



ELSEVIER

Available online at www.sciencedirect.com

SciVerse ScienceDirect

Current Opinion in
Environmental
Sustainability

People, oceans and scale: governance, livelihoods and climate change adaptation in marine social–ecological systems

Anthony Charles

This article explores several key ingredients for successful and sustainable interactions of people and oceans, based on an integrative social–ecological systems perspective. Several key themes are examined: governance and decision-making, livelihoods and well-being, and the modern challenge of adaptation to current and future climate change. Each of these applies at various scales, from the local to the global. While much attention in the literature lies on global and large-scale systems, the smaller scale is deserving of at least as much attention; this point is illustrated by a local-level example. Indeed, cross-scale linkages that connect scales of impacts and levels of decision-making are key elements in improving the governance of marine systems.

Address

School of Business & School of the Environment, Saint Mary's University, Halifax, Nova Scotia, B3H3C3, Canada

Corresponding author: Charles, Anthony (tony.charles@smu.ca)

Current Opinion in Environmental Sustainability 2012, 4:351–357

This review comes from a themed issue on **Aquatic and marine systems**

Edited by **R Ian Perry**, **Alida Bundy** and **Eileen E Hofmann**

For a complete overview see the [Issue](#) and the [Editorial](#)

Received 8 February 2012; Accepted 31 May 2012

Available online 23rd June 2012

1877-3435/\$ – see front matter, © 2012 Elsevier B.V. All rights reserved.

<http://dx.doi.org/10.1016/j.cosust.2012.05.011>

Introduction

This article focuses on current progress in finding solutions to the well-documented problems facing the world's oceans and the life within them. The solutions tend to focus on the 'human dimension' [1,2,3], notably how people themselves can collectively solve the problems they have created at sea, through improved ocean use and governance. This, then, is about positive interactions of people and oceans.

The article explores several key ingredients for success in those interactions. *Governance* involves people making decisions, in keeping with human values, and in order to best meet human goals [4,5]. A key part of that relates to *livelihoods* – not only how people 'make a living' but also how they spend their time and achieve their ambi-

tions [6,7]. In doing so, people must respond to change arising in many forms, whether environmental, social, economic or institutional. The manner of this response, referred to as *adaptation* (see, e.g. p. 879 of [8]), affects the well-being of households, communities and societies. A notable present-day challenge lies in finding successful and resilient adaptation strategies to respond suitably to current and future *climate change* [8,9,10,11].

All this takes place within webs of dynamic and interacting human and environmental components – which, in recent years, have come to be referred to as *social–ecological systems* [12,13–16,17,18]. This integrative 'systems thinking' reflects the reality that humans live in, interact with and adapt to both social systems and ecosystems [19,20]. In turn, this demands decision-making approaches that take into account the nature of continual and potentially heightened change over time, highlighting the need for dynamic governance.

This article explores these concepts, and how they come together to provide practical approaches for the sustainability of marine environments. In particular, it is noted that each concept applies at various scales, from the local to the global. While much attention in the literature lies on global and large-scale systems, here the importance of a smaller scale is highlighted – social–ecological systems relevant to coastal communities, on the front lines in meeting sustainability challenges.

Marine social–ecological systems

The concept of social–ecological systems has gained great popularity over the past decade, as a mechanism to integrate ecosystems, human systems (e.g. marine economic sectors, and communities and coastal regions dependent on the ocean) and governance systems (e.g. the values held by people in relation to the sea, and the various decision-making fora and processes) [12,13,15]. This builds on a longstanding recognition of the integrated nature of environmental and natural resource 'systems' [13], in which ecosystems and human systems interact in complex ways that affect overall governance. With human systems as complex and in need of understanding as ecosystems, the necessity of interdisciplinary approaches to spatially based and natural resource management is reinforced. In particular, these perspectives are crucial in marine environments, and notably fishery systems [19,20]. At present, the many aspects of marine social–ecological systems are being investigated, with major syntheses now emerging [16].

One important component of this synthesis is the focus it brings to the concept of resilience, an inherently systems-oriented concept. Resilience is the ability of a system to persist, “to absorb recurrent natural and human perturbations and continue to regenerate without slowly degrading or unexpectedly flipping into alternate states” – p. 380 of [21] and see also [15,22]. For example, in a marine fishery context, we can envision resilience as relating to all the components of the system – including a resilient ecosystem, resilient fishing communities, a resilient socioeconomic structure, and resilient governance institutions.

One challenge in discussions of social–ecological systems lies in connecting the lofty theoretical ideas with on-the-ground realities of particular places. Many research papers talk in general terms about social–ecological systems, drawing abundant generic flowcharts and organizational diagrams, but people live in social–ecological systems (a statement going not much further than the classic point that people live within ecosystems). It is important to connect the concepts with the reality, of life in a ‘system’. Essentially, the key benefit of talking in terms of such systems is to remind ourselves of the interconnectedness of human society, communities and households with the natural world around us. In fact, while being reminded of that interconnectedness may be important for academics in disciplinary ‘silos’, and resource managers in conventional sector-focused ‘silos’, those in coastal communities typically live and work with that interconnectedness on a daily basis [21,22]. Later in the article, this reality will be examined through a case study on Canada’s Atlantic coast.

Marine governance

Ideas and approaches for sustainable use of fisheries and other renewable resources – indeed a *science of sustainability* [23] – have developed in marine systems for well over a century. This knowledge base has led increasingly toward a global consensus on the need for management interventions and policy measures to ensure sustainability, and to achieve overall fishery goals and directions. However, over the past two or three decades, the realization has emerged that *how* management and policy are developed and implemented is at least as important as the measures themselves [24^{••},25,26].

Conventional decision-making about human uses of the oceans has had two major characteristics: it has taken place in a top-down manner, typically by a governmental authority, and it has occurred on a sector by sector basis, for example, for the fishery sector separately from shipping, tourism and other sectors. These two attributes led to a lack of support for management (since ocean users did not support the top-down rules) [19] and fragmented, uncoordinated decision-making, as well as a lack of attention to cumulative environmental impacts (given the ‘silo’ nature of management) [25,26].

Governance involves decision-making, including not only the specifics of the possible decisions themselves, but also who makes the decisions, what processes are used for this, and what is to be included for consideration. Modern *good governance* shifts decision-making toward participatory processes, collaborative or shared *co-management*, and ecosystem-oriented *integrated management* that creates multi-stakeholder institutions (i.e. organizations) to help in resolving conflicts among users while providing suitable environmental protection [24^{••},27–29].

Two key aspects of such governance should be noted. First, it begins logically with an understanding of values and visions – what people care about, and what directions they wish to pursue [24^{••}]. Second, governance is a *multi-level* matter, in which decisions that can be made locally take place at that level, but are linked effectively to those that must be taken at higher levels of organization [4,11^{••},12[•]]. This point, and the closely related importance of spatial *scale*, will be emphasized later in the article.

Marine livelihoods and well-being

Very recently, the concept of *well-being* has become a significant area of research in marine social–ecological systems [30,31^{••},32]. This builds on many years of interest in applying a *sustainable livelihoods approach* to fisheries and coastal communities [6]. The latter has been influential, particularly in applications to developing countries. It highlights the importance of a broad view of livelihoods rather than merely income and employment, and emphasizes the need to consider all five types of ‘capital’ – physical, social, human, natural and financial. This effectively broadens past analyses and approaches, by ensuring, for example, that natural capital is not neglected when the focus is on human dimensions, and that aspects of social capacity and social cohesion (under the heading of social capital) are included even in economics-focused studies and applications.

The well-being approach takes this a step further, shifting the emphasis from capital to well-being, taking a broader view of social relationships (as more than ‘capital’) and recognizing that in addition to what might be seen as objective measures, the subjective or perceived well-being of individuals, households and communities is also important [31^{••},32] – reflecting, for example, matters of food sovereignty and gender equality. Sustainability enters well-being discussions through inclusion of ‘well-being in relation to nature’ as one of the fundamental considerations. This highlights a perspective very different from the conventional one of humans as narrow-minded exploiters of the ocean, one that recognizes how livelihoods and well-being of people go hand in hand with resource sustainability and ecosystem health [31^{••}].

While livelihoods and well-being have been most often examined at the level of households and communities, an

important direction for research and for policy impact lies in aggregation and consequent linkages to higher-level governance. The key idea is that taking into account the dynamics of livelihoods and the complexities of well-being can help in formulating the most effective policy approaches, thereby creating more sustainable and resilient social–ecological systems.

Adaptation to climate change

Climate change will have a wide range of impacts on human uses of marine systems, and the coastal communities that depend on the ocean for their livelihoods [8[•],9,10,11^{••},33[•],34–36]. How will marine social–ecological systems be affected by climate change, and how will (or should) they adapt? Given the crucial interactions that occur between the world's oceans and its atmosphere, as well as the extensive impact of climate change projected for coastal areas, these questions are of immediate importance.

Discussions of climate change have come to focus particularly on ideas of vulnerability and adaptation – for example [37[•]] – which, in a marine context, are applied to a range of marine economic sectors, resource users and coastal communities [38]. The first of these, vulnerability, is defined by the IPCC as “the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change. . .” – see ‘Summary for Policymakers’ (p. 21) in [8[•]] – and is seen as comprised of three elements: exposure, sensitivity, and adaptive capacity (e.g. [8[•],37[•]]). Allison *et al.* [[33[•]], p. 175] apply these in a specific fishery context, describing the elements as: “exposure (E) to physical effects of climate change, the degree of intrinsic sensitivity of the natural resource system or dependence of the national economy upon social and economic returns from that sector (S), and the extent to which adaptive capacity (AC) enables these potential impacts to be offset.”

Adaptive capacity reflects the capability to deal with risks and to respond to impacts, including recovery from negative effects, learning and adapting over time, and taking advantage of opportunities for positive change. Sufficient adaptive capacity could even counteract high levels of exposure and sensitivity, so that some coastal communities might creatively achieve certain benefits in the course of climate change. For example, a community that depends strongly on its local resources, and is thus vulnerable to the possible spatial redistribution of the resources (e.g. traditional fish stocks shifting out of the local area), might utilize its adaptive capacity to adjust to emerging opportunities (such as new species redistributing into the area).

Adaptive capacity is a major factor in considering the other key climate change concept noted above, namely adaptation. According to Daw *et al.* [[39], p. 125], adaptation involves “strategies and actions taken by people in

reaction to, or in anticipation of, change in order to enhance or maintain their well-being.” While a variety of technological adaptations can be envisioned (e.g. building sea walls), these authors emphasize that “A technical approach to adaptation can underestimate the importance of institutions (especially informal) to facilitate or limit adaptation” (p. 127).

Adaptation may be viewed usefully through a governance lens, to focus on policy measures and decision making in the face of climate change [40,41,42^{••},43]. What institutional arrangements are needed, what policies need changing, and who will make the decisions, at which spatial and temporal scales? These questions arose in marine settings long before the current widespread attention to climate change [19,23] but this new imperative reinforces the particular need for adaptation to be applied to governance systems themselves, for these to become more flexible, participatory and precautionary.

Local-level marine social–ecological systems

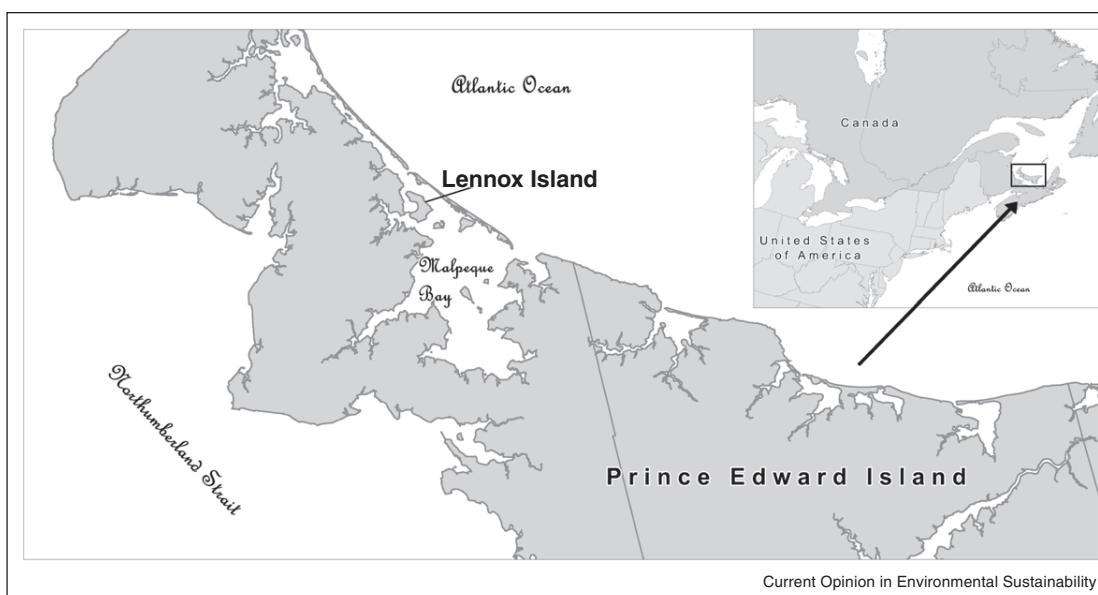
The above themes are relevant in marine settings around the world. Many articles discuss these in general terms, as has this one to now. But how do these considerations actually apply to the people and ecosystems in specific locations? In particular, how do the themes emphasized in this article – governance, livelihoods and climate change adaptation – manifest themselves at the ‘small scale’ of local coastal social–ecological systems?

To address these questions, we can draw on recent community-based coastal studies such as those on Canada's Atlantic coast [24^{••},44–46]. Consider the case of Malpeque Bay, which lies on the western side of Prince Edward Island, a small province of Canada located in the Gulf of St. Lawrence (Figure 1).

The bay and its watershed represent a social–ecological system that provides a diverse range of livelihoods and cultural values for the neighbouring communities. However, the system also faces a range of environmental threats, related to resource-based economic activities, such as fisheries and aquaculture, agriculture, forestry and tourism. Furthermore, “the increased and varied use of Malpeque Bay has resulted in conflicts between tourism operators, aquaculturists, fishers, and others who rely on the Bay for their livelihoods or for economic development” [24^{••}].

The focus here is on one of the bay's coastal communities, Lennox Island, an aboriginal First Nation comprised of indigenous Mi'kmaq people [24^{••},44]. First, with respect to livelihoods, Malpeque Bay has been crucial to the Mi'kmaq for food harvesting, transportation and recreation, among other uses, over a long history of thousands of years [24^{••}]. As noted earlier, livelihoods involve more than simply earning income – the cultural values and

Figure 1



The aboriginal community Lennox Island First Nation is located in Malpeque Bay, on the western side of the Canadian province of Prince Edward Island. (Map provided by the Mi'kmaq Confederacy of Prince Edward Island.)

ecosystem health of the bay are also important. Therein lies the rationale for a multi-faceted conception of well-being that values not only material aspects such as jobs, but also social and subjective aspects such as strong community organizations and a strong sense of place. Resilience of the social–ecological system arises out of these, as well as from adaptive capacity of the community and of local governance [15,21,22].

With respect to governance, recognizing the above-noted dependence on Malpeque Bay and its watershed, as well as the emerging use conflicts, Lennox Island is taking steps to seek a greater voice in decisions relating to local ecosystems and the economic activities within them. Indeed the community is acting as a local leader in spearheading an inclusive integrated management approach to decision-making [24••,44]. This involves a range of measures including (i) “a survey of the historical resource use of the Mi'kmaq of PEI”, (ii) “identifying resources and stakeholders in the Bay, and collecting resource use data”, and (iii) a “process of defining a common vision for the Bay, which includes all community members, both First Nations and other stakeholders” [24••].

This bottom-up initiative reflects well the idea of multi-level governance, as it seeks to provide a local-level complement to higher-level decision-making [45,46]. Already, there has been success in bringing stakeholders together from around the bay, to begin to discuss conflicts and environmental concerns. The challenge, however,

lies in the many government agencies that constitute the ‘higher-level decision-making’, including national-level fisheries, environment, transport, food inspection and aboriginal departments, and provincial aquaculture, fisheries, rural development and environment departments. Progress is slow as “[g]overnment departments use their mandates to compartmentalize management effectively” [24••], contrary both to the integrated management approach and to social–ecological systems thinking. Nevertheless, as a result of the ongoing engagement of the community with the various government agencies, and most importantly, the key reality that the Mi'kmaq have a constitutional right to be involved in decision-making (recognized as a government themselves), there continues to be some progress toward the goal of true multi-level governance. (Whether this path is feasible in the absence of a constitutional or legislated path for the local community, and thus whether it could be replicated elsewhere, is certainly an unresolved question.)

Finally, the third theme of this article, climate change adaptation, is the subject of considerable attention in Lennox Island. Two major concerns, both being addressed by the community in conjunction with research and government bodies, relate to (1) saltwater intrusion risks from sea level rise, given that “groundwater is the only source of drinking water in Prince Edward Island” and some locations elsewhere have already had their freshwater supply contaminated with sea water [47], and (2) threats to Mi'kmaq archeological sites in the area around Lennox Island, given that already in PEI,

“Many ancient sites have been submerged by rising sea levels and erosion” [48].

In fact, the latter is seen as more of an emergency situation than as adaptation *per se*, given a very rapid loss of sand bars at the entrance to Malpeque Bay. This location includes not only key archeological sites for the Mi'kmaq, but also certain rare plant species, and thus is of considerable cultural and biodiversity value. This leads Lennox Island to be closely involved in related decision-making [47–48], paralleling the broader governance initiative noted above, with local climate responses in keeping with local conditions.

The reality of Lennox Island and Malpeque Bay demonstrates, through both success stories and ongoing challenges, the practical importance of tailoring governance, livelihood measures and adaptation approaches to suitable scales. It also highlights the need for local capacity, in terms of strong communities and institutions, which in this example is providing critical support for livelihoods, for multi-level governance and for suitable climate adaptation responses.

Conclusions

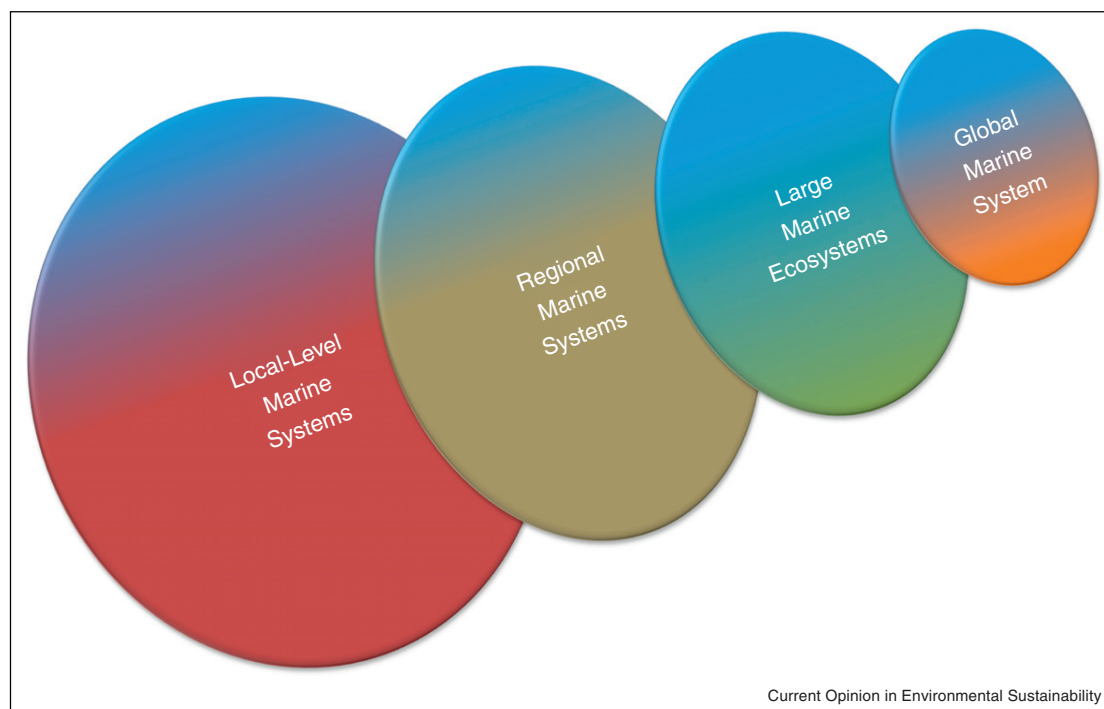
This article has highlighted several key themes in examining marine environmental and resource use challenges:

social–ecological systems, governance, livelihoods and well-being, resilience and adaptation to climate change. We have noted, particularly through a look at the coastal community of Lennox Island, on Malpeque Bay, the idea that while these various concepts are often discussed on a global or a generic (non-specific) basis, it is crucially important to see how they apply, and to what benefit, in particular locations.

This is a fundamental question of scale. A marine system of a given scale (e.g. a local system in a specific bay, or a large-scale one including a significant part of a certain ocean) has smaller-scale systems embedded within it, and (except perhaps for global examples) larger-scale systems containing it (Figure 2).

Accordingly, there is a need for greater attention to the nuances of scale [49]. On the one hand, marine social–ecological systems and their governance are often envisioned on a large spatial scale, even though they are just as relevant and important at a local scale. On the other hand, aspects of livelihoods, well-being, vulnerability and adaptive capacity are most often examined from a community perspective, but these are applicable as well to higher levels of governance. Emphasis must be placed on the *cross-scale linkages* connecting various scales of impacts and levels of decision-making, and how these

Figure 2



Marine social–ecological systems range across spatial scales from local to global. The single global system is comprised of 64 Large Marine Ecosystems, within each of which there are many regional systems and an even larger number of local-level ones to which governance and research initiatives are applied. Notably, the spatial scale of any given system interacts strongly with the required levels of governance.

can be utilized to improve overall governance of marine systems.

Overall, then, we need to understand how governance differs (or should differ) across scales, and how to 'scale up' insights and practices from local situations to apply more broadly, or 'scale down' large-scale arrangements to apply locally. This matter of scale would seem to apply in all the world's social-ecological systems, certainly in the complex environments of the global oceans, and very much including the local settings of coastal communities worldwide.

Acknowledgements

This article has drawn on ideas and approaches developed with many colleagues, notably those in the Coastal Community-University Research Alliance (Coastal CURA: www.coastalcura.ca), the Governance of Small-Scale Fisheries project on well-being (see www.wellcoast.org) and the research team for "Climate change, uncertainty and resilient fisheries: Institutional responses through integrative science" (see references). Special thanks to Randy Angus (Mi'kmaq Confederacy of PEI) for his assistance. Any remaining errors are this author's responsibility. I am grateful for very helpful suggestions from two anonymous referees and from the guest editor, Ian Perry. Funding support is acknowledged from the Natural Sciences and Engineering Research Council of Canada, the Social Sciences and Humanities Research Council of Canada, and the Canadian International Development Agency.

References and recommended reading

Papers of particular interest, published within the period of review, have been highlighted as:

- of special interest
 - of outstanding interest
1. De Young C, Charles A, Hjort A: **Human dimensions of the ecosystem approach to fisheries: an overview of context, concepts, tools and methods.** *Fisheries Technical Paper No. 489*. Rome, Italy: Food and Agriculture Organization of the United Nations; 2008.
 2. FAO: **Fisheries Management. 2. The Ecosystem Approach to Fisheries. 2.2 Human Dimensions of the Ecosystem Approach to Fisheries.** *FAO Technical Guidelines for Responsible Fisheries, No. 4, Supplement 2, Add. 2: Food and Agriculture Organisation of the United Nations, Rome: 2009.*
- As a component of the official FAO Technical Guidelines for Responsible Fisheries, this document describes how 'human dimensions' (notably social, cultural, economic, institutional and legal aspects) arise in applying the ecosystem approach to fisheries management. Greater detail on these aspects, which are applicable more broadly to marine governance, may be found in [1] above.
3. McCay BJ, Brandt S, Creed CF: **Human dimensions of climate change and fisheries in a coupled system: the Atlantic surfclam case.** *ICES J Mar Sci* 2011, **68**:1354-1367.
 4. Armitage D, Berkes F, Doubleday N (Eds): *Adaptive Co-Management: Collaboration, Learning, and Multi-Level Governance*. UBC Press; 2007.
 5. Kooiman J, Bavinck JM, Jentoft S, Pullin R: *Fish for Life: Interactive Governance for Fisheries*. Amsterdam: Amsterdam University Press; 2005.
 6. Allison EH, Ellis F: **The livelihoods approach and management of small-scale fisheries.** *Mar Policy* 2001, **25**:377-388.
 7. Allison EA, Béné C, Andrew NL: **Poverty reduction as a means to enhance resilience in small-scale fisheries.** In *Small-Scale Fisheries Management: Frameworks and Approaches for the Developing World*. Edited by Pomeroy RS, Andrew NL. CAB International; 2011:216-237.
 8. IPCC: **Climate change 2007: impacts, adaptation and vulnerability.** In *Contribution of working group II to the Fourth*

Assessment Report of the Intergovernmental Panel on Climate Change. Edited by Parry ML, Canziani OF, Palutikof JP, v.d. Linden PJ, Hanson CE. Cambridge Univ. Press; 2007.

The Intergovernmental Panel on Climate Change (IPCC) is the authoritative voice globally providing scientific consensus on climate change processes and impacts. This document provides one component of the IPCC's 4th assessment report.

9. Hall SJ: **Climate change and other external drivers in small-scale fisheries: practical steps for responding.** In *Small-Scale Fisheries Management: Frameworks and Approaches for the Developing World*. Edited by Pomeroy RS, Andrew NL. CAB International; 2011:132-159.
 10. Molnar JJ: **Climate change and societal response: livelihoods, communities, and the environment.** *Rural Sociol* 2010, **75**:1-16.
 11. Miller K, Charles A, Barange M, Brander K, Gallucci VF, Gasalla MA, Khan A, Munro G, Murtugudde R, Ommer RE, Perry RI: **Climate change, uncertainty and resilient fisheries: institutional responses through integrative science.** *Prog Oceanogr* 2010, **87**:338-346.
- This paper focuses on fishery systems and inherent uncertainties, from a perspective of integrative science, reflecting a transdisciplinary approach that "provides a means to answer questions based inherently on systems, linkages and feedbacks within the social-ecological fishery system". This perspective is used to examine fishery governance, resilience and robustness strategies, and potential responses to climate change.
12. Armitage D, Plummer R, Berkes F, Arthur R, Charles A, Davidson-Hunt I, Diduck A, Doubleday N, Johnson D, Marschke M *et al.*: **Adaptive co-management for social-ecological complexity.** *Front Ecol Environ* 2009, **7**:95-102.
- Through an approach of 'adaptive co-management', this paper connects together three themes fundamental to addressing marine systems: participatory governance, adaptive capacity and learning, and social-ecological systems.
13. Berkes F, Folke C (Eds): *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge: Cambridge University Press; 1998.
 14. Berkes F: **Restoring unity: the concept of marine social-ecological systems.** In *World Fisheries: A Social-Ecological Analysis*. Edited by Ommer RO, Perry RI, Cochrane K, Cury P. Wiley-Blackwell; 2011:9-28.
 15. Olsson P, Folke C, Berkes F: **Adaptive comanagement for building resilience in social-ecological systems.** *Environ Manage* 2004, **34**:75-90.
 16. Ommer RE, Perry RI, Cochrane K, Cury P (Eds): *World Fisheries: A Social-Ecological Analysis*. Wiley-Blackwell; 2011.
 17. Perry RI, Barange M, Ommer RE: **Global changes in marine systems: A social-ecological approach.** *Prog Oceanogr* 2010, **87**:331-337.
- This paper "presents the case for the adoption of a social-ecological approach to marine systems". It describes drivers of change in these systems (biophysical and human) and stressors (from local to global). The paper emphasizes the importance of scale, both temporal and spatial, contrasts how physical, biological, fishing and fishing community aspects differ across scales, and notes the need for multiple-scale approaches to marine management.
18. Perry RI, Ommer RE, Barange M, Werner F: **The challenge of adapting marine social-ecological systems to the additional stress of climate change.** *Curr Opin Environ Sustain* 2010, **2**:356-363.
 19. Charles A: *Sustainable Fishery Systems*. Wiley-Blackwell; 2001.
 20. Garcia SM, Charles A: **Fishery systems and linkages: from clockwork to soft watches.** *ICES J Mar Sci* 2007, **64**:580-587.
 21. Hughes TP, Bellwood DR, Folke C, Steneck RS, Wilson J: **New paradigms for supporting the resilience of marine ecosystems.** *Trends Ecol Evol* 2005, **20**:380-386.
 22. Berkes F, Seixas CS: **Building resilience in lagoon social-ecological systems: a local-level perspective.** *Ecosystems* 2005, **8**:967-974.
 23. Charles A: **Towards sustainability: the fishery experience.** *Ecol Econ* 1994, **11**:201-211.

24. Charles A, Wiber M, Bigney K, Curtis D, Wilson L, Angus R, ●● Kearney J, Landry M, Recchia M, Saulnier H, White C: **Integrated management: a coastal community perspective**. *Horizons* 2010, **10**:26-34.
This paper focuses on the role of coastal communities in marine governance. Through a broad review of local-level experiences, the paper highlights four key requirements for effective governance: real community participation, incorporation of community values, legal space for effective institutions, and building multi-scale approaches into governance. Examples are given from the Atlantic coast of Canada.
25. Grafton RQ, Hilborn R, Squires D, Tait M, Williams MJ: *Handbook of Marine Fisheries Conservation and Management*. Oxford University Press; 2010.
26. Makino M: *Fisheries Management in Japan: Its Institutional Features and Case Studies*. Springer; 2011.
27. Sumaila UR, Bassi AM, Ansah JP, Tan Z, Dyck AJ, Kronbak LG, Huang L, Bawumia M, Munro G, Arnason R et al.: **Fisheries: investing in natural capital**. *Towards a Green Economy*. United Nations Environment Program (UNEP); 2011: 78-111.
28. McConney P, Charles A: **Managing small-scale fisheries: moving towards people-centred perspectives**. In *Handbook of Marine Fisheries Conservation and Management*. Edited by Grafton RQ, Hilborn R, Squires D, Tait M, Williams M. Oxford University Press; 2009:532-545.
29. Pomeroy RS, Andrew NL (Eds): *Small-Scale Fisheries Management: Frameworks and Approaches for the Developing World*. CAB International; 2011.
30. Bavinck M, Vivekanandan V: **Conservation, conflict and the governance of fisher wellbeing: analysis of the establishment of the Gulf of Mannar National Park and Biosphere Reserve**. *Environ Manage* 2011, **47**:593-602.
31. Coulthard S, Johnson D, McGregor JA: **Poverty, sustainability ●● and human wellbeing: a social wellbeing approach to the global fisheries crisis**. *Global Environ Change* 2011, **21**:453-463.
The authors note, "The purpose of this paper is to explore the extent to which a social wellbeing approach can offer a useful way of addressing the policy challenge of reconciling poverty and environmental objectives..." The paper explains the need for new approaches, from both environmental and social perspectives, describes the theory of well-being, and discusses how the more comprehensive understanding arising from a well-being lens may improve fishery policy and governance.
32. Smith CL, Clay PM: **Measuring subjective and objective wellbeing: analyses from five marine commercial fisheries**. *Hum Organ* 2010, **69**:158-168.
33. Allison EH, Perry AL, Badjeck M-C, Adger WN, Brown K, ●● Conway D, Halls AS, Pilling GM, Reynolds JD, Andrew NL, Dulvy NK: **Vulnerability of national economies to the impacts of climate change on fisheries**. *Fish Fisheries* 2009, **10**:173-196.
This oft-cited article assesses "the vulnerability of 132 national economies to potential climate change impacts on their capture fisheries using an indicator-based approach". The authors identify the most vulnerable countries worldwide, which are largely in developing regions, and indicate that this "was due to the combined effect of predicted warming, the relative importance of fisheries to national economies and diets, and limited societal capacity to adapt to potential impacts and opportunities".
34. Badjeck M-C, Allison EH, Halls AS, Dulvy NK: **Impacts of climate variability and change on fishery-based livelihoods**. *Mar Policy* 2010, **34**:375-383.
35. Barange M, Cheung WL, Merino G, Perry RI: **Modelling the potential impacts of climate change and human activities on the sustainability of marine resources**. *Curr Opin Environ Sustain* 2010, **2**:326-333.
36. Perry RI, Ommer RE, Sumaila R, Allison E, Barange M, Hamilton L, Badjeck M-C, Jarre A: **Interactions between changes in marine ecosystems and human communities**. In *Global Change and Marine Ecosystems*. Edited by Barange M, Field JGH, Harris RH, Hofmann E, Perry RI, Werner F. Oxford University Press; 2010:221-251.
37. Smit B, Wandel J: **Adaptation, adaptive capacity and ●● vulnerability**. *Global Environ Change* 2006, **16**:282-292.
This has become a standard reference in defining the concepts of adaptation, adaptive capacity and vulnerability, notably in the context of climate change.
38. Johnson JE, Welch DJ: **Marine fisheries management in a changing climate: a review of vulnerability and future options**. *Rev Fisheries Sci* 2010, **18**:106-124.
39. Daw T, Adger WN, Brown K, Badjeck M-C: **Climate change and capture fisheries: potential impacts, adaptation and mitigation**. In *Climate Change Implications for Fisheries and Aquaculture. Overview of Current Scientific Knowledge*. FAO Fisheries and Aquaculture Technical Paper, vol 530. Edited by Cochrane K, De Young C, Soto D, Bahri T. 2009:107-150.
40. Adger WN, Brown K, Nelson DR, Berkes F, Eakin H, Folke C, Galvin K, Gunderson L, Goulden M, O'Brien K et al.: **Resilience implications of policy responses to climate change**. *Wiley Interdiscip Rev Clim Change* 2011, **2**:757-766.
41. McIlgorm A, Hanna S, Knapp G, Le Floch P, Miller F, Pan M: **How will climate change alter fishery governance? Insights from seven international case studies**. *Mar Policy* 2010, **34**:170-177.
42. Perry RI, Ommer RE, Barange M, Jentoft S, Neis B, Sumaila UR: ●● **Marine social-ecological responses to environmental change and the impacts of globalization**. *Fish Fisheries* 2011, **12**:427-450.
This is a major comparative analysis of four marine social-ecological systems in regions of the north, south and equatorial Atlantic Ocean. A particular emphasis is placed on time scales, focusing on differences between short-term and long-term responses (particularly of fishery-dependent human systems) to short-term and long-term societal and environmental change. The paper highlights the role of adaptive capacity and how this is affected by choices in marine governance.
43. Plagányi ÉE, Weeks JS, Skewes TD, Gibbs MT, Poloczanska ES, Norman-López A, Blamey LK, Soares M, Robinson WML: **Assessing the adequacy of current fisheries management under changing climate: a southern synopsis**. *ICES J Mar Sci* 2011, **68**:1305-1317.
44. Bood S, Coastal CURA: *A Coastal Partnership: Maritime Stories of Integrated Management (film)*. Coastal Community-University Research Alliance, Saint Mary's University; 2011 <http://www.coastalcura.ca>.
45. Wiber M, Wilson L: **Community perspectives on integrated management: a case study from the Annapolis Basin area, Nova Scotia, Canada**. *Ocean Coastal Manag* 2009, **52**:559-567.
46. Wiber M, Bull A: **Re-scaling governance for better resource management?** In *Rules of Law and Laws of Ruling*. Edited by von Benda-Beckmann F, von Benda-Beckmann K, Eckert L. Ashgate; 2009.
47. Anonymous: **Saltwater intrusion in the City of Summerside and Lennox Island First Nation**. Atlantic Climate Adaptation Solutions Association, <http://www.atlanticadaptation.ca/pei-saltwater-intrusion>.
48. Kristmanson H: **Climate change: threats to archaeological sites**. Atlantic Climate Adaptation Solutions Association, <http://www.atlanticadaptation.ca/pei-communities-lennoxisland>.
49. Perry RI, Ommer RE: **Scale issues in marine ecosystems and human inter-actions**. *Fisheries Oceanogr* 2003, **12**:513-522.

Provided for non-commercial research and education use.
Not for reproduction, distribution or commercial use.



This article appeared in a journal published by Elsevier. The attached copy is furnished to the author for internal non-commercial research and education use, including for instruction at the authors institution and sharing with colleagues.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Elsevier's archiving and manuscript policies are encouraged to visit:

<http://www.elsevier.com/copyright>