Øresund strait. In a polycentric governance approach, the States can do so while maintaining oversight on responsibilities and acting as arbitrators. This approach, proposed also in other European border regions [65], could help ensure that national and European biodiversity ambitions are met while continuing to offer Danish and Swedish citizens the ability to maintain a vibrant socioeconomic landscape embedded in the marine opportunities Øresund can offer.

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8. Appendix

Appendix A: Methods Notes

All text data retrieval, quality assurance, quality control, and analysis were performed using R version 4.2.1 [A.1]

Since we are using two differing databases one for Danish and another for Swedish documents, filtering within the search queries were as close as possible. For the three Danish queries we filtered only for documents categorized as "regler" (all binding laws and regulations, international conventions and treaties) [A.2]. For the three Swedish queries we filtered only for documents categorized as "Svensk författningssamling (SFS)" (Swedish laws and regulations) [A.3]. Document id and other associated data (date, ministry, text url, etc.) were retrieved from the search queries. Query results were exact wording for Danish legislation but not for Swedish legislation. For both countries, amended legislation is not pulled as a result, therefore only the most recent legislation is retained [A.2, A.3].

Restinformation's web-page uses JavaScript, so we used the R packages, RSelenium [A.4] and rvest [A.5], to scrape relevant text content within the document's html file. For the Swedish Parliament's API results, we used the R packages, jsonlite [A.6], httr [A.7], and rvest [A.5], to retrieve the full text data (title and body), since JavaScript was not used for the webpage. Additional terms in Table 2 were detected using the "str_textunderscore detect" function within the stringr R package [A.8] (Table 2).

A.1 Linking national legislation to EU legislation

For Danish documents, Retsinformation provides additional notes on each document. One of the notes is which EU documents is references in the Danish document, via footnotes [A.2]. We obtained the additional notes information, which states the EU legislation celex number (unique EU document id) [A.9] that was cited in the Danish document. The retrieval of this information was like how we retrieved the document's text data previously mentioned above. For this report we are only interested in legal texts that impose legal responsibilities: directives, regulations, decisions and recommendation. Swedish documents did not have a metadata on the citation of European legal texts; therefore, we mined the Swedish texts looking for references to European texts and we linked EU document through referencing within the text itself. If the Swedish document has a sentence stating "direktiv" (directive), "förordning" (regulation), "beslut/genomförandebeslut" (decision), and/or "rekommendation" (recommendation), along with their capitalized counterparts, the sentence was extracted. Within these sentences we then searched for an EU legislation act numbers [A.10]. If an act number was detected this was pulled and matched with the EU legislation titles and celex number. In addition, we performed additional referencing checks by hand. For example, if an EU act number did not link to an EU celex and if an act number linked to more than one celex number.

In the Swedish texts, three EU legislation act numbers referenced in eight legislations, did not have an associated EU celex number. It was concluded that the title codes are probably a

typographical error. However, we could not be certain even after reviewing, thus these references are not included in the Swedish to EU linkage data.

A.2 Network Analysis

We built citation networks based on the citation of EU legislation in a country legislation for each search query. These three networks (three network for each query) are directed unweighted bipartite networks because we are not considering the citations among EU legislation or among country legislation. We then merged all queries legislation and citation results and built a country specific EU legislation citation network, one for Denmark and one for Sweden. These two networks are also directed unweighted bipartite networks. Lastly, we estimated the Danish and Swedish legislation co-citation network in which a Danish and Swedish legal text are associated when they share a citation to EU legal text. This Danish - Swedish co-citation network is an undirected weighted bipartite network, where the weight on each link correspond to the number of EU legal text commonly cited by the linked Danish and Swedish texts. For all six networks we calculated the degree and the betweenness of the vertices (legal texts), and the network's community clusters (legislation groupings) [A.11]. The degree of a text is simply the count of the number of citations a text received or needed. It is a measure of how central this text is to the jurisprudence network. The betweenness is also a measure of centrality but integrate the importance of a vertex for the overall structure of the jurisprudence network. A text can have a high betweenness if for example it acts as a citation bridge between many legislation groupings.

Appendix B: Additional Results

B.1 Legislation citation networks

B.1.1 Search Query networks

For the fisheries citation network there are a total of 305 EU legislations, 155 Danish legislations and 39 Swedish legislations, totalling to 500 legislations (Figure 1C). For the hunting citation network there are a total of 101 EU legislations, 55 Danish legislations and 17 Swedish legislations, totalling to 179 legislations (Figure 1A). For the maritime traffic citation network there are a total of 186 EU legislations, one Danish legislation and 36 Swedish legislations, totalling to 223 legislations (Figure 1B). In the hunting and maritime traffic network we can see that few mixed clusters of Danish and Swedish legal text connected by EU legislation co-citation exist. However, the fisheries network is rich in Danish-Swedish clusters (Figure 1). Since there are more Danish legal texts than Swedish ones, the centrality measures of EU legislation are dominated by their links to Danish legal text. However, this tripartite representation (a network with three kinds of nodes in it), also provides a mean to identify those EU legal texts that achieve high betweenness and degree across both Danish and Swedish legal texts (Figure 1C). Those are offering the most common ground for shared work for a theory of change to agree on common management instruments, which we investigate further in section B.1.3 (Figure B.3 & B.4)

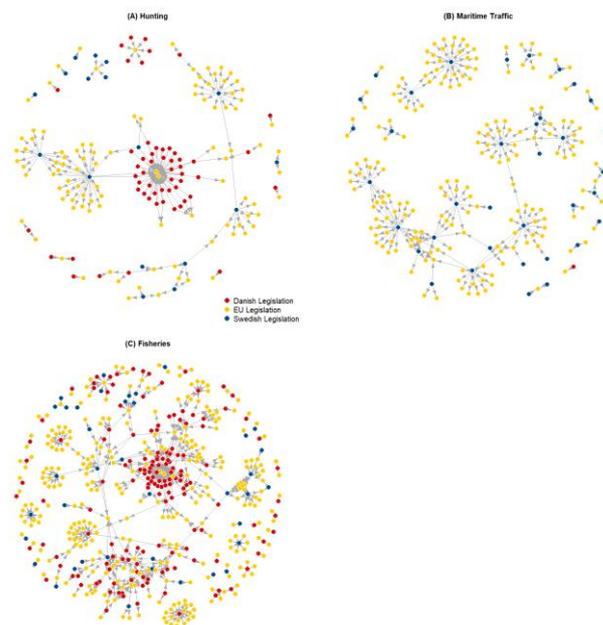


Figure B.1: (A-C) Country-EU legislation citation networks for each search query (A: hunting, B: maritime traffic, C: fisheries), where the vertices are the type of legislation (Danish, Swedish, EU) and the edges connecting them show a citation interaction. Colors indicate the legislation type (reference legend).

B.1.2 Country Specific legislation citation networks

For the Danish-EU legislation citation network, the Habitats Directive, the Birds Directive, and the directive on polluter-pays principle and environmental liability are the top three EU legal texts with which Danish legal texts interact the most. The number of Danish texts with which those interact, measured as the degree of the EU legal text in the network are respectively 82, 70, and 16. We can also assess the overall importance of each legal text for the overall network architecture through their betweenness. The three EU legislations that have the highest betweenness scores are The EU's services directive (betweenness = 0.201), regulation on the EU market for fishery and aquaculture products (betweenness = 0.125), and the directive on Maritime safety: port State control (betweenness = 0.1138) (Appendix Table 1a). Danish legislation that interact the most with EU legislation are the Promulgation of the Act on Safety at Sea (degree = 21; [B.1]), the Promulgation of the Environmental Protection Act (degree = 21; [B.2]), the Executive order on value added tax (the VAT executive order) (degree = 19; [B.3]), and the Order on the importation of food, feed, animal by-products, derived products and food contact materials with special restrictions etc. and on penal provisions for infringement of related EU legal acts (degree = 15, [B.4]). The three Danish legislation that have the highest betweenness scores are the Order on authorization and registration of food businesses etc. (betweenness = 0.199, [B.5]), Guidance on hygiene rules for fresh fish products up to and including the first stage of turnover (betweenness = 0.173, [B.6]), and Executive order on subsidies for sales promotion (betweenness = 0.117, [B.7]).

For the Swedish-EU citation network, the EU Directive on General data protection regulation (GDPR) interacts the most with Swedish legislations (degree = 10). Five other EU legislations also interact highly with Swedish legislation (all having a degree = 8, EU celex: 31976L0769, 31991L0155, 31993L0067, 31993L0105, 32000L0021). The three EU legislation that have the highest betweenness scores are the regulation on establishing the European Food Safety Authority (betweenness = 0.086), The EU's common fisheries policy (betweenness = 0.078) and ensuring the safety and performance of medical devices (betweenness = 0.076). Swedish legislations that interact the most with EU legislations the Environmental Code (degree = 30; [40]), the Environmental Supervision Ordinance (degree = 29, [B.8]) and Ordinance (2022:1718) with instructions for the Police Authority (degree = 27; [B.9]). The three Swedish legislation that have the highest betweenness scores are Publicity and Privacy Act 2009:400 (betweenness = 0.136, [B.10]), Income Tax Act (1999:1229) (betweenness = 0.09; [B.11]), and Value Added Tax Act (1994:200) (betweenness = 0.075; [B.12]).

Overall, the Danish, Swedish, and European legal texts we identified here are central to the flow of information through this network of citation between the EU legislation and the respective national legislation. Therefore, they form the backbone of the common jurisprudence arguments used in both countries to manage the marine activities.

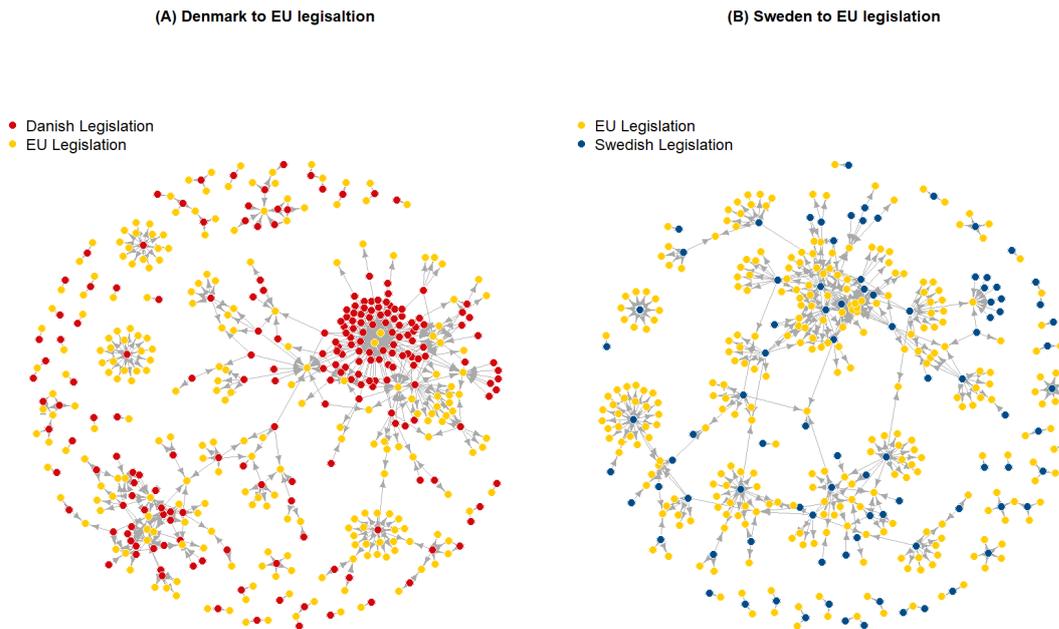


Figure B.2: (A) Danish to EU legislation citation network. (B) Swedish to EU legislation citation network. Colors indicate the type of legislation, refer to legend.

B.1.3 Danish-Swedish legislation network

For the Danish and Swedish legislation through shared EU citations network, there are 153 Danish and 42 Swedish legislations sharing at least one EU citation (Figure B.3), ranging from one to 4 shared citations, with a median of one citation. The three Swedish legislation with the highest betweenness scores are Environmental Code (betweenness = 8468.77; [48]), Food Ordinance (betweenness = 4991.03; [B.13]), and Species Protection Ordinance (betweenness = 3492.27; [B.14]). The top three Swedish legislations that interact the most with Danish legislations are also the Environmental Code (degree = 89; [48]), Species Protection Ordinance 2007:845 (degree = 85; [B.14]), along with Ordinance (1998:1252) on area protection according to the Environmental Code, etc (degree = 82; [B.15]). The three Danish legislations with the highest betweenness scores are “Promulgation of the Act on Environmental Assessment of Plans and Programs and of Specific Projects (EIA)” (betweenness = 5098.17; [B.16]), “Notice on Begtrup Røn Wildlife Reserve” (betweenness = 2329.63; [B.17]), and “Decree on waste” (betweenness = 2072.60; [B.18]). The top three Danish legislations that interact the most with Swedish legislations are Promulgation of the Environmental Protection Act (degree = 9; [B.2]), Decree on Green Development and Demonstration Program (degree = 8; [B.19]), Decree on mussels etc [B.20]. We found that there are eight community modules in the shared citation network (Figure 3B & 4), with a range of one to 19 EU legislations and three to 82 country legislations associated to a module (Table B.1).

Table B.1: Number of associated legislations for community modules within Danish-Swedish shared citation network. To find the specific EU legislations cited within the modules reference.

Module	No. DK legislations	No. SE legislations	Total	No. of associated EU legislation
1	79	3	82	12
2	4	5	9	19
3	9	2	22	15
4	33	9	42	6
5	13	12	25	8
6	7	7	14	1
7	7	2	9	17
8	1	2	3	1

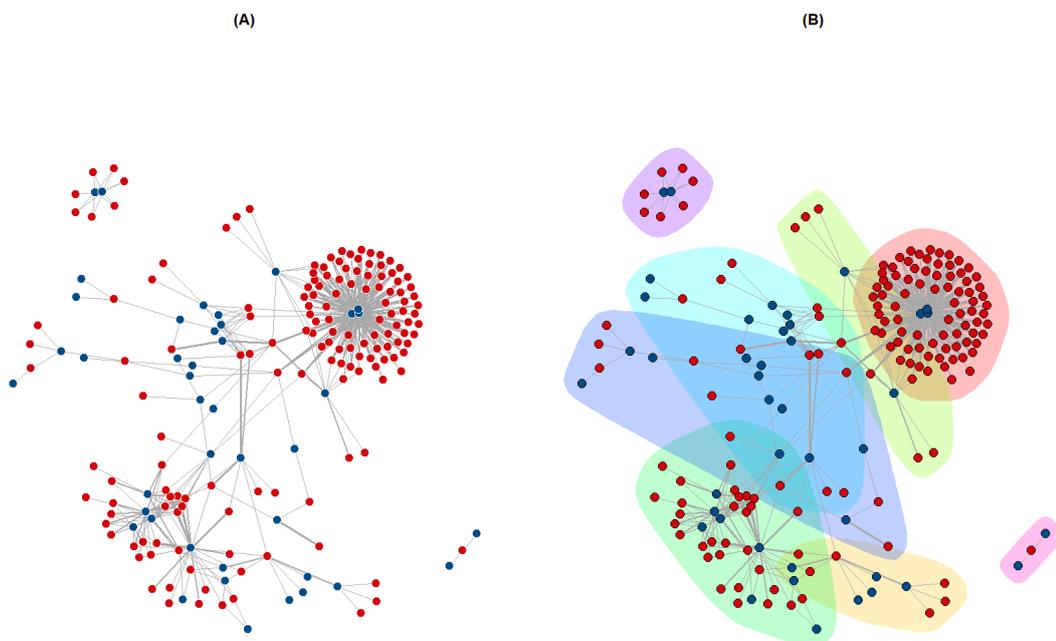


Figure B.3: Swedish-Danish legislation network, based on shared EU legislation citations. Edges connect Danish and Swedish legislation if they share an EU citation, the width of the line is relative to the number of shared citations. Blue vertices indicate Swedish legislations and red vertices indicate Danish legislations. (B) Corresponding network clusters. Colored spheres indicate community modules within the network.

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Technical
University
of Denmark

DTU Aqua
Kemitorvet
DK-2800 Kgs. Lyngby

www.aqua.dtu.dk