Integrating diverse objectives for sustainable fisheries in Canada
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*(Authorship reflects the contribution of a subset of the project members in development of this specific paper. A full list of project participants is presented in Appendix A. The first three authors contributed to the day to day leadership of the project and to the primary shape of the paper. The other authors are listed alphabetically.)

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Abstract

An interdisciplinary team of academics, and representatives of fishing fleets and government collaborated to study the emerging requirements for sustainability in Canada’s fisheries. Fisheries assessment and management has focused on biological productivity with insufficient consideration of social (including cultural), economic and institutional (governance) aspects. Further, there has been little discussion or formal evaluation of the effectiveness of fisheries management. The team of over 50 people 1) identified a comprehensive set of management objectives for a sustainable fishery system based on Canadian policy statements, 2) combined objectives into an operational framework with relevant performance indicators for use in management planning, and 3) undertook case studies which investigated some social, economic and governance aspects in greater detail. The resulting framework extends the suite of widely accepted ecological aspects (productivity and trophic structure, biodiversity, and habitat/ecosystem integrity) to include comparable economic (viability and prosperity, sustainable livelihoods, distribution of access and benefits, regional/community benefits), social (health and wellbeing, sustainable communities, ethical fisheries), and institutional (legal obligations, good governance structure, effective decision-making) aspects of sustainability. This work provides a practical framework for implementation of a comprehensive approach to sustainability in Canadian fisheries. The project also demonstrates the value of co-construction of collaborative research and co-production of knowledge that combines and builds on the strengths of academics, industry and government.
**Introduction**

Canada's legislation and international commitments require attention to ecological, social (including cultural), economic and institutional (governance) aspects of fisheries. The Federal Sustainable Development Strategy (FSDS; ECCC 2016), which with the Fisheries Act is the basis for the management of fisheries, specifies ‘that sustainable development encompasses and requires thorough consideration of economic, social and environmental factors’. The 2011 Report of the Commissioner of the Environment and Sustainable Development (Office of the Auditor General 2011) explicitly points out that ‘the Federal Sustainable Development Act…acknowledges the need to integrate environmental, economic and social factors when making all…decisions. A fourth category, organizational properties, includes ways of integrating and managing the first three’ (Office of the Auditor General 2011: p21). DFO’s Sustainable Fisheries Framework, which guides Integrated Fisheries Management Planning, also requires integration of social and economic considerations (DFO 2016). Further, the guidance documents on Integrated Fisheries Management Planning (DFO 2010) refer to the need to incorporate economic, social and cultural aspects, but without instructions on how to do so.

Canada has an extensive system of analysis (including peer review) for biological advice, especially productivity of the target stock, but no formal system for analysis or consideration of other aspects of fisheries systems (Paul and Stephenson 2018). While much has been done by DFO to develop an expanded set of conservation objectives, these have not been applied comprehensively to all fisheries, and key properties have not been placed in a practical framework for implementation. Further, while the list of conservation objectives is growing, the social (including cultural), economic and institutional objectives and related performance indicators have generally not been articulated, and there is no agreed framework for practical
integration of these aspects in management decision-making. The result is that although Canada
has broad objectives for fisheries management, several aspects are not currently being tracked in
most fisheries. Economic, social and institutional aspects, including trade-offs, are considered
later in the process or as political decisions (Lane and Stephenson 1998; Parlee 2016; Benson
and Stephenson 2017). This approach has been criticised for a lack of transparency, prevalence
of short-term considerations, and for resulting in unintended consequences (Stephenson 2012;
Bavington 2010; Pinkerton 2013).

These points collectively highlight the need for research that will help Canadian fisheries
management move from an approach that has been based largely on the consideration of
biological aspects of conservation (e.g., Gavaris 2009) to a practical framework that
appropriately incorporates additional social (including cultural), economic and institutional
aspects that make up the four pillars of sustainability (e.g., Boyd and Charles 2006; Stephenson
et al. 2017). This is not only an issue in Canada, but internationally as many nations move to
implement a more holistic approach to management and a broader perspective towards
sustainability (Charles 1994; 2001; FAO 1999; 2003a; 2003b; Fletcher et al. 2010; Rametsteiner
et al. 2011).

The widespread failure to integrate all four pillars of sustainability (ecological, social, economic,
and institutional or governance) has arguably contributed to the inability of nations to achieve the
aspirations of ecosystem-based and integrated management (Begg et al. 2015; Garcia et al.
2014). Stephenson et al. (2017) point to three major impediments identified in the literature; (1)
a relative lack of explicit social, economic and institutional objectives, (2) a general lack of
process (frameworks, governance) for routine integration of all four pillars of sustainability, and
(3) a bias in assessment and management processes towards biological considerations. They call
for a ‘systems’ approach with explicit consideration of strategic and operational aspects of management: multidisciplinary or transdisciplinary evaluations, practical objectives for the four pillars of sustainability, appropriate participation, and a governance system that is able to integrate these diverse considerations in management. There is a need to expand governance to include more diverse players in the science advisory and management processes, and for a framework in which specific objectives can be established and used in practical management.

In this paper, we first describe the methodological approach taken in our collaborative work. We then describe the iterative development of a framework for sustainability objectives related to Canadian policy, which includes: 1) a broad set of objectives reflective of the four pillars of sustainability relevant to Canadian fisheries policies, and 2) an operational framework for use in management planning. There follows a description of the case studies undertaken within the project to specifically evaluate and apply those aspects of the framework that have not been well addressed to date, including distribution of benefits, wellbeing and governance. Our discussion then focuses on the framework of sustainability objectives, requirements for new information/processes and the process of interdisciplinary collaboration.

**Methodological approach**

There is a need to prepare Canadian fisheries to be more sustainable and to participate effectively in emerging management regimes. This project (Project 1.1) of the Canadian Fisheries Research Network (CFRN, Thompson et al. this volume) anticipated this critical need and thus undertook interdisciplinary research into an expanded perspective on sustainability. As in all projects of the CFRN, this research was based on questions identified by industry, of importance to fisheries
management, and requiring collaboration among industry, academia and government. The project, which began in 2010 and extended through 2016, involved a collaborative, participatory, and interdisciplinary engagement process that also represents the methodology used to develop the framework.

The overall context of the research was to provide support for ‘ecosystem-based’ and ‘integrated’ management, which demands new knowledge requirements with emphasis on a broader view of sustainability that goes beyond biological considerations. Insights from diverse knowledge systems, when brought together, allowed us to build a common understanding about the needs of future management and how to evaluate progress towards meeting those needs.

The project was deliberately focused on co-construction of new knowledge, and included over 35 academics (including students) from several disciplines, working with members of the harvesting sector of industry, and government (science and policy/management) representatives (listed in Appendix 1). The team was not static over the 6 years, but expanded in 2014 to include interested members of other CFRN projects including several working on management strategy evaluation, and on adaptive management.

The primary mechanism through which the framework was developed was a series of workshops, working groups, and project conference calls designed to:

- develop a definition of sustainable fisheries, rooted in Canadian policy
- develop a logic frame and comprehensive framework for evaluating fisheries against the principles and objectives identified in the definition of sustainable fisheries, and
- design and conduct a series of case studies in which we investigated aspects and attempted to apply the framework.
In the context of an ecosystem approach, we drew on IFMP guidance documents (DFO 2010), a report of the Commissioner for Sustainable Development (Office of the Auditor General 2011), and international literature, to expand applied Integrated Fisheries Management Planning (IFMP) to a more comprehensive consideration of the ‘human dimension’. A management committee organized working groups to address specific aspects of the framework, which were then workshopped in 10 face-to-face meetings and more than 19 conference calls for the entire research team. In addition, student working groups who were developing case studies, collaborated on refining indicators for under-theorized aspects of the framework (see later section on case studies). We took an ‘incremental’ approach, asking how little we need to change existing management planning to make the required improvements. The team worked around a logic frame, aimed at matching the suite of common ecological aspects (productivity, biodiversity and habitat) with comparable social (including cultural), economic, and institutional (governance) aspects in order to form a ‘report card’ with a comprehensive set of objectives. We benefitted directly from perspectives articulated by fish harvesters, mostly representatives of the independent owner-operator fishing fleets. The collaborative approach allowed us to place this research firmly in a context of theory development, public policy, legislation, and relevant case studies in order to arrive at credible, salient and legitimate results (Cash et al. 2003).

Throughout the process, the general approach was to engage in discussion to achieve consensus on project objectives. This was considered important because we wanted to integrate the insights from different disciplines, research approaches, perspectives, and experiences. Consensus was interpreted as general agreement that an aspect was ‘good enough’ to move forward (Star 2010). Achieving consensus around each of the objectives was a challenging process that took substantial time and effort. In retrospect, the success of this approach depended on several
conditions. One key condition for success was building a comment set of concepts and
principles, which required learning to work across disciplines and experiential knowledge and to
understand perspectives and experiences outside one’s own field or area of work. Progress was
slow to start because it took several meetings to develop trust in the collaboration and in a
common approach. For example, should we work from international aspirational goals or instead
focus on solving practical problems specific to local fisheries? It was a particular challenge to
connect those from social science and natural science backgrounds into a common approach,
which sometimes required mini-workshops to clarify methods or theoretical orientations. This is
typical of efforts to collaborate within interdisciplinary and participatory science groups (Star
2010; Chilvers and Kearns 2016).

Compounding this challenge were the unique demands of linking the ‘human dimensions’ of
fisheries (e.g., social (including cultural), economic, and institutional aspects) with each other
and with the biological aspects throughout the process. While the aspects that form the human
dimensions feature in international agreements, and even in Canadian policy, they have been
relatively neglected in comparison to biological aspects of fisheries in the past (Stephenson et al.
2017). Fishery biologists and managers have a long history of working together and have had an
opportunity to achieve consensus on many relevant aspects of the biological basis for
management. The relevant literature for the human dimensions is less known among managers
and by biological scientists and less prescriptive, and there generally is less agreement on
performance indicators. Building these aspects had to be from the bottom up, and developing a
consensus on these aspects of fisheries management required far more discussion relative to
ecological aspects.
A second, related key methodological condition for success was the highly iterative nature of the engagement process. We deliberated on the concepts of sustainability, especially as reflected in Canadian legislation and policies and in relevant international agreements. We discussed the structure of frameworks that would be most useful to current and future management, and we undertook extensive research to propose, review, discuss and validate the dimensions, goals, indicators and attributes of a comprehensive framework. Specific issues that had to be worked out included discussion of inductive versus deductive approaches to the development of evaluation frameworks. The number and range of objectives or elements and indicators received significant discussion in the early workshops. Issues of scale, potentially conflicting objectives, and the relative weight given to various objectives were areas of extensive iteration and discussion.

A third and perhaps unexpected methodological condition for success was the interaction between framework development and case study research. Students of this project collaborated with those of other projects in a ‘student indicator working group’ (see Angel 2017; Angel et al. 2017). With the framework development moving more slowly than expected, student research proceeded by integrating partial insights from the draft framework. Framework development benefited from the results emerging from case studies, with discussions drawing on concrete evidence from field experiences to inform priorities around objectives, criteria, and indicators.

In this sense, early drafts of the evaluation framework impacted the design of research projects and the early research results from the field affected discussions and later iterations of the framework.

The development of a comprehensive framework formed the core theme for a sequence of research activities and meetings that included evaluation of Canadian policy objectives,
development of candidate objectives related to policies, development of performance indicators
and study of select aspects in case studies.

A framework for sustainability objectives related to Canadian policy

The project team reviewed Canadian fisheries policies (Table 1) and international agreements to
compile a list of objectives or aspirations related to the four pillars of sustainability. We
discussed the spectrum of aspects of sustainability, and agreed on a working definition of a
sustainable fishery:

A sustainable fishery respects the ecological integrity of the ocean and its resources; is ethical,
responsibly governed, economically viable and technologically appropriate; supports
communities; draws on local culture, heritage, and diverse knowledge systems; and enhances
health, wellbeing and the public good (Project meeting; April 2012)

We deliberated on these diverse aspects of sustainability in workshops to develop a list of
elements for social, economic, and institutional or governance aspects that were analogous to the
widely accepted ecological elements concerning productivity, biodiversity and habitat. We
sought to extend the framework for incorporation of ecological aspects of an ecosystem approach
to management currently in use in fisheries in Canada (summarised by Gavaris 2009) to include
social, economic and institutional aspects. While it is not the role of a research group to dictate
objectives, we defined a spectrum of candidate objectives we suggest is relevant to Canadian
fisheries management (Fig 1). These candidate objectives, with associated policy statements, are presented in Table 2.

The project focused on developing a comprehensive framework that would link the candidate objectives with relevant performance indicators so as to be useful in management decision support. Several major iterations of the framework, which differed in emphasis, took place over the life of the project (Supplementary Material). An initial ‘scoping framework’ (Supplementary Material #1) was developed early in the project from a scan of Canadian policies and international literature and deliberations of the project team. We sought to find social, economic and institutional equivalents to the productivity, biodiversity and habitat elements of the ecological domain. A second, ‘indicator framework’ (Supplementary material #2) was a more academic treatment in which elements are linked explicitly to a thorough literature review related to performance indicators undertaken by the student working group (Angel et al. 2017). A third ‘policy framework’ (Supplementary Material #3) blended the elements of two previous versions around the practical needs of Canadian policy and decision-making. While there was some variation in the wording and specific structure of the framework during this evolution, the basic scope remained the same.

The resulting CFRN Comprehensive Fisheries Sustainability Framework (Table 2) includes a list of ecological, social, economic and institutional aspects (elements for candidate objectives) that logically flowed from Canadian policy and the literature, to be considered in Canadian fishery planning, management and evaluation. It also lists candidate performance indicators that allow practical implementation. The framework’s three ecological objectives of productivity, biodiversity and habitat, are well recognized in Canadian fisheries management planning (e.g., Gavris 2009) and are based on reasonable international consensus (e.g., Sinclair &
Valdimarsson, 2003). These objectives are well described in Canadian polices, including the Sustainable Fisheries Framework (DFO 2016).

We have proposed four economic elements. ‘Economic viability and prosperity’ emphasizes the performance of individual/private operations. ‘Sustainable livelihoods’ focuses on ongoing continuity of employment within the fishing sector. ‘Distribution of access and benefits’ includes allocation, equitable trading relationships, equity and fairness in distribution of access and benefits and intergenerational equity. ‘Regional economic benefits to community’ reflects the role of fishing within regional economic development (employment, income, human capital, labour) as well as synergies with other sectors, such as tourism, through the integration of regional community resources. These objectives are best articulated in the 2007 Policy for Preserving the Independence of the Inshore Fleet in Canada’s Atlantic Fisheries (DFO 2007) and the 2004 Policy Framework for the Management of Fisheries on Canada’s Atlantic Coast (DFO 2004).

We suggest three social and cultural objectives. ‘Health and wellbeing’ includes working conditions, occupational safety, and general health within a wider community and broad economic context. ‘Sustainable communities’ emphasizes the importance of the contribution of fishing to the wellbeing of dependent communities, social capital, informed citizenry, and heritage. ‘Ethical’ issues in fisheries include basic human interests in welfare, freedom and justice. While less well articulated, these objectives appear in aspirational terms in several policies including the Sustainable Development Strategy (Canada 2010), and are certainly prominent in international agreements such as the Guidelines for Responsible Fisheries (FAO 1999).
Institutional elements include legal obligations, good governance structures, and effective decision-making processes. ‘Legal obligations, including to indigenous peoples’ recognizes the close and traditional dependence of many indigenous and local communities on fishing (DFO 2006), and is prevalent in current management planning (e.g. DFO 2016). ‘Good governance structure’, including growing interest in collaboration, shared stewardship, and participation in management and ‘effective decision-making processes’ reflect the need for democratic, participatory, transparent, openly communicated, integrated, structured decision-making. These are prevalent aspirations in policy documents including the Sustainable Fisheries Framework (DFO 2016). For each candidate objective, we have identified a suite of candidate or potential indicators from the literature. A more detailed version of the table, with a complete set of candidate indicators is presented in Supplementary Material Table #4. Such a framework enables more structured and comprehensive inclusion of ecological, social, economic and institutional aspects of management in integrated decision-making (see also Stephenson et al. 2018).

**Further evaluation and application of the framework in Canadian situations**

This project investigated some elements and candidate objectives from policy in more detail in applied case studies. In this way, the project attempted to link aspirational and bottom-up considerations to objectives. Case studies (undertaken between 2011 and 2016) were not exhaustive, but covered some areas identified by industry participants and other participants as important to the fisheries and relatively neglected in the applied literature relating to Canadian
fisheries - especially in relation to distribution of benefits, wellbeing, institutional considerations and practical framework implementation.

Case studies on distribution of benefits

Mombourquette et al. (2017) evaluated cumulative changes in distribution of fishing benefits from local fisheries in relation to the island community of Grand Manan, New Brunswick resulting from changes within individual fisheries. The study found that groundfish and herring licenses have been sold or transferred away from the island with the result that the community has not only lost overall benefits from fishing but is now reliant almost completely on a single fishery (lobster). This demonstrates an unintended, or at least untracked, negative consequence of economic redistribution resulting from (1) deliberate management actions such as the introduction of individual transferrable quotas (ITQ’s) within single fisheries and (2) inadequate consideration of community-level objectives. Further, within the current lobster fishery, the next generation of fishers is facing increasing barriers to entry. Notably, higher ownership costs are reducing profit margins (compared to the past), which are forcing many to seek equity financing or enter controlling agreements with processors. These dynamics have weakened fleet independence and shifted power in the fishery. Conflicts continue between the interests of independent operators and vertically integrated firms in this part of the Bay of Fundy. This case study illustrates the consequences of individual decisions (in this case regarding sale of ITQs) on the overall distribution of benefits, with unintended negative consequences regarding overall community wellbeing, when these objectives are not specified and not monitored.
Squires (2016) studied, through extensive interviews with fishery participants (2014/2015), how benefits from the Eastern Nova Scotia snow crab fishery quotas, which were distributed to fish harvesters in 2005, have affected the recipients, and what has happened to those allocations in the intervening years. The study documents the great value that has been derived from this expanded fishery and, most importantly, recent trends that seem destined to incrementally narrow and reduce the community base of those benefits. The study documents conflict between established and aspiring fishery rights holders as well as trade-offs between narrow and wider community fishery benefits. Should current trends continue, community benefits will fade as individual harvesters transfer their rights to a diminishing number of resource owners. Some concentration of benefits over time had been anticipated by fishermen, but this case study demonstrates the extent to which policy choices around managing the distribution of benefits have had an influence on fish harvesters’ operational and investment behaviors. This finding, along with the documentation of diminishing community benefits, reinforces the need for fishery policy development to take a broader view of sustainability over time so that it addresses community sustainability. As indicated by the Grand Manan case study, explicit attention to the distribution of benefits and contributions to community wellbeing, as proposed in the CFRN framework, would allow explicit management of these aspects.

Barnett (2017) surveyed lobster fishermen in Port La Tour, Cape Sable Island, and Woods Harbour, Nova Scotia, to examine the factors that contribute to livelihood vulnerability. The results indicated that dependency on lobster has increased substantially, along with inequality and a decrease in quota ownership in other fisheries. Captains and crew who were more dependent on lobster, had lower incomes and were less able to maintain their income during the downturn in lobster prices. Further, evidence from this study indicates that the licensing system,
which has increased entry costs and contains loopholes that allow controlling agreements by
companies, may threaten incomes. Fishermen in the area did not see a future for themselves and
their children in the fishery at the time of this study. This was true both for those who had quota
in other fisheries, and those who did not. While it was hypothesized that quota ownership would
have a significant impact on a captain’s ability to maintain his or her income during economic
downturns, it was surprising to find those who still had quota were equally uncertain about their
future in the fishery. This study raises questions of how long term economic viability and
sustainable of fishing livelihoods are being tracked in this fishery, which is currently integral to
Maritime coastal communities.

Hass et al. (2016) studied the change in distribution of economic benefits associated with license
concentration in Pacific salmon and herring fisheries in British Columbia. This case study
revealed that: 1) the profile of fisheries license ownership has shifted over the past twenty years,
from larger percentages of licenses held by ‘owner-operators’ at the beginning of the time series,
to greater percentages of licenses held by ‘fish processors’ at the end of the time series; and, 2)
the distribution of fisheries licenses has become more inequitable over the time period under
examination; i.e., there was a greater concentration of licenses held by fewer and fewer entities –
namely fish processors including one in particular. This case study also identified that
evaluations of equitable distribution of fisheries access is an element not present in current
fisheries assessments. It was hypothesized that the degree of concentration of fisheries licenses
would have risen over the time period under examination, however markedly fewer entities than
anticipated were responsible for that concentration.

Foley et al. (Foley et al. 2013; 2015; Foley and Mather 2016) used key informant interviews in
their comparative study of the impact of fisheries allocation policy on regional development in
the northern shrimp fishery in three regions of Newfoundland and Labrador from the late 1970s to 2012. Key aspects of the study included attention to economic elements of policy impact (sustainable livelihoods, distribution of access and benefits, and regional economic benefits to community), and social elements (sustainable communities and ethical fisheries). The study determined that federal allocation policies guided by ethically informed principles of adjacency, community, and regional economic development goals since the 1970s resulted in the creation of innovative community-based organizations in southeast Labrador (Labrador Fisherman’s Union Shrimp Company Ltd.) and in Newfoundland’s Northern Peninsula (St. Anthony Basin Resources Incorporated), and strengthened a third organization on Fogo Island (the Fogo Island Co-operative Society Ltd). These organizations used wealth derived from relatively small allocations of shrimp to help sustain local inshore and nearshore owner-operator fisheries, as well as creating or sustaining employment for processing workers during a period of dramatic social-ecological restructuring triggered by the collapse of regional groundfish stocks in the early 1990s. Investment of royalty revenues in this way helped sustain the tax base for regional communities and, to varying degrees, contributed to broader regional economic diversification and development outcomes. Outcomes of allocation policies in these cases measure well against the objectives of social sustainability contained in the CFRN framework and increasingly articulated as aspirations by fisheries management agencies around the world. As expected, allocations to inshore harvesters since the late 1990s have been a crucial factor advancing regional economic development for each organization specifically and in each region, more generally. The results of this study suggest that allocation policies in offshore fisheries can be designed to benefit inshore owner-operators, shore-based processing plants, and communities through allocations to organizations with a mandate to benefit inshore fisheries and communities.
In the cases examined, the community-based organizations generated royalties that help support inshore fisheries and community development. Separate allocations to inshore owner-operator harvesters since the late 1990s have also been a crucial factor advancing regional economic development for each organization specifically and in each region, more generally.

**Case studies on wellbeing**

Angel (2017) studied integrated assessment of sustainability for the Skeena River salmon fishery with an emphasis on the wellbeing of dependent communities. From the findings of this study it was apparent that the existing fisheries management system is compelled to severely restrict the type and quantity of value extracted from the fishery resource in order to maintain a limited degree of control over human impacts on the natural system. It is hypothesized that this is the case because of two exogenous factors 1) attenuation of value chains under globalized trade systems and increasing environmental uncertainty, and 2) internal limitations, principally a structural inability to experiment productively with power sharing arrangements. As hypothesized, this case studied documented a high degree of conflict among participants in the fishery. Likewise, there was a broadly similar perception across stakeholder groups of the management system as ineffective and lacking in legitimacy. Indicators of the wellbeing of commercial fishermen and fishing communities showed this had declined substantially in the previous twenty years, which is in keeping with broader trends in salmon fisheries in British Columbia. Unexpectedly, the study found that salmon populations are healthier than the public perception of crisis in salmon fisheries would suggest. While chum salmon populations were a concern in some areas, coho stocks appeared to have recovered from the low abundances seen in
the 1990s and the status of the majority of sockeye conservation units was acceptable.

Furthermore, commercial fishing has declined to such a degree that there would not seem to be any demonstrable impact on the status of sockeye populations from harvesting.

The findings led the author to suggest moving from management, which is a technocratic system of control focused on producing results, to governance, conceived as a way of making choices about enhancing human wellbeing that are more broadly legitimate. Second, it was argued that governance regimes should be built around natural systems and their dynamics, in this case watersheds and ocean basins, rather than unnatural boundaries that are administratively convenient. Finally, findings from this study were used to argue that, given the complexity of social-ecological interactions in the contemporary world, the only long-term solution that is sufficiently robust is one that involves shared decision-making with all stakeholders across the entire suite of fisheries management functions. Additional studies of the importance of coastal community well-being in the evaluation of fisheries policies (Pinkerton 2009; 2013; 2015; Pinkerton and John 2008; Pinkerton et al. 2014) have examined new knowledge and analysis of moral economy, strategies for rebuilding fisheries management institutions, and policy control, as well as involving people in the management of natural resources. These studies demonstrate the importance and scope of the relatively understudied elements of wellbeing and of governance in the CFRN framework.

**Case studies on institutional considerations**

Parlee (2016; Parlee and Wiber 2014) studied institutional elements of management including co-operation, institutional resourcing, transparency, accountability, and inclusiveness of the Southwest New Brunswick Bay of Fundy Marine Advisory Committee (MAC). Comparing and
contrasting the MAC’s Community Values Criteria (CVC) and the CFRN fisheries evaluation framework exposed interesting similarities and differences. Noticeably absent from the CVC are institutional values. These were intentionally left out to “avoid the biases of politics”. However, the researchers found that it was obvious that without explicit institutional values, tradeoffs were made in favor of short-term efficiency and economics rather than addressing institutional requirements essential for longer-term effectiveness such as conflict resolution, transparency and accountability.

A case study of decision-making processes related to a change in start time in a lobster fishery (Barnett et al. 2016) in south-west Nova Scotia Lobster Fishing area 34 documented problems around decision making in response to market or ecosystem change. This research documented problems with the operation of species management boards, lack of transparency in decision making, and related issues around participatory governance.

Fraser et al. (2017) examined Department of Fisheries and Oceans (DFO) experience with five participatory resource management processes. DFO is moving towards more broad-based collaborative processes for its decision-making on policy and program development. The general intent is to give stakeholders and others with an interest in fisheries and oceans resources a more direct say in decisions that affect them and to provide for broader consideration of social and economic factors in decision-making. The overall objective is to improve decision-making by making it more relevant to the affected interests, more easily understood, and better accepted. The way in which more collaborative management is being pursued within the Department varies a lot in terms of geographic scale, overall mandates for the processes, the extent of participation, and the procedures being used to facilitate dialogue and ultimate decision-making.
Findings from this case study indicate that fully collaborative or empowering processes are inevitably time consuming and resource intensive.

These case studies provide support for the inclusion in the CFRN framework of specific attention to ‘good governance structure’ (including collaboration, shared stewardship, participation, roles and responsibilities of participants, policies, agreements) and ‘effective decision-making process’ (democratic, participatory, transparent, openly communicated, integrated, structured decision-making, collaborative, cooperative, responsible and effective management, compliance, accountability, adaptive management). We suggest there has been insufficient attention to the institutional or governance aspects of fisheries management. Use of the CFRN framework provides an opportunity for explicit attention to aspects that will enable improved attention to other objectives.

**Framework implementation**

The project also considered aspects of framework implementation. An analysis of Integrated Fisheries Management Plans (IFMPs) (Paul and Stephenson 2018) included a gap analysis of the objectives and information in current Canadian IFMPs in relation to the CFRN framework for comprehensive evaluation of fisheries. That study documented the great imbalance that currently exists in both objectives and information from ecological aspects (well considered) to social, economic and institutional considerations (poorly considered). It demonstrated the need for increased attention to social and economic objectives, information and analysis in fisheries management planning. The framework of objectives provided in this paper, linked to policy statements and candidate performance indicators, should be useful in fleshing out how IFMPs
could include the four pillars of sustainability anticipated in the IFMP planning document (DFO 2010).

Long et al. (2015; 2016) undertook a synthesis of key principles of ecosystem-based management from the literature and identified differences between fishing industry priorities (from interviews with fish harvesters) and literature priorities, which was used to inform the scope of the framework. That study produced a refined definition of ecosystem-based management, and emphasized the need to resolve apparent differences in industry vs literature priorities for effective implementation of EBM. The scope of the framework presented in this paper is similar to the spectrum of elements of ecosystem-based management identified by Long et al. (2015), and indicates that this framework may be used to move towards EBM in fisheries management planning.

Mussells and Stephenson (2018) compared the elements of the CFRN framework with those of Marine, Aquaculture and Forest Stewardship Council certification schemes. The Marine Stewardship Council does not have specific criteria for social and economic aspects of fisheries, and the scope of the CFRN framework is much more closely aligned with that of the Forest Stewardship Council.

Benson and Stephenson (2017) compared analytical options for integrating ecological, social and economic aspects in evaluation and management of fisheries. That synthesis addressed the need to identify practical tools and methodologies that can facilitate implementation of the CFRN framework in fisheries management. The initial goal was to develop an inventory of methods that have been proposed to be able to incorporate ecological, social and economic aspects and to provide a more comprehensive evaluation of fisheries and of management. However, over the
course of the research analysis was broadened to develop a structure for understanding the nature
of the tradeoffs inherent in holistic management, and showed that the information required
differs in scale (fishery, ecosystem, society), timeline, use (tactical, strategic, research) and in the
nature of advice (prescriptive, descriptive, insight) potentially provided to decision makers. This
study additionally developed a set of criteria for evaluating methods in terms of the relevance
and influence of advice in the policy area. Evaluation provides insight into why some apparently
practical approaches (e.g., ecosystem models) are not used in fishery decision-making in many
situations. The synthesis showed that the diversity of information required cannot be provided by
any single method or approach, and that it is important to select methods according to their
intended use.

Discussion

Defining and implementing a comprehensive suite of Sustainability Objectives

Ecosystem-Based and Integrated Management, which have been identified as key for sustainably
managing fisheries and other marine activities (Charles 2014; Charles et al. 2014), require a
broader set of objectives than have been explicit in management to date. They require
consideration of the four (ecological, social (including cultural), economic and institutional)
pillars of sustainability. We have identified the spectrum of considerations needed for a
comprehensive approach to integrated fisheries management representing all four pillars of
sustainability in a Canadian context. We recognize that the pillars are not entirely discreet, but
have produced a logical and useful list that covers the spectrum of objectives with potential
performance indicators required of an ecosystem-based approach (see for example Long et al. 2015; Stephenson et al. 2017).

Our summary of Canadian fisheries policy (Table 2) demonstrates that there is an adequate policy basis for all four pillars of sustainability in evaluations and management. However, our study also shows (especially in the case study by Paul and Stephenson, 2018) that current assessments and management focus on only a subset, of primarily biological aspects, of policy. There are several factors contributing to the lack of integration of the four pillars in Canada. There is a definite bias towards ecological considerations in the structure and function of DFO. The structure of DFO separates science from economic/policy and fisheries management aspects and is an impediment to integration (Lane 1998). The Canadian Science Advisory Secretariat, which has a respected process of peer review, considers and provides advice only on ecological aspects. DFO science is staffed almost completely by those with biological backgrounds, and there is a dearth of in-house capacity for social and economic aspects. Previous attempts to bring social science capacity to together to be useful to DFO, notably in the Oceans Management Research Network, have had limited success (OMRN Network Secretariat 2009). This narrow focus has been criticized by the Commissioner for Sustainable Development (OAG 2011) and the lack of specific attention to social and economic aspects has been at the root of recent legal challenges related to access and distribution of benefits (for example Elson vs Canada (Attorney General) 2017 FC 459 - 2017-05-05). The lack of integration is also the case in other countries including USA (see for example Sharp and Lach 2003; Abbot-Jamieson and Clay 2010), Australia and Europe (Begg et al 2015).

This work was designed to be used to help guide incremental improvement of existing integrated fisheries management plans and processes. We approached this by asking how little we need to
change existing management planning to make improvements. The result is a framework that may be used as a basis for the development of more comprehensive management plan objectives, as a basis for comparison of management scenarios, and as a comprehensive ‘report card’ for fisheries management (these aspects are elaborated in Stephenson et al. 2018). These should help overcome the current inconsistent treatment of objectives (emphasis on biological productivity, absence of evaluation of distribution of benefits, etc.) noted by Paul and Stephenson (2018) and should fulfill the aspirations of IFMP planning (DFO 2010). The framework presented here with policy links and performance indicators (Table 2) should assist in fulfilling the aspirations of IFMPs and the recommendations of the 2011 Report of the Commissioner of the Environment and Sustainable Development (Office of the Auditor General 2011) to include ecological, social and economic aspects in fisheries evaluation and management.

Requirements for new information and modified processes

The framework presented in this paper will allow comprehensive evaluation and can form the basis for a more comprehensive approach to include the four pillars of sustainability required of a social-ecological systems approach, but it will require new and different information, as well as some modification to processes for analysis, review, and use of that information within fisheries evaluation and management. There will be an ongoing need for attention to data availability, institutional structure and methodological requirements in support of the following steps in fisheries’ plans:

1. articulation of specific objectives of relevance to the management plan
2. agreement/choice of specific performance indicators
3. identification of best sources of information relevant to the achievement of each objective
4. choice/development of appropriate methods to acquire information
5. choice/development of appropriate method(s) for evaluating information
6. modified institutional processes to enable discussion of the diverse aspects and use of the information in decision-making

The case studies completed as part of this project demonstrated lack of attention to the full suite of relevant objectives, including the distribution of access to fisheries benefits within and between groups and communities and its impacts on well-being. In the absence of specific objectives, such social and economic aspects of management are not being tracked and are therefore not informing fisheries management initiatives. There is a need for modification to governance processes to enable articulation of the relevant suite of objectives in management plans. There will be difference of opinion about the priority of objectives. We have presented our framework as ‘candidate’ objectives, recognizing the need for governance processes in which objectives may be debated and specified for a particular situation. All of the candidate objectives are tractable. In a companion paper we have articulated the need for scenario comparisons that will demonstrate trade-offs among objectives (Stephenson et al. 2018).

At present, only some of the information related to the social (including cultural), economic and institutional aspects of sustainability is available for management. There is a requirement for further development of the data streams that will support evaluation of diverse objectives and for integration of the resulting data into fishery evaluation and management planning processes. We contend that development of a process in which objectives may be better defined, and the addition of specific objectives into management plans, will result in rapid development of
relevant data streams. Much of this information will come from research carried out with the commercial fishery participants (e.g., Chouinard et al. 2015; Stephenson et al. 2016), but there will be additional information required from First Nations participants, ENGOs, provincial government representatives and others.

Analysis of the diverse information represented by the four pillars of sustainability poses an additional challenge. At present Canada (like many other nations) has a well-established process for acquisition, evaluation, peer review and advice that is restricted to ecological aspects, and no analogous process for economic social or institutional aspects. Furthermore, and of particular concern in Canada, is the lack of social science capacity in advisory or management processes. While Canada has a long history of academic social science research related to fisheries, that expertise remains divorced from management. There is a need to either expand the scope of consideration of the Canadian Science Advisory Secretariat (which coordinates the peer review of information for assessment and management; DFO 2017) or develop another process for analysis, evaluation and review of social, economic and institutional considerations. One key to effective integration is the recognition of both a routine (perhaps annual) operational cycle of evaluation that may deal with some aspects (such as stock productivity) and a less frequent strategic cycle that would consider major changes in strategic direction with respect to other (perhaps social, cultural and economic) aspects (as discussed by Benson and Stephenson 2017; Stephenson et al. 2017).

There is currently a capacity shortfall with respect to information acquisition, analysis and use for most fisheries. This will be an ongoing challenge. It will require strategic consideration of information need (‘what information would be of most use in relation to objectives’) and ongoing collaboration (industry, government and others) in gathering and analyzing relevant
information. For example, Stephenson et al. (2016) synthesized international experience in integrating fishers’ knowledge in science and management. Fishery participants are able to provide unique knowledge, which should form an essential part of ‘best available information’ for fisheries science and management. Fishers’ knowledge includes, but is much greater than, basic biological fishery information. It includes ecological, social, economic and institutional knowledge, as well as experience and critical analysis of experiential knowledge, which is part of the new and different information required in evolving ‘ecosystem-based’ and ‘integrated’ management approaches. While fishers’ knowledge may be added to traditional assessment with appropriate analysis and explicit recognition of the intended use of the information, it is best implemented in a participatory process designed to receive and use it (see also Curtis Maillet et al. 2017). Co-generation of knowledge in appropriately designed processes facilitates development and use of fishers’ knowledge and facilitates the participation of fishers in assessment and management, and is suggested as best practice in improved fisheries governance.

**Process of interdisciplinary/transdisciplinary collaboration**

This project had several novel aspects: (1) It was novel in scope. There has been no research program in Canada (and few if any in the world) attempting to define practical requirements of conservation as well as social, economic and institutional aspects of fisheries. This paper demonstrates that it is possible to identify specific objectives for each of the four pillars of sustainability and puts forward a framework that could be used in developing an improved governance process. (2) It was practical. Much of the research, especially on social science aspects of fisheries, has been descriptive, analytical and theoretical, but not linked directly to
efforts to improve current decision-making. This project put an interdisciplinary team together with industry and government (researchers and managers) in a way that would result in recommendations that would be of use in management. Such practical research on the more extensive suite of aspects is necessary to inform a broader view of sustainability as required, for example, in gaining social acceptance and sustainability certifications/verifications that are critical for market access. (3) The combination of framework development and case studies (top down + bottom up or pincer-approach) is unique in that it allows conceptual development and practical testing.

This project required collaboration on knowledge requirements for ecosystem-based management. In addition to linking to industry, academics and government (as in all projects of the Network) this project linked researchers from diverse fields with different literatures, research traditions and approaches. We recognized that the Project and Network would be stronger if we put effort into understanding these differences so that we could collaborate more effectively. As anticipated in literature (e.g., by Star 2010 in relation to ‘boundary objects’) it took considerable effort (and time) to ensure our own commonality, flexibility, and shared structure in this work. This slowed initial project start-up – but once underway, the collaboration was productive. The project enhanced collaboration among industry, academics, and government in development of understanding and appreciation of the complexity of interdisciplinarity research and of needs of management. We were able to generate knowledge of the scope of ecological, social, economic and institutional requirements for emerging ecosystem-based and integrated management approaches. As our collaboration involved co-construction of the research and co-production of knowledge (e.g. Jasanoff 2004) across actors and disciplines it was, in fact, transdisciplinary (e.g. Paterson et al. 2010). This is a feature of ‘post-normal
science’ and of the move from interdisciplinary to transdisciplinary collaboration (e.g. Funtowicz and Ravetz 1993). We recognize the importance of this approach as the basis for future participatory management (Noy et al 2013). While the project formally concluded in 2016, new interactions and collaborative research projects among various participants have been developed and we expect the CFRN Project 1.1 initiative to have long-term impact and legacy. This research marks a substantial step in ongoing attempts to integrate social science in fisheries in Canada (building on projects such as Coasts under Stress (Ommer et al. 2007), the Coastal Community-University Research Alliance (Coastal CURA; e.g., Wiber et al 2008) and the Community-University Research for Recovery Alliance (CURRA, Neis et al. 2014). It is our hope that the research presented here is useful in meeting Canada’s ambition (stated in the Oceans Act, IFMP guidance documents and elsewhere) for full spectrum sustainability.

Acknowledgements

We are grateful to our many colleagues in the Canadian Fisheries Research Network, especially to Marc Allain, Susan Thompson and others in Appendix 1, who helped shape this project. We appreciate the thorough and constructive critiques of anonymous reviewers. This research was funded primarily by NSERC grant NETGP 389436 - 09 to the Canadian Fisheries Research Network.
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https://doi.org/10.1111/faf.12235


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Fraser, S., Angel, E. and Saunders, M. in prep. A review of selected Fisheries and Oceans Canada experience with participatory resource management processes. CFRN Working paper. (This will be available, likely as a DFO Tech report by the time this paper is published).


http://authors.elsevier.com/sd/article/S0308597X1500024X


Star, S.L. 2010 This is not a boundary object: Reflections on the origin of a concept. Science, Technology and Human Values 35: 601


Table 1. Canadian policies and international commitments used to define the scope of objectives for the Canadian Fisheries Research Network framework.

<table>
<thead>
<tr>
<th>Canadian Policies and international agreements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAO Tech8</td>
<td>Food and Agriculture Organization of the United Nations. 1999. FAO Technical Guidelines for Responsible Fisheries 8: Indicators for sustainable development of marine capture fisheries</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>WPS</td>
<td>DFO (Fisheries and Oceans Canada). 2005. Canada’s Policy for Conservation of Wild Pacific Salmon. Her Majesty the Queen in Right of Canada, Vancouver, BC.</td>
</tr>
<tr>
<td>Objective Topic</td>
<td>Examples of Objectives from Policy Statements</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td><strong>Productivity and Trophic Structure</strong>&lt;br&gt;(productivity regimes)</td>
<td>Ensure continued health and productivity of Canada’s fisheries and healthy fish stocks (SFF)</td>
</tr>
<tr>
<td></td>
<td>Long-term sustainability (SFF; WPS) / Sustainable use of the biological resource in a way and at a rate that does not lead to their long term decline, thereby maintaining the potential for future generations... (WPS)</td>
</tr>
<tr>
<td></td>
<td>&quot;Maintenance of target, bycatch, and ecologically dependent species and their ecological relationships within the bounds of natural fluctuations in abundance.&quot;(SFF)</td>
</tr>
<tr>
<td></td>
<td>&quot;Minimization of the risk of changes to species’ abundances or relationships which are difficult or impossible to reverse.&quot;(SFF)</td>
</tr>
<tr>
<td></td>
<td>&quot;Exploitation of any stock should take account of both the productivity of the stock and its trophic role in the ecosystem.&quot;(SFF)</td>
</tr>
<tr>
<td></td>
<td>&quot;Forage species should be managed in ways which ensure local depletion of population components does not occur.&quot;(SFF)</td>
</tr>
<tr>
<td></td>
<td>&quot;Principles of Precautionary Approach...management of forage fisheries...future recruitment of the target species is not impaired, and food supply for predators is not depleted.&quot;(SFF)</td>
</tr>
<tr>
<td></td>
<td>No tolerance for preventable decline...rebuilding plan must be in place to promote stock growth (SFF)</td>
</tr>
<tr>
<td></td>
<td>&quot;Multispecies interactions are important factors to consider in defining rebuilding objectives and management measures...&quot;(SFF)</td>
</tr>
<tr>
<td></td>
<td>Provide long-term protection of marine biodiversity, ecosystem function and special natural features... Protecting examples of all types of biodiversity (genetic, species and ecosystem level)... (MPA)</td>
</tr>
</tbody>
</table>

| Biodiversity<br>(within population, food web persistence, community-level, non-native species) | | |
| | | • Species Assemblage Structure (e.g. Species richness, Shannon diversity index) |
| | | • Genetic Diversity (e.g. genetic variation using microsatellites and mitochondrial DNA, genetic mixing, phenotypic sex ratio) |
| | | • Phenotypic Diversity (e.g. maturation at age, size at age, phenotypic sex ratio) |
"Maintenance of full reproductive potential of the forage species, including genetic diversity and geographic population structure" (SFF, WPS, Aichi)
Reduce direct pressures on biodiversity and promote sustainable use (Aichi)
Promote responsible fishing that helps reduce bycatch and mitigate impacts to habitat anywhere it is biologically justified and cost effective (SFF, Code)

- Metapopulation structure
- Proportion of rare species subject to anthropogenic activities
- Food web interactions (e.g. stability, probability of change)
- Biogenic structures (proportion surveyed, degree of impact from anthropogenic activity)
- Non-native species (e.g. abundance, degree of impact, probability of introduction)

Healthy environment (SDS; COS)
Protect and conserve fisheries habitat. (SFF, WPS, AFPR; MPA)
Maintain habitat and ecosystem integrity (WPS)
"...mitigate impacts of fishing on sensitive benthic areas..." (SFF)
"Conservation of fisheries resources and fish habitat...is a key priority of fisheries management decision making." (SFF, AFPR; POF; WPS, Code)

- Substrate characteristics
- Proportion of gear modified to reduce impact on substrate species
- Proportion of nursery, spawning or sensitive areas
- Pollution (e.g. proportion of anoxic zones, eutrophication risk, potential for catastrophic events)
- Proportion of migration pathways and pelagic pathways
- Probability of climate-change induced Regime Shift
- Presence/abundance of biogenic species
- Introduction and proliferation of disease/pathogens

Economic prosperity for commercial, Aboriginal, and recreational fish harvesters and communities with the common goal of a sustainable, economically viable, internationally competitive industry. (SFF, SDS)
Fisheries will become a biologically sustainable resource supporting fisheries that are sustainable and economically viable, contributing to the economic base of coastal communities (AFPR)
Support sustainable economic opportunities, which requires the development of a scientific knowledge base of oceans resources and development impacts... Sustainable economic activities depend on the provision of a safe and secure operating marine environment (COS)

- Human Demographics (e.g. age, sex, education, income level)
- Historical fishing levels (e.g. amount of time in industry, Number of generations of fishing history)
- Number of employees meeting certification standards (e.g. first aid, marine emergency duties, master's ticket)
- Social mobility
- Technological Impacts (e.g. job losses, deskilling, loss of customary or traditional knowledge)
- Realized catch relative to potential target harvest
- Discard waste
- Market price relative to private marginal cost of production
- Output (e.g. cost relative to the lowest possible average
Maintain an independent and **economically viable** inshore fleet... (through the creation of circumstances for resource users to be more self-reliant, **economically viable** and self-sustaining on a long-term basis) (PIIFCAF)

“Where resources allow, the inclusion of a **cost-benefit analysis**...valuable instrument in development and implementation of rebuilding plans” (SFF)

**Sustainable Livelihoods**
(employment, income, human capital, labour)

An **economically viable** and internationally competitive industry that is adaptable to changing markets... Pursuing this vision requires the integration of economic analysis into departmental decision making, into the design and evaluation of policies and programs. (Socio-Eco Frame; SFF)

- Provide attractive **incomes** to industry participants (Socio-Eco Frame)
- **Attract and retain skilled workers** (Socio-Eco Frame)

total cost, output obtained from given quantity of inputs relative to the maximum output obtainable from that given quantity of inputs)
- Number of fisheries that fishing enterprises participate in
- Net profit of enterprises
- Bankruptcy rates
- Investment, stock/flow in fishery
- Availability of capital/debt financing
- Number of enterprises dependent on one fishery
- Proportion of investment stock/flow in depreciating assets versus access by operator
- Experience and education of fishermen
- Availability of fishermen with the required education and certification
- Distribution and means of compensation for fishermen
- Amount of labour force represented by an industry organization
- Presence/absence of oligopsony or monopsony
- % Control of each stage of the value chain by a single entity
- Presence/absence of legislation to restrict market failure
- Economic sustainability index

- Livelihood index (Sustainable Livelihood Security Index, Economic Security Index)
- Unemployment rate
- Employments gains vs. losses
- Evidence of subjective perception of the viability of livelihoods
- Reallocation (e.g. reallocations of stakeholders without compensation, compensation relative to fair market value, proportion of realized allocation relative to potential allowed allocation, loss of income from reallocation of access rights)
<table>
<thead>
<tr>
<th>Distribution of access and benefits</th>
<th>Owner-Operator and Fleet Separation policies (PIIFCAF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensure that inshore fish harvesters remain independent, and that the benefits of fishing licences flow to the fish harvester and the coastal community (PIIFCAF)</td>
<td></td>
</tr>
<tr>
<td>Assist fish harvesters to retain control of their fishing enterprises, enhance access to capital from traditional lending institutions and maintain the wealth generated from fish harvesting in coastal communities (PIIFCAF)</td>
<td></td>
</tr>
<tr>
<td>Access and allocation of fisheries resources will be more stable and predictable, and decisions will be made and conflicts resolved through fair, transparent and rules-based processes. (AFPR)</td>
<td></td>
</tr>
<tr>
<td>Consider aquaculture to promote diversification of income and diet (FAO Code)</td>
<td></td>
</tr>
<tr>
<td>Regional economic benefits to community</td>
<td>Provide an economic driver for communities in coastal regions (Socio-Eco Frame)</td>
</tr>
<tr>
<td>&quot;The fishery is common property resource to be managed for the benefit of all Canadians, consistent with..., including socio-economic benefits to communities.&quot; (SFF)</td>
<td></td>
</tr>
<tr>
<td>Ensure that the benefits of fishing licences flow to the fish harvester and the coastal community (PIIFCAF)</td>
<td></td>
</tr>
<tr>
<td>Social health and well-being (occupational safety, food security)</td>
<td>&quot;States should ensure that...all fisheries activities allow for safe, healthy, and fair working and living conditions&quot; (FAO Code)</td>
</tr>
<tr>
<td>Social factors (e.g. suicide rate, infant mortality rate, unemployment rate, migration rate)</td>
<td></td>
</tr>
<tr>
<td>Proportion of population below the poverty line</td>
<td></td>
</tr>
<tr>
<td>Amount of harvest being contested by one or more stakeholders groups</td>
<td></td>
</tr>
<tr>
<td>Distribution of catch</td>
<td></td>
</tr>
<tr>
<td>Distribution of access by fisheries participants</td>
<td></td>
</tr>
<tr>
<td>Number of reallocations across stakeholder groups without compensation</td>
<td></td>
</tr>
<tr>
<td>Proportion of realized compensation relative to fair market value of reallocated workers across stakeholder groups</td>
<td></td>
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<tr>
<td>Proportion of realized allocation relative to potential allowed allocation</td>
<td></td>
</tr>
<tr>
<td>Loss of income from reallocation of access rights</td>
<td></td>
</tr>
<tr>
<td>Sum of seafood harvest being contested by one or more stakeholder groups</td>
<td></td>
</tr>
<tr>
<td>Distribution of catch income by sector</td>
<td></td>
</tr>
<tr>
<td>Distribution of access by fisheries participants</td>
<td></td>
</tr>
<tr>
<td>Number of major changes to access conditions over time</td>
<td></td>
</tr>
<tr>
<td>Value of fisheries related public infrastructure (e.g. wharves, docks, piers, coast guard facilities)</td>
<td></td>
</tr>
<tr>
<td>Value of fisheries related fisheries related private infrastructure (e.g. vessels, processing plants, service providers)</td>
<td></td>
</tr>
<tr>
<td>Natural capital socks (amount, rate of depletion)</td>
<td></td>
</tr>
</tbody>
</table>
Harvesting, handling, processing and distribution should maintain the nutritional value, quality, **safety and security of food** (FAO Code)

Governance should ensure ... human ... well-being and equity." (FAO Tech4:2)

"...objective to consider under...fisheries sustainable development...Cater for the **well-being of a fishery workforce within a wider community** and broader economic context (FAO Tech8)

Support sustainable economic opportunities, which requires the development of a scientific knowledge base of oceans resources and development impacts... Sustainable economic activities depend on the provision of a **safe and secure operating marine environment** (COS)

Management processes and decisions will honour obligations to First Nations and their treaties. (WSP, AFPR, SFF)

<table>
<thead>
<tr>
<th>Sustainable communities (community well-being, social capital, informed citizenry, heritage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;The WSP... is intended to foster a more robust resource that supports sustainable fisheries and recognizes the <strong>intrinsic value to society</strong>&quot; (WSP)</td>
</tr>
<tr>
<td><strong>Vibrant society</strong> for current and future generations ~SDS</td>
</tr>
<tr>
<td><strong>Self-reliant fisheries</strong> and collaboration among all orders of government will contribute to the <strong>well-being of coastal communities</strong>. To be more self-reliant, resource users will have more flexibility to make decisions about their own economic and social objectives. (AFPR)</td>
</tr>
<tr>
<td><strong>Sustainable communities</strong> is a priority. (SDS)</td>
</tr>
</tbody>
</table>

| • Income disparity (e.g., Gini coefficient, ratio of highest wage to average wage) |
| • Availability of affordable services (education housing, daycare, medical care) to population |
| • Proportion of Seafood caught within community that is consumed by local population |
| • Sum of seafood caught by local population |
| • Self-determination (subjective perception of self-efficacy, attachment to place, social mobility) |
| • Food safety (e.g. number of seafood establishments regulated for food safety, number of recent inspections, number of establishments in compliance with regulations, reported cases of food-borne illness from seafood) |
| • Occupational safety (e.g., number of deaths at-sea, Number of injuries over time, ranking of job safety, proportion of fisheries work force subject to Canadian labour laws, proportion of fisheries workforce that meets certification standards) |

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<tr>
<td><strong>Sustainable communities</strong> is a priority. (SDS)</td>
</tr>
</tbody>
</table>

<p>| • Social capital (e.g. subjective perception of shared values and norms within a local population, participation in social institutions within local population, social networks) |
| • Informed citizenry (e.g. rating of importance of fisheries, preference valuation for the existence of fisheries dependent communities, willingness to pay for local seafood, readily accessible data, number of visits to fisheries websites, organization of seafood community events) |
| • Vital civic culture (e.g. condition of social institutions, voter turnout in local elections, quality of local education) |</p>
<table>
<thead>
<tr>
<th>Ethical fisheries (equity, rights)</th>
<th>Institutional Legal obligations, including to Indigenous Peoples</th>
</tr>
</thead>
<tbody>
<tr>
<td>One goal of national network of MPA is &quot;to enhance public awareness and appreciation of Canada's marine environments and rich maritime history and culture.&quot; (MPA) Ensure that inshore fish harvesters remain independent, and that the benefits of fishing licences flow to the fish harvester and the coastal community (PIIFCAF)</td>
<td>&quot;Management processes and decisions will Honour obligations to First Nations and their treaties&quot; (WPS; AFPR, SFF)</td>
</tr>
<tr>
<td>Improve human well-being and equity (FAO Tech4:2)</td>
<td>&quot;involving fishing participants as partners and involving others through engagement facilitates co-management interactions and shared stewardship&quot; (SFF) &quot;Shared stewardship is an important part of managing Canada's fisheries...promote collaboration, participatory decision-making and shared responsibility with resource users&quot; (SFF; AFPR) Self-reliant fisheries and collaboration among all orders of government and other stakeholders (AFPR, SFF)</td>
</tr>
<tr>
<td>&quot;Objectives of the code are to provide standard of conduct for all persons involved in the fisheries sector” (FAO Code) Allocate user rights (FAO Tech4:2) Recognize important contributions and protect rights of artisanal and small-scale fisheries (FAO Code; CLoS) ‘Ethical’ issues in fisheries include the basic human interests in welfare, freedom and justice (FAO 2005), and include aspects ranging from ecosystem well-being and conservation through wellbeing and just access, to equity, social efficiency, right to food and food safety (FAO 2005)</td>
<td>&quot;involving fishing participants as partners and involving others through engagement facilitates co-management interactions and shared stewardship&quot; (SFF) &quot;Shared stewardship is an important part of managing Canada's fisheries...promote collaboration, participatory decision-making and shared responsibility with resource users&quot; (SFF; AFPR) Self-reliant fisheries and collaboration among all orders of government and other stakeholders (AFPR, SFF)</td>
</tr>
<tr>
<td>• Individual and collective wellbeing (e.g. evidence of subjective perception of wellbeing within local area, wellbeing indices within local population)</td>
<td>• Explicit reference to and adherence to First Nations obligations • Record of accountability with respect to laws and policies</td>
</tr>
<tr>
<td>• Specific attention to well-being and equity including in allocations and access</td>
<td>• Rules (e.g. commercial activities covered by institutional processes, evidence of support for institutional processes, evidence of consistency between institutional processes local population norms and values, evidence of consistency in institutional processes between stakeholder groups) • Resources (e.g. level and duration of support for management activities amongst stakeholder groups, types of conflict resolution processes available to deal with disputes)</td>
</tr>
</tbody>
</table>
"Objectives of COS is international leadership... influencing international priorities, **decisions and process**" (COS)
"Commitment of COS is to **work collaboratively** within the federal government and among levels of government" (COS)
"Commitment of COS is to share responsibility for achieving **common objectives**” (COS)
"Fish harvesters will address problems of fisheries in Canada, adopting specific mechanisms and regulations as required” (Code)
"Producing a workable **decision framework** for a fishery will require the **participation** of fishery interests in all aspects of the process to develop the framework.” (SFF)
Objective of "**improved governance** by increasing sustainability, transparency and accountability in fisheries management and by promoting shared stewardship." (SFF; AFPR)
Manage fisheries for sustainable benefits (responsibility to provide sustainable harvesting opportunities that will best meet its obligations to First Nations, contribute to social well-being, and provide employment and other economic benefits to individuals and fisheries-dependent communities) (WPS)
"The fishing industry must be **responsible** for sharing costs of, and **participating** in, monitoring of ecosystem properties used in management of fisheries on forage species.” (SFF)
"Fish harvesters will develop, maintain and **promote public awareness** and understanding of the issues surrounding **responsible fishing** and the measures taken by fishers to conserve stocks and protect the environment.” (Code)
Fish harvesters will **conduct harvesting operations** in accordance with Canadian **fisheries' laws and regulations; international laws, regulations, conventions, declarations and protocols adopted by Canada; and harvesting plans adopted by each fishery” (Code)

- Agreement (e.g. agreements involving stakeholder groups and local population, agreements supported by institutional processes or legislation, evidence of distribution of authority in agreements)
Governments, Aboriginal groups, coastal communities, industries and other persons and bodies affected by or affecting marine resources have a duty and shared responsibility for supporting the sustainable development of marine resources." (POF; Code)

"Integrated management" is an essential aspect of ensuring commercial and non-commercial interests are considered in the planning and managing of ocean activities, such as fishing." (SFF; COS)

Ecosystem approach is fundamental to the conservation and sustainable use of Canada's fisheries (SFF)

Ecosystem sustainability and function is of primary importance. The identification of ecosystem-based management objectives and reference levels will guide the development and implementation of management to achieve sustainable development (POF)

"The precautionary approach is a fundamental component of an effective risk management strategy." (SFF; POF; COS)

Flexible management: The implementation and monitoring efforts of many different authorities, organizations and interests are brought together and focused on a jointly defined set of issues and objectives (POF)

Self-reliant fisheries and collaboration among all orders of government will contribute to the well-being of coastal communities. To be more self-reliant, resource users will have more flexibility to make decisions about their own economic and social objectives (AFPR)

The principles of Sustainable Development maintain that social, economic, and environmental issues are interconnected and must be integrated into the decision making process. (SDS; WPS; COS; POF; SFF)

Existence of management plan (e.g. IFMP; marine use plan) with specified decision-making process

Documentation of changes (improvements) to plan in relation to effective decision-making

Evidence of stakeholder group collaboration in processes of decision-making

Evidence of accountability (documented roles and responsibilities, explicit consequences for non-performance of duties, binding commitments to 3rd party standards) as part of General Management Activities

Evidence of accountability Legislation/Regulation and Institutions and Fisheries Management Activities

Degree to which assessment exists (performance based audit, program evaluation, fishery management plan evaluation)

Evidence of process for addressing trade-offs, and degree to which processes are implemented

Attention to mechanism for power sharing and dispute resolution

Attention to inclusivity and appropriate representation in composition of planning team

Processes to ensure that participants are informed and that processes are transparent

Stakeholder perception of collaboration, cooperation, inclusivity, flexibility and transparency
Make environmental **decision-making** more **transparent** and ensure that the government's environmental goals are taken into account when pursuing social and economic goals (SDS).

**Decisions** on protection and sustainable use will be based on meaningful public input to ensure they **reflect society's values** (WPS).

Participants will be effectively involved in fisheries management **decision-making processes** at appropriate levels; they will contribute specialized knowledge and experience, and share in accountability for outcomes (AFPR, SFF; COS; POF; Code; Aichi).

"Whenever appropriate, **management decisions** and actions will take into account **socio-economic factors** as well as biological." (SFF; WSP)

"**Managing decisions** should take into consideration Aboriginal traditional knowledge and other local and **traditional knowledge.**" (SFF)

Fish harvesters will work to balance the level of fishing effort with the sustainable supply of fisheries' resources to ensure **responsible management** and responsible professional harvesting (Code, SFF)

"**MSE...provides users with the information to evaluate trade-offs among performance measures arising from conflicting objectives.**" (SFF)

Reflect the best science as well as traditional knowledge (WPS)
Fig. 1. Spectrum of core elements of objectives for a sustainable fishery as determined by the Canadian Fisheries Research Network
Checklist of core elements of Objectives

- **Ecological**
  - Productivity and trophic structure
  - Biodiversity
  - Habitat and ecosystem integrity

- **Economic**
  - Economic/financial value and viability
  - Distribution of access and benefits
  - Regional economic benefit
  - Livelihoods

- **Social and cultural**
  - Sustainable communities
  - Health and well-being
  - Ethical fisheries

- **Institutional**
  - Obligations to law and First Nations
  - Good governance structure
  - Effective decision-making processes
Appendix A

Table A1. Participants in Project 1.1 framework development

<table>
<thead>
<tr>
<th>First Name</th>
<th>Surname</th>
<th>Position</th>
<th>Affiliation</th>
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<tbody>
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<td>Allain</td>
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<td>Carruthers</td>
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<td>Anthony</td>
<td>Charles</td>
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<td>Omer</td>
<td>Chouinard</td>
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<td>Université de Moncton</td>
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<td>Ratana</td>
<td>Chuenpagdee</td>
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