



Practical steps toward integrating economic, social and institutional elements in fisheries policy and management

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Total number of authors:
11

Published in:
ICES Journal of Marine Science

Link to article, DOI:
[10.1093/icesjms/fsx057](https://doi.org/10.1093/icesjms/fsx057)

Publication date:
2017

Document Version
Peer reviewed version

[Link back to DTU Orbit](#)

Citation (APA):

Stephenson, R. L., Benson, A. J., Brooks, K., Charles, A., Degnbol, P., Dichmont, C. M., Kraan, M., Pascoe, S., Paul, S. D., Rindorf, A., & Wiber, M. (2017). Practical steps toward integrating economic, social and institutional elements in fisheries policy and management. *ICES Journal of Marine Science*, 74(7), 1981-1989. <https://doi.org/10.1093/icesjms/fsx057>

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Practical steps toward integrating economic, social and institutional elements in fisheries policy and management

Journal:	<i>ICES Journal of Marine Science</i>
Manuscript ID	ICESJMS-2016-428.R3
Manuscript Types:	Food for Thought
Date Submitted by the Author:	15-Mar-2017
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Keyword:	Fisheries sustainability, ecosystem approach, integrated management, integrating social and economic aspects, social-ecological system

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Manuscripts

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3 Draft – V15(20170317)
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6 **Proposed ‘Food for thought’ for ICES JMS:**
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9 **Practical steps toward integrating economic, social and institutional elements in fisheries policy and**
10 **management**
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Abstract

2 While many international agreements and legislation in most jurisdictions call for incorporation of four
3 pillars of sustainability, the social (including cultural), economic and institutional aspects (the 'human
4 dimension') have been relatively neglected to date within the practice of fishery assessment and
5 management. As a result, nations are failing to achieve the aspirations of ecosystem-based and
6 integrated management. Recent research publications and discussions have focused on three key
7 impediments: a relative lack of explicit social, economic and institutional objectives; a general lack of
8 process (frameworks, governance) for routine integration of all four pillars of sustainability; and
9 assessment and management processes that are biased towards biological considerations. The practical
10 integration of ecological, economic, social and institutional aspects requires a 'systems' approach with
11 explicit consideration of strategic and operational aspects of management: multidisciplinary or
12 transdisciplinary evaluations; practical objectives for the four pillars of sustainability; appropriate
13 participation; and a governance system that is able to integrate these diverse considerations in
14 management. We challenge all involved in fisheries to immediately take five practical steps toward
15 integrating ecological, economic, social and institutional aspects: 1) Adopt the perspective of the fishery
16 as a 'system' with interacting natural, human and management elements; 2) Be aware of both strategic
17 and operational aspects of fisheries assessment and management; 3) Articulate overarching objectives
18 that incorporate all four pillars of sustainability; 4) Encourage appropriate (and diverse) disciplinary
19 participation in all aspects of research, evaluation and management; and 5) Encourage development of
20 (or emulate) a participatory governance system.

Key Words: Fisheries sustainability, ecosystem approach, integrated management, integrating social and
economic aspects, social-ecological system

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22 Introduction

23 There has been substantial movement towards implementation of objective-based management in
24 fisheries, including an increasing prevalence of specific objectives and performance indicators used in
25 both fisheries assessment and management decision-making (e.g. Punt, 2015; Rindorf et al, 2016a).
26 There is also widespread recognition of the need for increased attention to the four pillars of
27 sustainability (ecological, economic, social (including cultural) and institutional) in fishery management
28 advice and decision-making (Garcia et al, 2014; Rindorf et al, 2016b). Although international agreements
29 and legislation in most jurisdictions call for incorporation of all four pillars, the social, economic and
30 institutional aspects (the ‘human dimensions’) have been relatively neglected to date within the practice
31 of fishery assessment and management in most countries. Current stock assessment methods and
32 established assessment review and management processes in most nations, including those in Canada,
33 Europe (e.g. ICES) and Australia, remain heavily dominated by, and biased towards, biological
34 perspectives and have been unable to adequately embrace economic, social and institutional aspects
35 (e.g. Bond and Morrison-Saunders, 2011).

36 The failure to fully embrace economic, social and institutional considerations has resulted in a failure to
37 achieve the aspirational objectives of sustainable development and ocean-related policies of many
38 countries (Begg et al, 2015). This, in turn, has produced major negative consequences. Many of these
39 have been unintended, or at least untracked, such as the direct social and economic costs of lost or
40 foregone community benefits resulting from changes in the distribution of benefits from fisheries
41 (Pinkerton, 2013; Pinkerton and Davis, 2015; Wiber, 2000). There has also been dissatisfaction with
42 management; from both the public and the fishing industry. Public dissatisfaction is commonly
43 expressed through a lack of societal acceptance or ‘social license’ (as seen, for example, in negative
44 public reaction to the “supertrawler” Magiris/Abel Tasman in Australia (Hayward et al 2013); or the

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3 45 approval of new 'pulse' fishing gear in the Netherlands (Haasnoot et al 2016)). Industry may perceive
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5 46 management directions as flawed or a threat to continued existence (as seen for example in the concern
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7 47 about concentration of lobster fishing rights in Canada (Barnett et al, 2016), or of the introduction of the
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9 48 landing obligation in Europe (Kraan and Verweij, 2016)). These have contributed to increased
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11 49 management complexity and costs including considerable additional re-evaluation and meetings and to
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13 50 a lack of compliance, further reducing the efficiency of management and worsening the overall results.
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18 51 Practical integration of ecological, economic, social and institutional objectives and indicators in fisheries
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20 52 was the focus of the recent (November 2015) international ICES/Myfish symposium on targets and limits
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22 53 for long-term fisheries management (summarized in Rindorf et al, 2016b). The set of papers arising from
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24 54 that meeting (see ICES Journal of Marine Science Volume XXX) demonstrates that, while there have
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26 55 been some efforts made to modify existing approaches, these have not yet been able to adequately
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28 56 combine the full suite of economic, social and institutional considerations required of management.
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30 57 More recently (June, 2016) another ICES symposium was devoted to 'Understanding marine social-
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32 58 ecological systems: including the human dimension in integrated ecosystem assessments' (see ICES
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34 59 Journal of Marine Science Volume YYY; [Thébaud et al, 2017](#)). Both symposia have pointed to a dilemma:
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36 60 the incorporation of economic, social and institutional aspects is necessary, but current biologically-
37
38 61 based assessment and management systems seem unable to do it. This paper explores why the
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40 62 aspirations to include economic, social/cultural and institutional objectives have been so difficult to
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42 63 convert into real outcomes. We argue that there is need for substantial modification of the approaches
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44 64 to and processes of fisheries assessment and management, and that implementation of five practical
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46 65 steps could have widespread benefits to fishers, managers, the public, and decision makers.
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67 **The Problem - failure to attend to the four pillars of sustainable fisheries**

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3 68 Three major problems or characteristics have been identified in recent literature and meetings (for
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5 69 example Rindorf et al, 2016b; Begg et al, 2015) with respect to the failure to attend to the four pillars of
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8 70 sustainable fisheries.

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11 71 First, there is a relative lack of explicit social, economic and institutional objectives (Symes and
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13 72 Phillipson, 2009; Spangenberg et al, 2002). These 'human dimensions' are generally undefined, or poorly
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15 73 specified relative to the biological aspects of fisheries. For example, international agreements and the
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17 74 legislation of many nations contain only high-level, aspirational objectives related to economic, social
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19 75 and institutional considerations (FAO, 1999). Human dimensions are commonly assumed to be included
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21 76 within overarching concepts (for example as part of 'sustainable yield') or adequately covered by proxies
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23 77 (e.g. catch per unit effort - CPUE) for economic return and lifestyle aspects of social dimensions (Brooks,
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25 78 2010). The tendency to deal in broad terms means that few fisheries have specific operational
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27 79 objectives and appropriate indicators to monitor economic, social and institutional performance of
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29 80 fisheries.

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35 81 Secondly, there is a general lack of process (frameworks, governance) for routine integration of
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37 82 ecological, economic, social and institutional considerations (Begg et al., 2015; Bond and Morrison-
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39 83 Saunders, 2011). Many jurisdictions have legislation and policies calling for integration, but lack
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41 84 empowered governance structures that enable practical implementation. Historically, social and
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43 85 economic aspects have been typically included as longstanding political imperatives (e.g.
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45 86 implementation of ITQs to overcome perceived problems of competitive fisheries; "modernization"
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47 87 versus "social welfare" objectives - Charles, 1992; Barnett et al., 2016), or as short term political choices
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49 88 during the decision making process (e.g. perceived impact on employment in processing plants;
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51 89 Paterson et al 2013), rather than proactive explicit social and economic objectives. Where they have
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53 90 been included in routine decision-making, social and economic aspects are often added after ecological
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3 91 consideration, in an inconsistent or ad hoc manner according to the political pressure applied, and often
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5 92 without the benefit of analyses or appropriate methods (e.g., Clay et al, 2014; Lane and Stephenson,
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8 93 1998, Beeton et al., 2012).

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11 94 Thirdly, fisheries assessment and management processes are biased towards biological considerations
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13 95 (Begg et al, 2015; Brooks et al, 2015; Pascoe et al, 2013). Scientific study, data collection and advice are
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15 96 almost exclusively on biological aspects, which are considered to be the primary mandate of traditional
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17 97 assessment and management. Most nations have structured fisheries institutions around assessments
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20 98 with elaborate processes for production of peer reviewed biological advice, but have no process for
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22 99 development of comparable economic, social and institutional evaluations (for a recent discussion see
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25 100 Constanza et al, 2016). Advisory processes are generally not asked to provide, and are not ready to
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27 101 provide, more comprehensive advice. The issue is complicated by the predominant institutional views
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30 102 and histories of participants. Some argue that advice related to economic, social and institutional
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32 103 aspects of fisheries is beyond the scope of expertise of traditional fisheries assessment bodies (it's 'not
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34 104 our job', or 'we don't have the expertise'), and indeed fisheries agencies lack such expertise because
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36 105 they have prioritized building expertise in biological sciences. In other cases, scientists appear hesitant
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38 106 to ask for financial information from fisheries participants, or mistrust between agencies and fishers
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41 107 limit sharing of data and information that may be perceived as private, even though catch and effort
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43 108 information is routinely collected. Most scientific staff who are accustomed to conventional fisheries
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45 109 assessment and management processes have backgrounds in biology and ecology, and lack the training
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48 110 or experience to integrate other aspects. Where economists have been involved in assessment
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50 111 processes, there is usually a dearth of information to provide anything more than qualitative advice.
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52 112 Other social scientists, who may have the relevant backgrounds, have generally been relatively
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55 113 unconnected with traditional assessment and management processes, and are therefore unable to
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57 114 easily contribute to the conventional system (see Urquhart et al, 2011). Furthermore, participants who
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3 115 are entrenched in established processes or in academic disciplines may also be simply unmotivated
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5 116 (unwilling or unable) to 'take up the torch' to include diverse aspects of the four pillars, perhaps due to
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8 117 the lack of agreed methodologies and common terminologies.
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11 118 The combined effect is an imbalance in the four pillars. There is continued dominance of biological
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13 119 aspects of assessment and management, considerably less consideration of economic aspects, and very
14
15 120 little incorporation of social and institutional factors (Charles et al., 2014; Paul and Stephenson, in
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17 121 review). Fisheries governance systems either do not include economic, social and institutional aspects,
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19 122 or include only a small subset of these considerations. Where they have been included, it tends to be
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21 123 around biological analyses, without appropriate evaluation, late in the decision-making process (as with
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23 124 political considerations), and in a system that is difficult to change (see Parlee and Wiber, 2014).
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28 125 This situation is not new. Calls for *consideration* of economic and social aspects extends to the first half
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30 126 of the 20th century (e.g. Sinclair, 1988; Gordon, 1954; Anderson, 1983 translation of Warming 1911),
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32 127 and published critiques and calls for greater *integration* date back more than two decades (e.g.
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34 128 Stephenson and Lane, 1995; 2010; Garcia, 1996). ICES, for example, established a 'Fisheries
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36 129 Management Committee' in 1997 to include considerations of 'economics, sociology and management
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38 130 science' (Rozwadowski, 2002). It has been increasingly popular to establish working groups and
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40 131 initiatives related to the 'human dimension' e.g. Fisheries System and Maritime Systems working groups
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42 132 of ICES (ICES 2000, 2013; 2015); the Strategic Initiative on the Human Dimension
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44 133 (<http://www.ices.dk/community/groups/Pages/SHHD.aspx>); the Human Dimension initiative of PICES (a
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46 134 Study Group on Human Dimensions was replaced by the Section on Human Dimensions of Marine
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48 135 Systems (<http://meetings.pices.int/members/sections/S-HD>) then, in November 2016, replaced by a
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50 136 PICES Science Board standing committee, the Human Dimensions of Marine Systems Committee) and
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52 137 IMBER (<http://www.imber.info/Science/Working-Groups/Human-Dimensions>). However, in spite of such
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3 138 initiatives, movement to full integration of ecological, economic, social and institutional aspects has
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5 139 been very slow. Many previous proposals for frameworks with diverse indicators remain
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8 140 unimplemented (e.g., Boyd and Charles, 2006; Charles et al., 2002), and there remains a profound
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10 141 inertia in fisheries assessment and management that is preventing integrated attention to the four
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12 142 pillars of sustainability.
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18 19 144 **Priorities for integrating ecological, social, economic and institutional aspects of fisheries**

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22 145 We suggest there are five key elements for the practical integration of ecological, economic, social and
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24 146 institutional aspects of assessment and management:
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26 27 147 1. Adopt a systems approach, recognizing interacting natural, human and management elements

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30 148 There is a longstanding recognition of the need to assess and manage fisheries as integrated systems,
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32 149 including consideration of the ecosystem, society and management (e.g., Charles, 1995). To this end,
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34 150 there have been a variety of attempts to describe or conceptualize the fishery as a social-ecological
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36 151 system (see for example Kooiman et al, 2005; Ommer et al., 2011; 2012; Kittinger et al., 2013; Begg et
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38 152 al., 2015). We suggest there is a need to adopt the perspective of interacting natural, human and
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40 153 management systems (Cochrane, 2000; Charles, 2001) requiring explicit consideration of ecological,
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42 154 economic, social and institutional aspects of both assessment and management.
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47 48 155 2. Be aware of both strategic and operational aspects of fisheries management

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50 156 Further, we emphasize that management of fisheries has both operational and strategic aspects
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52 157 (conceptualized in Fig 1) that operate on very different time scales, utilize different types of information,
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54 158 and require different participation. The familiar, management planning cycle (operational cycle of Fig 1)
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56 159 is a routine (e.g. annual) approach to evaluating and updating tactical aspects of management decision-
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3 160 making. It tends to involve a subset of the interested parties (especially industry and government), and
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5 161 only the biological subset of management objectives. This is quite distinct from a strategic cycle (outer
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7 162 cycle of Fig 1) that should occur from time to time to modify policies or strategies, and should involve
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10 163 broader participation (industry, government, NGO's and even the public) and a more comprehensive set
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12 164 of considerations. It is especially in relation to this strategic cycle that economic, social and institutional
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14 165 objectives and indicators may be identified and monitored in relation to medium or long term goals of
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16 166 fisheries management. Much of the complication in integrating ecological, economic, social and
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18 167 institutional considerations stems from the fact that these aspects cannot be included directly in the
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20 168 annual tactical management planning (except perhaps as political imperatives), and most current
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22 169 processes do not include an explicit strategic planning cycle that would allow such consideration. There
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24 170 is need for greater appreciation of which aspects of management are operational and which are
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26 171 strategic, and to include processes for both operational and strategic aspects in assessment and
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28 172 management planning. A systems approach to fisheries, as outlined in Fig 1, should provide a
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30 173 mechanism for incorporating and integrating both strategic and operational aspects of ecological,
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32 174 economic, social and institutional objectives, within an appropriate framework or governance process
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34 175 (discussed later).
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41 176 3. Define practical objectives for the four pillars of sustainability

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44 177 Modern, objective-based (or performance-based) fisheries management decision-making requires
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46 178 articulation of specific objectives, which will drive relevant performance indicators and reference points
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48 179 that can be used in applied decision-making. The imperative to include the four sustainability pillars,
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50 180 and in particular social, economic and institutional objectives is well articulated in international
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52 181 agreements (albeit in high-level aspirational terms as in the UN Sustainable Development Goals (UN,
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54 182 2012)) and increasingly in national policies. The challenge is twofold, first requiring political articulation
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3 183 or at least direction, and then implementation. Contrary to common belief, the scope of economic,
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5 184 social and institutional objectives can be anticipated. Indeed, several initiatives have recently articulated
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8 185 candidate operational objectives with relevant performance indicators related to ecological (e.g.
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10 186 productivity, trophic structure, biodiversity and ecosystem integrity), economic (e.g. viability and
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12 187 prosperity, distribution of benefits), social (e.g. health and well-being, sustainable communities, ethical
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14 188 fisheries) and institutional (e.g. legal obligations, good governance, effective decision-making) aspects of
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17 189 management (e.g. Canadian Fisheries Research Network (<http://www.cfrn-rcrp.ca/Public-Products-EN>),
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19 190 Australia (Triantafillos et al , 2014; Begg et al, 2014; Brooks et al, 2105), and the USA: NOAA
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21 191 (<http://www.st.nmfs.noaa.gov/humandimensions/social-indicators/>).

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25 192 Practical implementation of economic and social objectives continues, however, to be confounded by
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27 193 major issues. Economic and social priorities (or values, or objectives) differ among interest groups, and
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29 194 are less easily agreed upon than are biological objectives. While biological objectives of maximum
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31 195 sustainable yields can be and often are debated, decisions focusing on economic and social objectives
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33 196 (such as fishery access and allocation) are much more controversial as the impact is more direct and
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35 197 explicit, there are clear “winners” and “losers”. In addition, even when a set of objectives can be agreed
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37 198 on, the priorities given to these objectives can also vary substantially between different interest groups
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39 199 ([Pascoe et al. 2009](#); [Pascoe et al. 2013](#)). Consequently, while there may be internationally agreed
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41 200 objectives regarding the biological aspects of the stock, nations with different development needs
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43 201 and/or diverse participants will have different priorities in terms of specific social and economic
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45 202 objectives. For this reason, the diversity of interests cannot generally be distilled into a single specific
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47 203 fishery objective. Identifying and recognising these differences in objective priorities is as important as
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49 204 identifying the objectives themselves, if buy-in from all stakeholders is to be achieved. The disciplinary
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51 205 considerations differ in scale and in use (strategic vs operational; Fig 1) (Benson and Stephenson, in
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53 206 review; Punt et al., 2015), so that the processes as well as methodologies of attempting to identify
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3 207 uniform objectives and performance measures pose barriers. Further, systems that are accustomed to
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5 208 defined and immutable objectives and measures have difficulty accommodating the fluidity in economic
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8 209 and social considerations. The bottom line is that there are structural and institutional reasons for the
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10 210 failure to integrate economic and social aspects. This points to the need for improved governance
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12 211 processes, starting with an analysis of these structural and institutional reasons in order to allow
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15 212 appropriate flexibility in the consideration of the four pillars.
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18 213 4. Undertake multidisciplinary or transdisciplinary research, evaluation and management
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21 214 Fisheries assessment and management must broaden its focus beyond biological considerations to
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23 215 become interdisciplinary (integrating disciplines) or transdisciplinary (spanning disciplines in a joint
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25 216 approach) (Phillipson and Symes, 2013; Lang et al, 2012; Begg et al, 2014 & 2015). Economic, social and
26
27 217 institutional aspects require focused analyses and devoted expertise. The 'silos' of disciplinarity are both
28
29 218 a strength and a weakness in comprehensive fishery evaluation. There is a need for, and value in,
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31 219 disciplinary-specific methods and analyses, coupled with an imperative to overcome differences and
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33 220 work together to provide integrated assessments and practical management advice. Comprehensive
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35 221 evaluation has been hampered by the fact that prime contributors to assessment and management tend
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37 222 to be from government institutions that have predominantly biological and other natural science
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39 223 expertise. The natural science apparatus within government has not typically provided structure or
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41 224 incentives for staff to social science expertise. As a result, social scientists, affiliated primarily with
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43 225 academic institutions, have been often excluded from (typically government-driven) applied assessment
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45 226 and management processes. There may also be a lack of interest among some in both natural sciences
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47 227 and social sciences to develop better relationships and greater integration. This may be due in part to
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49 228 the practical challenges of engaging with biologically-dominated institutions, which do not understand
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3 229 or recognize the relevance of the economic and social sciences to the biological/ecological part of the
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6 230 system, and which feel fully subscribed with existing programs and considerations.
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9 231 Regardless, there is a need to overcome issues and to link disciplinary silos in effective processes. The
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11 232 need to provide agreed (i.e. consensus) and peer-reviewed advice has become an important feature in
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13 233 assessment and fishery evaluation. Social science relates to diverse aspects of the human dimension
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15 234 including features such as employment, ownership, business prosperity, understanding and knowledge;
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17 235 perceptions of legitimacy and social empowerment, human behaviour, culture, values, norms and
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19 236 worldview, as well as governance and institutional frameworks. Social context is the essential
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21 237 component of social analysis. Social evaluation requires diverse methodologies, the outcomes of which
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23 238 are not always easily linked to an analytic framework defined on the basis of a single (previously
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25 239 biological) subject matter. As a result, there is a mismatch between the richness of social context and
26
27 240 the reduction or simplification required in traditional quantitative assessments. Institutionally, there is
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29 241 also need for evolution in management approaches from separate consideration of disciplines (where
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31 242 each discipline is competing for primacy in consideration) to new transdisciplinary approaches in which
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33 243 all can contribute to informing and meeting the over-arching objectives which span all the disciplines.
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40 244 5. Include appropriate participation

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42 245 Fisheries stakeholders are not a single group and therefore flexible approaches and attitudes need to be
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44 246 adopted in management frameworks. Fisheries governance systems have tended to privilege one set of
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46 247 participants (those in the harvesting and processing sectors of the fishery, and increasingly the
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48 248 conservation sector) rather than consumers and others who also gain indirect benefits (such as non-use
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50 249 and aesthetic values) from fish resources, as well as broader societal considerations. There has been a
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52 250 widespread call for more transparency in decision-making and for greater participation in governance.
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55 251 Without downplaying the very real challenges around appropriate stakeholder participation (Hurlbert
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3 252 and Gupta, 2015) we suggest insufficient attention is currently paid to determining and developing
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5 253 appropriate forms of participatory decision-making in fisheries management. This implies the need to
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8 254 recognize the diversity of objectives, the structure of governance (Raakjaer et al 2014), and raises issues
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10 255 of the diversity of considerations at the governance table (whose concerns are evident there?) (Mikalsen
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12 256 and Jentoft 2001), and of power dynamics (whose objectives are paramount?) (Van Leeuwen et al 2014;
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15 257 Pascoe et al, 2013 & 2014).
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21 259 **Revising governance to address diverse objectives in strategic and operational fishery management**

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24 260 The governance, or management process is key to all aspects of fisheries assessment and management.
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26 261 Governance links the participants and the processes. At present, fisheries management planning is
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28 262 focused on operational aspects (tactical management plan, informed by an annual stock assessment).
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30 263 Effective governance of fishery systems requires explicit attention to both the strategic and operational
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32 264 aspects, (which will be on different time and space scales) as well as consideration of the spectrum of
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35 265 participation (Fig 1) at appropriate stages. The question remains as to how to construct a governance
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37 266 system with processes that allows for meaningful integration of the four elements of sustainability
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40 267 across different temporal and spatial scales.
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43 268 The current operational management situation is a sequential process in most places (conceptualized in
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45 269 scenario 'a' of Fig 2), in which explicit biological aspects are considered first (as objectives and then
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47 270 interpreted as targets and performance measures), usually with analysis including peer review. The
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49 271 economic, and perhaps social and institutional, aspects are added later, most often without clearly
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51 272 articulated objectives and usually without formal analysis or assessment as to the effects of the
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53 273 management options being considered. This status quo has been criticized for lacking an institutional
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55 274 process for formal evaluation of social/cultural and economic aspects and for including those aspects in
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3 275 a manner that is largely opaque and political. As food for thought, we ask if there are alternative
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5 276 conceptual options that might allow an improved integration of economic, social, and institutional
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8 277 aspects? One might imagine at least four other scenarios.
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11 278 Scenario 'b' (Fig 2) anticipates a sequential set of separate processes in which ecological aspects are still
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13 279 considered first, but social, economic and institutional aspects are added subsequently after being
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15 280 subjected individually to expert analyses, and perhaps to peer review. This has the obvious advantage of
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17 281 more thorough and formal treatment of social, economic and institutional aspects, but raises the
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19 282 questions of how they will be integrated with other considerations, and is therefore rather a more
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21 283 nuanced description of the status quo. Scenario 'c' represents a possibility of analyses by separate
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23 284 teams (ecological, social, economic and institutional) linked in a process which requires formal
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25 285 integration or consideration of interaction and trade-offs among these aspects. Scenario 'd' anticipates
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27 286 that these diverse elements can be linked in a single, integrated process. Scenario 'e' represents the
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29 287 possibility of starting with assessment of the human dimensions of the fishery system, and then
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31 288 restricting/modifying those according to ecological considerations or constraints. This would ensure the
32
33 289 early articulation of social and economic objectives, and would fit with the reality that fisheries are
34
35 290 rooted in diverse societal goals of providing food supply, social and cultural aspects of livelihoods and
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37 291 economic value. All of scenarios, 'b' through 'e', anticipate a more formal treatment of social, economic
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39 292 and institutional aspects, and scenarios 'c' through 'e' introduce those considerations earlier.
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46 293 Scenario 'c' would be classified by most definitions (e.g. Paterson et al 2010) as an interdisciplinary
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48 294 approach. Scenario 'd' could represent either an interdisciplinary approach or, if the treatment of the
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50 295 disciplines was comprehensive and from the beginning of the process, could be a transdisciplinary
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52 296 approach according to the definitions of Aboelela et al 2007 ('research efforts conducted by
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54 297 investigators from different disciplines working jointly to create new conceptual, theoretical,
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3 298 methodological, and translational innovations that integrate and move beyond discipline-specific
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5 299 approaches to address a common problem’) or Paterson et al 2010 (‘research that starts from real-world
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8 300 problems to develop solutions in partnership with multiple stakeholders’).

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10 301 Several methods have been proposed in the literature as being able to combine social, economic and
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12 302 institutional aspects (see Benson and Stephenson, in review), including Ecological Risk Assessment for
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14 303 Fisheries (Fletcher, 2009; Hobday et al, 2011), Management Strategy Evaluation (Cox and Kronlund,
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16 304 2008; Dichmont et al, 2008, Punt et al, 2014; Fulton et al., 2014), Ecosystem models (Link et al 2002;
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18 305 Curtin and Prellezo, 2010), multi-objective modelling ([Pascoe et al. 2016](#)), multi-criteria decision analysis
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20 306 approaches ([Dichmont et al. 2013](#)) and Bayesian Belief Networks (Kuikka et al, 1999; Duespohl et al,
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22 307 2012). Further, there is the possibility of using (combining) several methods, as was done for example,
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24 308 in integrating the biological, economic and cultural outcomes in the analysis of alternative management
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26 309 systems for the Torres Straits lobster fishery; [Plagányi et al. 2012](#); [Plagányi et al. 2013](#)). Although
27
28 310 integration of ecological, economic, social and institutional aspects has often been articulated as an
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30 311 aspiration, practical implementation has to date generally been confounded by the historical dominance
31
32 312 of biological approaches and a lack of clarity as to the spectrum of non-biological objectives. As
33
34 313 discussed above, ecological, economic, social and institutional considerations differ in application
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36 314 (operational vs strategic) and scale (e.g., spatial or jurisdictional) – of the fishery itself, and through to
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38 315 society as a whole. They therefore require different types of advice (prescriptive, descriptive or insight)
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40 316 (Benson and Stephenson, in review). A single process for integrating all of these aspects is naïve, but it is
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42 317 critical that the processes work together to integrate ecological, economic, social and institutional
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44 318 aspects across strategic and operational considerations. While we recognize that governance processes
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46 319 and power structures are unlikely to change unless there is major influence (such as judicial directive or
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48 320 widespread public outrage), we suggest there is need for modification of governance processes to
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3 321 include explicit consideration of both strategic vs operational cycles of management (as described in Fig
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5 322 1), and the full suite of ecological, economic, social and institutional aspects of management (Fig 2).

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12 324 **Overcoming inertia to integrate social, economic and institutional objectives**

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15 325 The literature provides a litany of criticisms of conventional fisheries management (Charles, 2013;
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17 326 Hilborn, 2007; Symes & Phillipson, 2009; Pinkerton and Edwards, 2009; Wiber, 2000). In spite of
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19 327 elaborate fisheries management processes, there has been an inability to achieve the aspirations of
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21 328 international agreements and national legislation related to sustainability, and a failure to prevent
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23 329 unintended consequences including stock collapse, overcapacity and collapsed coastal communities.
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25 330 There is need for an integrated approach to fisheries (and to other marine activities) in relation to a
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27 331 more diverse set of objectives that include the higher standards of ecological integrity and diverse
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29 332 social, economic and institutional aspects of sustainability, and that can account for and manage societal
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31 333 expectations in relation to ecosystem constraints in a context of change (Stephenson, 2012). Failure to
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33 334 adopt a more comprehensive integrated approach will perpetuate the focus on a subset of primarily
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35 335 ecological objectives and the neglect of many social, economic and institutional objectives. This will
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37 336 result in further unintended (or at least untracked) consequences, failure to achieve the diverse
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39 337 spectrum of objectives in legislation, and further loss of confidence in management systems. In contrast,
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41 338 a successfully integrated approach promises better success at meeting objectives, fewer unintended
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43 339 consequences, better appreciation and support of management and increased management credibility.
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45 340 We have illustrated several examples where such integration has been undertaken successfully. This
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47 341 demonstrates that such approaches are possible even if not broadly adopted.

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50 342 An appropriate governance process is key to resolving the challenges of integration. The governance
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52 343 system establishes the participation and disciplinary scope, allows the emergence of objectives and puts
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3 344 in place the processes for transdisciplinary consideration. Ideally, these processes would be
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5 345 institutionalized, but we suggest there is scope within most existing fisheries assessment and
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8 346 management systems to make immediate progress and to overcome the inertia that has been prevalent
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10 347 to date.

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13 348 We call on all participants in fishery assessment and management to challenge themselves and each
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15 349 other to work within their sphere of existing influence to improve the integration of ecological,
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18 350 economic, social and institutional aspects in evaluation and management of fisheries and to promote
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20 351 the articulation of overarching transdisciplinary objectives. We suggest the following practical steps
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22 352 would be useful to undertake immediately, by individual participants and collectively:

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25 353 1. View the fishery as a 'system' with interacting natural, human and management elements
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28 354 2. Be aware of both strategic and operational aspects of fisheries management
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30 355 3. Articulate overarching objectives that incorporate all four pillars of sustainability
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33 356 4. Encourage appropriate (and diverse) disciplinary participation in all aspects of research,
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35 357 assessment and management
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37 358 5. Encourage development of (or emulate if there are institutional impediments) a participatory
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39 359 governance system.

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42 360 Although difficult, greater (and more effective) attention to social, economic and institutional aspects of
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44 361 assessment and management is critical to the sustainability of fishery systems, and the benefits they
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46 362 provide for fishery participants, management decision-makers, and society. There is a need for both
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48 363 leadership to articulate a strategy for integration of the four pillars in assessment and management.
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50 364 and collective creativity, in modifying governance regimes to incorporate those aspects effectively.

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52 365 An increased emphasis on the consideration of social, ecological and economic aspects of fisheries
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55 366 resources is fundamental to producing better political and public outcomes. Measures to achieve this

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3 367 include: clearly identifying the social and economic objectives sought in accessing and harvesting
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5 368 resources; distinguishing between the strategic and operational aspects of assessment and
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8 369 management; and addressing – at least in part – the complications traditionally cited with the use of
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10 370 objectives and indicators. Clarity in objectives for all domains (ecological, economic, social and
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12 371 institutional) must underlie the governance changes that will facilitate integration of the four pillars of
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14 372 sustainable resource management. Articulation of social and economic aspirations, even in a strategic
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16 373 “visioning” process, would engage a broad range of stakeholders, and provide policy makers with a
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18 374 broader and more solid platform from which to speak in future planning processes. This would improve
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20 375 transparency of the process, provide a stronger basis for decision-making, and reduce unintended (or
21
22 376 unacknowledged) consequences of management actions. Importantly, it will also improve credibility and
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24 377 societal acceptance in the management process. Establishing that management policy reflects societal
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26 378 priorities, and that management is perceived to be achieving desired outcomes, are key elements to
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28 379 achieving and maintaining a social license for fisheries.
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6 589 Fig 1. Conceptual representation of a comprehensive fishery system in which there is explicit recognition
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11 591 Fig. 2. Conceptual tactical or process options for integrating ecological, economic, social and institutional
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16 593 white ellipse indicates a lack of formal process.
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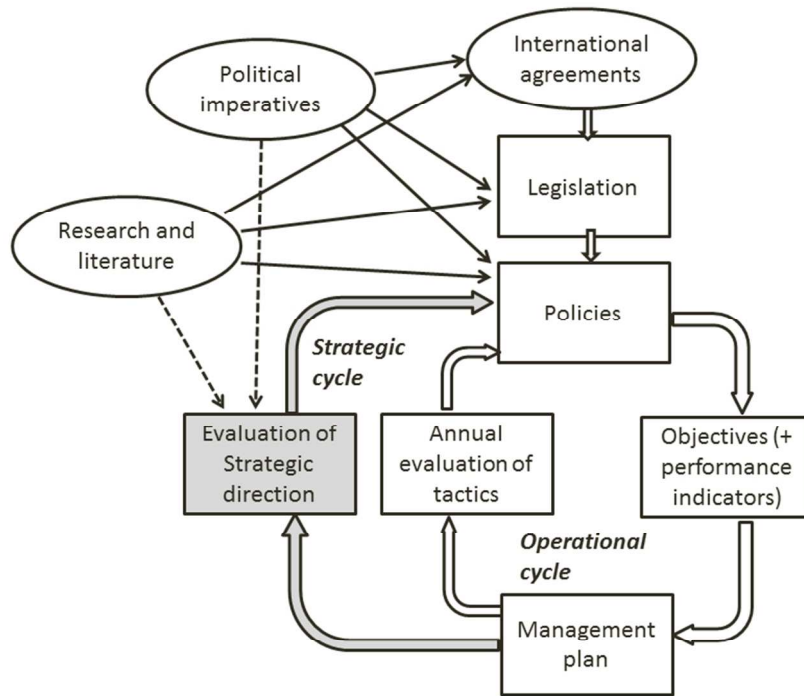


Fig 1. Conceptual representation of a comprehensive fishery system in which there is explicit recognition of both the common operational cycle and a strategic cycle, currently missing in most situations.

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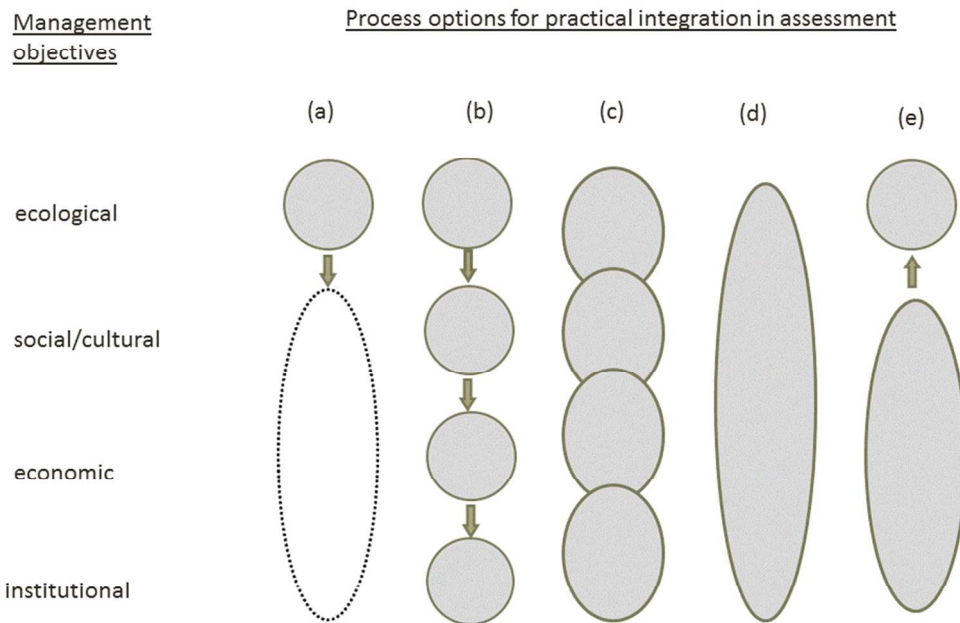


Fig. 2. Conceptual tactical or process options for integrating ecological, economic, social and institutional considerations in fisheries evaluation and management. Spheres represent distinct processes. The white ellipse indicates a lack of formal process.

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