AMBIO 2014, 43:600–613
DOI 10.1007/s13280-013-0446-y

KUNGL. VETENSKAPS-AKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES

REPORT

An Interactive Governance and Fish Chain Approach to Fisheries Rebuilding: A Case Study of the Northern Gulf Cod in Eastern Canada

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Received: 13 March 2013 / Revised: 24 June 2013 / Accepted: 16 September 2013 / Published online: 10 October 2013

Abstract Rebuilding collapsed fisheries is a multifaceted problem, requiring a holistic governance approach rather than technical management fixes. Using the Northern Gulf cod case study in eastern Canada, we illustrate how a "fish chain" framework, drawn from the interactive governance perspective, is particularly helpful in analyzing rebuilding challenges. The analysis demonstrates that factors limiting rebuilding exist along the entire fish chain, i.e., the pre-harvest, harvest, and post-harvest stages. These challenges are embedded in both the ecological and social systems associated with the Northern Gulf cod fisheries, as well as in the governing systems. A comparative analysis of the pre- and post-collapse of the cod fisheries also reveals governance opportunities in rebuilding, which lie in policy interventions such as integrated and ecosystem-based management, livelihood transitional programs, and cross-scale institutional arrangements. Lessons from the Northern Gulf cod case study, especially the missed opportunities to explore alternative governing options during the transition, are valuable for rebuilding other collapsed fisheries.

Keywords Northern Gulf cod · Wicked problems · Fisheries rebuilding · Fish chain · Interactive governance · Canada

INTRODUCTION

Around the world, many commercial fisheries have collapsed and several others, particularly groundfish and large pelagic, are experiencing the impacts of overexploitation (Worm et al. 2009; FAO 2012). To date, most institutional responses to troubled fish stocks have been related to reducing fishing pressure, restructuring the industry, and rationalizing fleet capacity (Ruseski 2007; OECD 2010; Clift and Working Group Team 2011). Although there are some examples of successful management (Worm et al. 2009) such as increasing spawning stock biomass for many commercial fisheries in Europe (Cardinale 2011), much remains to be done for other fisheries such as those in the Mediterranean and in the developing world. The latter is particularly important given that fisheries, especially small-scale, contribute significantly to food and livelihood security (Song and Khan 2011). The challenges of meeting sustainable fisheries partly stems from a management approach that emphasizes single species rather than multispecies approaches (Rice et al. 2003), and inadequate local governing capacity toward environmental and global economic changes (Khan and Neis 2010; Perry et al. 2011). In the case of collapsed fisheries, rebuilding efforts are highly contested with numerous stakeholder conflicts because of disagreements as to what caused the collapse and how best to restore fisheries to sustainable levels (Charles 1992; Gray and Hatchard 2008). Among others, conflicting objectives do arise during rebuilding transition due to trade-offs between protecting non-threatened species and supporting community livelihoods (Caddy and Agnew 2005; Gray and Hatchard 2008). Despite the success of legal instruments for the recovery of several marine populations such as sea otters, whales, and birds (Lotze et al. 2011; Dawe and Neis 2012), rebuilding has been difficult for commercial marine fisheries due to trophic interactions, stakeholder buy-in, compliance to rules, and market factors (DFO 2005; OECD 2010). Furthermore, fisheries rebuilding measures such as quota reductions and processing plant closures intended to deal with overcapacity issues have major effects on regional economic development, especially in the absence of effective institutions (Ommer et al. 2007; Hanna 2010).

Many scientific papers have addressed the mismanagement of the cod stocks that led to the collapses in Atlantic Canada, focusing mostly on the ecological constraints on recovery (Hutchings 2000). There is relatively little focus, however, on the essential governance mechanisms that might be required to achieve rebuilding (Ommer et al. 2007; Khan and Neis 2010). These challenges still persist as reflected in the high percentage of commercial fisheries that require rebuilding on a global scale (Worm et al. 2009; FAO 2012). What is constantly lacking in these rebuilding efforts is a holistic understanding of governing interactions among stakeholders and their institutions and how fish production activities influence rebuilding outcomes. As learned from successful fisheries around the world (Hilborn 2007), new ways of thinking about fisheries management and governance, through a better understanding of human–nature interactions is crucial (Bundy et al. 2008; Chapin et al. 2009). Too often, decision-making arenas related to rebuilding fisheries are dominated by the perspectives of a limited number of stakeholders concentrated at one end of the production chain, resulting in the marginalization of other viewpoints that are necessary to achieve the rebuilding imperative in fisheries. According to the interactive governance theory, which emphasizes the importance of interactions between state and public actors in addressing fisheries problems; inclusiveness, accountability, and transparency are principles that are likely to contribute to achieving rebuilding goals (Kooiman et al. 2005; Song et al. 2013). As shown by experiences in Newfoundland, the impact of cod collapse in the Northern Gulf has consequences throughout the entire fish chain, especially on the livelihoods of the fish harvesting and processing sectors, and on coastal community heritage (Schrank 2005; Ommer et al. 2007; Clift and Working Group Team 2011). Rather than a narrow recovery effort, we therefore argue for a holistic rebuilding imperative, focusing not only on marine ecosystems but also on social, cultural and economic aspects associated with the fisheries. This perspective acknowledges a broader set of challenges in the natural and social systems, as well as in the governing system itself, due to their "wicked problem" nature, as submitted by Jentoft and Chuenpagdee (2009), and based on the original proposition by Rittel and Webber (1973) and Churchman (1967). Conceptualizing fisheries rebuilding as a wicked problem provides options and opportunities to consider solutions that lie outside of narrow managerial measures, some of which may be brought about through consultation with stakeholders and institutional partnerships. Such perspective aligns well with the interactive governance theory, which offers the "fish chain" as an analytical tool in understanding rebuilding challenges and opportunities. A comparative analysis of the fish chain pre- and post-collapse, presented in this paper, is one of the first steps in understanding temporal and spatial changes taken place in the fisheries. It also provides insights into what drives the fish chain contributing to stock collapse, and what associated governance challenges and opportunities are there for rebuilding.

Specifically, this paper addresses two central questions: how have changes in the Northern Gulf cod fisheries, in the pre- and post-collapse periods, affected rebuilding prospects? And what alternative institutional mechanisms and arrangements could promote social–ecological rebuilding of Northern Gulf cod fisheries? First, we provide background information about the study region and the governing context of the Northern Gulf cod fisheries. Subsequently, we present the interactive governance theory and describe the fish chain framework as an analytical tool in dealing with wicked rebuilding problems. This is followed by data collection methods through semi-structured interviews with multiple stakeholders. The results and discussion about key challenges and governing options for the rebuilding of Northern Gulf cod fisheries are presented next. The paper concludes with some key messages and governing implications for regions grappling with the dilemmas of resource collapse and rebuilding.

MATERIALS AND METHODS

Case Study Region and the Governing Context

Northern Gulf cod stocks are found in the Northwest Atlantic Fisheries Management Organization (NAFO) region 4RS3Pn in the Gulf of St. Lawrence, bordering Quebec and Newfoundland and Labrador (NL in Canada). The stocks collapsed in the early 1990s, resulting in two complete moratoria in 1994–1996 and in 2003 (DFO 2010a). The fish stocks are still regarded as threatened, with biomass level far less than historical levels compared to the early 1980s (DFO 2011). The total allowable catch (TAC) has been reduced in subsequent years after the first moratorium, along with the implementation of several restructuring and adjustment programs in fleet and fishing capacity (Ruseski 2007). The stocks are managed by various jurisdictional structures and mandates, including the federal Department of Fisheries and Oceans (DFO), responsible for decisions about fisheries regulations and conservation measures, and various provincial departments in Quebec and NL for processing and marketing policies. The stocks annually migrate between southeastern Quebec and southwestern Newfoundland in both the spring and summer months for spawning and feeding (Fig. 1).

Taken into consideration the stock collapse in the early 1990s, fisheries management measures, both input controls (e.g., number of licenses and boats) and output controls

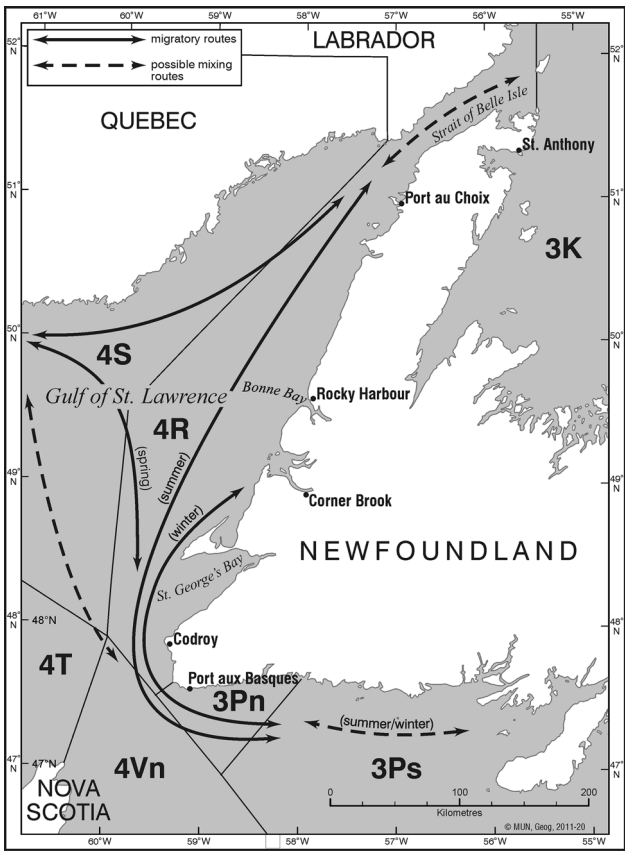

Fig. 1 Northern Gulf cod migratory routes in NAFO region 4RS3Pn (adapted from Yvelin et al. 2005; Murray et al. 2008)

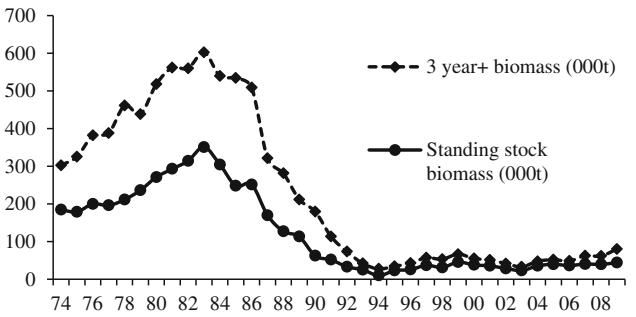

Fig. 2 Trend in biomass estimates for Northern Gulf cod stocks based on DFO stock assessment data and recovery indicators proposed by Caddy and Agnew (2005)

(e.g., TACs) were revised to take into consideration fishing capacity (DFO 1996). In addition, several task forces, focusing on restructuring and adjustment programs, were established in response to the collapse and stalled rebuilding of the regional cod stocks in Atlantic Canada (ACOA 2004). This began with the Federal Task Force on Incomes and Adjustments in the Atlantic Fishery in 1993 (Cashin 1993), culminated to federal–provincial Cod Recovery Action Teams in 2003 (Canada-Newfoundland and Labrador 2003; Canada-Quebec 2005), and to the Fisheries Resources Conservation Council (FRCC). FRCC, which is now defunct, conducted nation-wide stakeholder consultations in the spring and summer of 2010 on groundfisheries rebuilding (FRCC 2011).

Initiatives at the provincial level also took place to help recovery and rebuilding. For instance, the Great Northern Peninsula Fisheries Task Force (GNPFT) was established in western Newfoundland in the mid 1990s to initiate policy discussions and engagement among stakeholders such as industry and community groups (GNPFT 2006). A Provincial Act for professionalization of the harvesting sector was put in place in 1997 to limit access and to provide safety and other types of training for "fish harvesters," as referred by the Fish, Food and Allied Workers Union (FFAW) in NL. This was primarily based on the recommendations from the Federal Task Force on Incomes and Adjustments Reports (Cashin 1993). Similar policy measures were recommended for the processing sector with various divestiture programs (DFO 1996). The cost of the restructuring initiatives and adjustment programs implemented in eastern Canada from early 1990s to mid 2005 was estimated to be close to 4.0 billion CAD (Rice et al. 2003; Ruseski 2007). These programs were terminated in 2005 due to several reasons relating to the high cost, absence of other employment options, and the continuous unmet social needs of stakeholders.

Despite these legislative and policy changes and recovery efforts to date, recent stock assessments show that Northern Gulf cod stocks are below conservation limit reference points (Rice et al. 2003; DFO 2010a). Matured biomass of 3+ years and spawning stock biomass (SSB) have declined from historical high in the early 1980s to historical lows in the mid 1990s (Fig. 2).

With these stalled rebuilding, only small commercial and recreational cod fisheries are allowed, with TAC of about 10 % of the historical levels (DFO 2010a). This has raised many questions about rebuilding timeframe because of ecosystem shifts, consumer preferences and product substitution, social regime shifts due to demographic changes, and intergenerational equity when the stocks recover. These wicked and multifaceted problems deserve a more holistic governance approach to rebuilding than the traditional top-down management panaceas.

Theoretical and Analytical Framework

Governance and institutional mechanisms are central to the rebuilding imperative as they provide the structure and process for policy change and shape the various meaning and benefits that fisheries generate through time. Although there are many definitions of governance in the social and

policy sciences, it generally implies going beyond governments and state management, to include contributions from civil society and the private sector (Kjaer 2004). This broader approach is in recognition of the complexity of the ecological and social systems and the interactions between them. From an interactive governance perspective, fisheries governance is understood as "the whole of public as well as private interactions taken to solve societal problems and create societal opportunities. It includes the formulation and application of principles guiding those interactions and care for institutions that enable them" (Kooiman et al. 2005, p. 17). The relevance of this approach is that it aims to better understand rebuilding challenges from problem identification, e.g., how "wicked" is the rebuilding problem, who is included or excluded from decision-making during agenda setting, and to institutional design, and policy instrument choices (Bavinck et al. 2005). Perceiving fisheries rebuilding as a wicked problem underscores the complexity and persistence of the fisheries rebuilding challenges (Khan and Neis 2010). These challenges go beyond scientific problems to include governance concerns about social justice, legitimacy, power, equity, corporate social responsibility and stewardship (Ludwig et al. 2001; Bundy et al. 2008; Jentoft and Chuenpagdee 2009; Ommer et al. 2011).

It has been demonstrated with many examples across the world that management panaceas and reactive measures after fisheries collapse are not enough to achieve recovery as socioeconomic and sociopolitical concerns tend to be key limiting factors (Wakeford et al. 2009; OECD 2010). With the premise that rebuilding Northern Gulf cod fisheries is indeed a very wicked problem, then the traditional top-down management approach is insufficient to address these multiple interactions that entail social, economic, and political challenges. Thus, "for wicked problems, a governance approach is needed; whereas management is for what Rittel and Webber call tame problems" (Jentoft and Chuenpagdee 2009, p. 554). Because rebuilding problems are place and context specific, and management panaceas often have unintended consequences, there are no "one size fits all solutions" hence the need for multiple policy instruments (Khan and Neis 2010). Moreover, there is limited space for failure and social experimentation because of a high level of both perceived and real risk, which can be difficult to anticipate because of the complexity and cross-scale dynamics of fishery systems (Berkes 2002).

Rebuilding also involves consideration about multiple spatio-temporal scales, requiring for instance, trade-offs between short-term losses and long-term benefits and between regional small-scale fisheries and global large-scale fisheries. Further, policy initiatives in one part of the fish chain will have consequences elsewhere and will affect stakeholders on varying levels. These considerations provide opportunities to identify factors that influence successful outcomes and governing options along the fish chain (Chuenpagdee 2011). According to interactive governance theory, such examination can be done systematically by looking at the natural and social systems-to-be-governed, the governing system, and the interactions between them, in all three parts of the fish chain (Fig. 3).

The fish chain provides an analytical framework for understanding the system dynamics through the inter-linkages and interactions in the fish production stages in both the pre- and post-collapse periods. It is assumed that the more diverse, complex, and dynamic the fisheries systems and production stages are, the less governable they are likely to be, unless the governing system is highly capable and appropriate institutional mechanisms exist (Chuenpagdee and Jentoft 2009). Concerns around governing capacity in fisheries are central to rebuilding, as they provide the foundation for capacity building and effective policy instruments to deal with cross-scale interactions. The various production stages are interconnected through formal and informal institutions as well as social networks and economic organizations at multiple spatial scales. Moreover, multiple policy instruments are employed to govern the fish chain as shown in Fig. 3. The stakeholders along the chain are very interactive and may be dominant in one or more production stages with varying levels of power (Mikalsen and Jentoft 2001). The options for change along the fish chain are also mediated by historical context through such processes as institutional mechanisms; power relations, leadership, and behavioral incentives. Furthermore, various governance mechanisms along the fish chain may "compel, coerce or encourage" key actors to behave consistent with conservation and stewardship principles (van der Schans et al. 1999).

Comparing the fish chain in the pre- and post-collapse periods provide opportunities to understand how fishing activities affect changes in marine ecosystems, stakeholders and their networks, and the role of various policy instruments in influencing cognitive and behavioral changes and rebuilding outcomes.

Data Collection and Analyses

An extensive review of fisheries recovery efforts was conducted, covering existing and historical documents, policy and legal statutes, statistical information, and scientific reports. An analysis of this information was performed to identify ecological constraints toward cod rebuilding, policy changes that promote or exacerbate rebuilding, community concerns on governing options, and institutional arrangements for economic viability. Moreover, semi-structured interviews were conducted with 50 key informants from diverse stakeholders groups along the entire fish chain. The interviewees included 8 decision makers in provincial and federal government agencies, 7 research scientists and

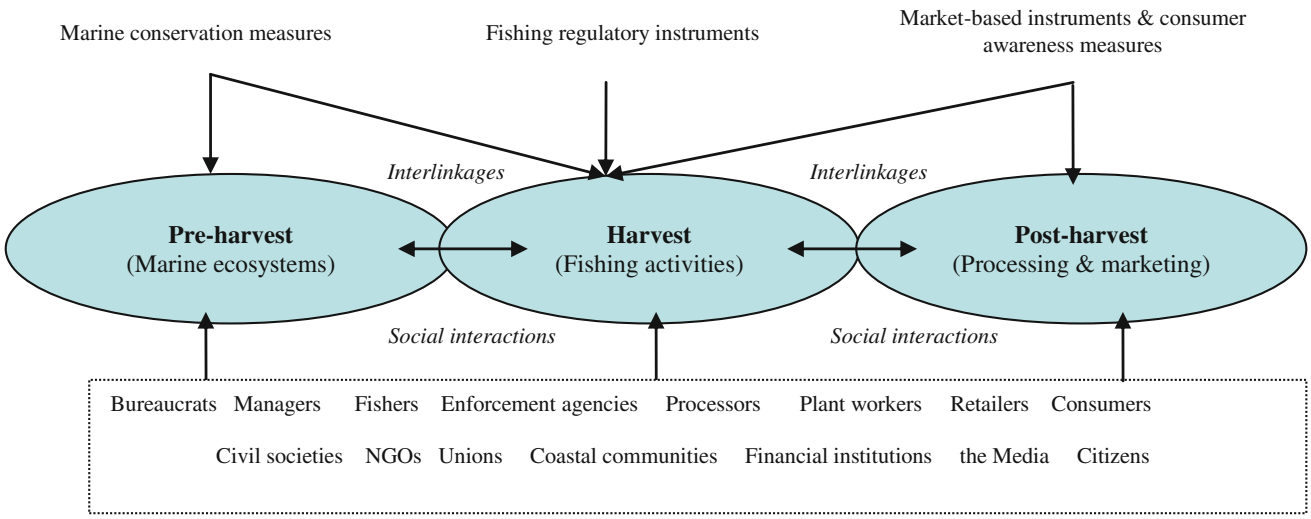

Fig. 3 The fish chain includes vertical and horizontal linkages between the three production stages (*ovals*), policy instruments (*texts on the top*), and stakeholders (*texts in the bottom box*). Diagram adapted from Mikalsen and Jentoft (2001) and Bavinck et al. (2005)

fisheries managers, 12 resource users including fishers and allied workers such as processors, 8 entrepreneurs in the retail and processing sectors, 7 municipal governors and regional economic planners, 8 analysts including scholars, consultants, media, and trade union representatives. The interview themes centered on status and prospects of restored fisheries ecosystems, scientific and management efforts, socioeconomic and livelihood concerns, stewardship toward rebuilding, and institutional and policy initiatives for rebuilding. In this paper, we focus on various stakeholder perspectives toward rebuilding challenges and opportunities along the fish chain.

The selection criteria for the key informants included 20 or more years of experiences from the various stakeholder groups along the fish chain. In-person interviews were conducted throughout northwestern and southern Newfoundland in the 4R3Pn gulf region in the fall of 2009 mostly with fishers, processors, community planners, and municipal leaders. The interviews took place from St. Anthony in the Strait of Belle Isle in the Northern Peninsula in 4R region to the Codroy valley around Port aux Basques and Rose Blanche in the 3Pn region. More interviews were carried out in fishing communities around Bonne Bay as well as communities around Corner Brook and in Port au Choix. Further in-person and telephone interviews were conducted with fisheries scientists, managers and policy makers in the greater St. Johns region (NL), Mont Joli (Quebec), and Ottawa (Ontario) until the spring of 2010. The interview transcripts were arranged and thematically coded to identify areas of consensus, disagreements, or heterogeneity in responses, as they relate to rebuilding challenges and opportunities. The transcripts were further analyzed using both diagnostic and prescriptive approaches. The diagnostic analysis centered on identifying rebuilding challenges and the prescriptive analysis on identifying rebuilding opportunities and potential policy recommendations. This is in addition to examining government commissioned reports and policy papers that speak to the historical context of the fishery collapse. Both the primary and secondary data are analyzed and framed around the fish chain, as shown in the "Results" section.

RESULTS

Based on the fish chain analytical framework, the findings are organized to illustrate how the various changes in the three stages of the production chain have affected rebuilding prospects, the missed opportunities and potential governing options.

The Pre-harvest Stage: Trophodynamic Changes and Associated Rebuilding Challenges

At the pre-harvest stage, the focus is on understanding marine ecosystem dynamics, particularly life history parameters, stock migration patterns, predator–prey relationships, and evolutionary factors. Both bio-physical and ecological factors and associated policy processes that influence ecosystem-based management are central at this stage particularly for understanding stock health and recovery potential.

It is widely documented that fishing activities affect marine ecosystems, in particular studies on life history parameters such as growth and recruitment rates, as well as changes associated with fisheries collapse such as regime shifts (Frank et al. 2005; Savenkoff et al. 2007). Since the collapse of the Northern Gulf cod fisheries, there have been

indications and records of changes in marine ecosystem structure, as identified by shifts on capelin predation rate and energy flow from a predominant groundfish population in the pre-collapse period to cetaceans and seal predation in the post-collapse period (Savenkoff et al. 2007; Morissette et al. 2009). These changes have implications for cod growth, recovery timeframe, and the TAC for current fishing activities.

Interview respondents underscored several concerns about the single species approach to fisheries management and the challenges of implementing ecosystem-based management policies especially in a multispecies context where the stocks are managed individually. In addition, evolutionary changes were identified by stakeholders as major limiting factor for effective rebuilding due to a shift in ecosystem structure, low food availability, slow growth rates due to sexual maturity, and predation intensity on juvenile cod. This concern is further supported by earlier studies done on Northern cod in the 2J3KL NAFO region on maturity and life history traits (Olsen et al. 2004). Such evolutionary changes have implications for setting harvest policy measures for commercial capelin fisheries, which are key prey for cod and other groundfish.

As reiterated by some key informants, the lack of tangible criteria to monitor trophodynamic changes and trends in the level of vulnerability for collapsed cod stocks may inhibit conservation objectives and stock rebuilding outcomes (Hutchings 2000; Morissette et al. 2009). It has been demonstrated that successful stock recovery planning requires a transition period for stocks to grow and the use of harvest decision rules for monitoring stocks in meeting target reference points (Shelton and Rice 2002; Caddy and Agnew 2005). These scientific procedures are critical for monitoring recruitment and growth rates, and providing feedback response to stakeholders and policy makers (Murawski 2010). Caddy and Agnew (2005) proposed two key indicators for monitoring stock recovery: an increase in SSB to about 40 %, and an increase in mature biomass to about 75 % of historical maximum sustainable yield (MSY) levels. Interview responses from research scientists in both academia and state agencies concur that there is a lack of harvest decision rules employed in setting target and limit reference points during the rebuilding transition. Unlike Canada, TACs in the US for collapsed stocks strictly adhere to decision rules and conservation reference points that take into consideration precautionary principles (Shelton and Rice 2002; Caddy and Agnew 2005; Wakeford et al. 2009). These policy measures in the US, which are enshrined in the revised Magnuson-Stevens Act, are necessary to prevent overfishing and promote rebuilding. So far, these legal mandates have contributed to the rebuilding of 21 collapsed stocks in the past decade in the US (Stokstad 2012).

Furthermore, research scientists and managers revealed that the scope of science and policy making toward rebuilding is generally narrow in Canada and with poor funding and budget cuts. Recent cutbacks in DFO spending and the disbandment of the FRCC speak to some of these challenges. There are apprehensions among stakeholders that these challenges may persist with ramifications for scientific research and stock assessments, as well as the institutional capacity required for successful rebuilding. Although some of these management dilemmas have been addressed through a participatory process involving fish harvesters in tagging and sentinel surveys, these rebuilding approaches need to be strengthened and scaled-up to include the contribution of non-industry stakeholders including municipal and regional economic planners. Bottom-up processes and structures are missing for ecological stewardship and sustainability practices at the municipal and community level, despite the fact that these regions are also the hardest hit regarding youth outmigration and unemployment (Macdonald et al. 2006; Vodden 2009). We argue that broad base governing efforts are crucial for trust and legitimacy that could lead to compliance and greater stewardship ethics, which are necessary prerequisites for rebuilding, as these communities are highly dependent on fisheries for livelihood and regional economic development (Hamilton and Butler 2001).

Although the Northern Gulf cod stocks are considered isolated, there is scientific evidence that they occasionally mix with other NAFO regions including the Strait of Belle Isle around 3K, the Burgeo Bank region in 3Ps, and the southwest part of the gulf region around 4TVn (Yvelin et al. 2005; Murray et al. 2008). Fish harvesters interviewed in the 3Pn region (especially Rose Blanche and Port aux Basques) were apprehensive about successful recovery due to the migration patterns of 4RS3Pn stocks and the on-going winter fishing activities in adjacent NAFO region 3Ps. Both local fish harvesters and scientists agree that the stock might have been "hammered" or overfished during its winter migration to 3Ps region (see Fig. 1). Other emerging concerns that affect rebuilding success include poor knowledge about residence times for migratory stocks, the impact of oil and gas exploration and seismic activities on stock behavior, and invasive species such as Green Crab that affects cod habitats (DFO 2011).

Harvest Stage: Impact of Policy Changes on Stock Rebuilding and Livelihoods

The harvest stage in the fish chain includes fishing activities and policy measures, fleet demographics, catch and landed value, by-catch and discards, as well as cost and earnings of fishing activities. For this stage, we focus on

changes in fishing policies and their impacts on stock rebuilding, transitional livelihoods, and stewardship.

A review and synthesis of fishing-related policies in the pre- and post-collapse era demonstrated several changes that have contributed to both resource sustainability and unintended consequences on ecosystem health and community viability (Table 1). Specifically, these changes can be summarized as: (i) by-catch and related ecosystem concerns; (ii) new target species and access policies; and (iii) transitional livelihood and cultural heritage concerns.

With the collapse of the groundfish stocks, several fisheries such as cod are managed through by-catch regulations, e.g., restrictions on cod by-catch in the turbot fishery (DFO 2010a). Compliance to by-catch regulations in multispecies fisheries is necessary for vulnerable collapsed stocks to mature to healthy levels and to meet rebuilding targets without problems of recruitment overfishing. As mentioned in Table 1, new policy measures have been implemented since the collapses to influence effective rebuilding. These include multispecies by-catch restrictions, fleet restructuring, and the establishment of dock-side monitoring and on-board surveillance mechanisms (DFO 2010a).

Nonetheless, these policy changes did not address all of the rebuilding concerns, as noted by some key informants including managers and fish harvesters. The persistence of by-catch issues in both the pre- and post-collapse periods due to the multispecies and multi-scale nature of fishing activities in the gulf and beyond speaks to enforcement and surveillance challenges. Moreover, other management problems persist especially with fishing mortality on fragile stocks and gear impacts on critical habitats. With the stock collapsed, the fishing fleets have been restructured and rationalized to address capacity issues alongside a ban on foreign and offshore mobile fleets till the TACs exceed 9000 tonnes. The total number of licenses issued in 2009 was 915 and 905 in Quebec and Newfoundland, respectively, with only 179 active in Quebec and 720 in Newfoundland. All the active licenses are for boats less than 65′ long using fixed gears in inshore regions, with none of the mobile boats greater than 65′ being operational (DFO 2010b). A survey on the impact of fishing gear on habitats in Atlantic Canada showed that bottom mobile gears, such as trawls, are the most destructive (Fuller et al. 2008), hence the continuous ban on dragger fleets in the Northern Gulf.

The collapse of the groundfish stocks in NL also brought in new target species, and access policies through the 1997 Professionalization Act. Northern Gulf cod stocks fluctuate from historical high landings of 100 000 tonnes in the early 1980s to small recreational landings that are below 10 000 tonnes (DFO 2010a). Because of these constraints on resource availability, fishing activities have changed from

Table 1 Pre- and post-policy changes relevant to rebuilding and alternative institutional mechanisms

Changes in fisheries policy	Pre-collapse period	Post-collapse period
Multispecies approach	Multispecies licenses and some restriction on catch landings	Multispecies licenses but with by-catch policy measures
Compliance to fisheries regulations	Incidence of misreporting, high grading, illegal and unreported catch	Dock-side monitoring programs in place, in addition to log books and vessel monitoring
Gear use and habitat measures	No specific conservation measures for gear restrictions on sensitive habitats	Ecologically and biologically sensitive areas identified for protected areas and seasonal closures through ICZM initiatives
Fleet types and control	Presence of foreign and dragger mobile trawler fleets	Absence of foreign and dragger trawler fleets and a predominantly fixed gear fishery
Overfishing and vulnerability assessment	No formal policy process and legal mandate for vulnerability assessment for commercial fish species	Enactment of SARA and the role of the Committee on the Status of Endangered Wildlife in Canada on extinction risk assessment
Species targeted and harvested	Mostly groundfisheries	Mostly shellfisheries and small pelagics
Access rights	Open access to community residents and input control measures and regulations	Closed access with professionalization based on fleet ownership, dependency, and experience
Allocation measures	Enterprise allocation for individual vessels for offshore fleets and competitive fishery for inshore fleets	Enterprise combining policies to include individual transferable quotas, “buddy up” system, license buy-outs, and quota consolidations
Coastal community considerations	Poor consideration toward regional or community quotas	Regional quota allocation system implemented in Northern Peninsula
Management regime	Top-down management and single species approach	Integrated management and a move toward ecosystem approach and stakeholder involvement
Resource user participation	Limited role for fisher union—the Food, Fish and Allied Workers Union (FFAW) in shared stewardship	Greater involvement of FFAW in sentinel fisheries, cod tagging studies, and inputs toward conservation harvest plans

Table 1 continued

Changes in fisheries policy	Pre-collapse period	Post-collapse period
Dependency on resource	High dependency on groundfisheries in both harvesting and processing sectors	Low dependency on groundfisheries as stocks collapsed, fleet restructuring, and plant closures
New management approaches	Limited attempts at integrated livelihood and regional planning initiatives	Greater emphasis on integrated management and regional economic development through the defunct Regional Economic Development Boards, FRCC, and other community initiatives

predominantly groundfish to shellfish and small pelagics to maintain livelihoods. Shellfish represents 75 % of the landings in 2010 and 86 % of the value according to the Seafood Industry Review in 2011 (Government of Newfoundland and Labrador 2011). The total shrimp landings in NL have increased from 20 000 tonnes in 1990 to 120 000 tonnes in 2008 (DFO 2010b). Similarly, total crab landings in the province increased from 8500 tonnes in 1987 to 70 000 tonnes in 1999. There has also been a corresponding change in fleet structure and higher production value that reached post-collapse peak of 1.2 billion CAD in 2004 (DFO 2010a). Bigger fleets with multiple licenses for shellfish, groundfish, and pelagics have higher revenue than smaller fleets with single licenses, although the sunk cost and operational expenses is higher for the former than the latter.

Despite these higher landed values in the post-collapse cod period, there have been concerns about stewardship ethics and livelihood concerns at the community level due to distributional and allocation concerns from professionalization policies. Professionalization entails limiting access and entry based on level of dependency, years of fishing experience, and enterprise ownership that distinguishes core and non-core fisher harvesters. According to this policy, a core fish harvester is a full time experienced enterprise owner with license(s) to fish key species such as cod, crab, and shrimp, and obtains 75 % of his/her income earnings directly from fishing. Others are considered non-core fish harvesters who may not meet this criteria and would be mainly new entrants who need to go through an initial Apprentice Program, administered by the Professional Fish Harvesters Certification Board, created in 1997. Upon successful completion of the apprentice training, one could advance to fishing Level I, then to Level II, and ultimately to a core fish harvester level. While core fish harvesters can sell their fishing enterprise or transfer to a family member who is at Level II, given approval from DFO, non-core enterprises can neither be transferred nor sold. These policy changes have ramifications for distributional and intergenerational equity concerns and community interest toward rebuilding. They draw attention to the many uncertainties about who would have access to future quotas and what is the fate of fishing-dependent communities without youth involvement (Jackson et al. 2006).

Fisheries rebuilding involves multiple spatial, temporal, and governance dimensions. For this reason, stakeholder deliberations on trade-offs between long-term gains and short-term costs could highlight the imperative to explore governing options and transitional livelihoods. Policy changes from groundfisheries to shellfisheries came with allocation measures to deal with livelihood changes in the Northern Peninsula on the west coast of Newfoundland. Because this is the most fishery-dependent region in Canada, and in the context of very small TACs for cod, most mobile gear quotas were allocated to fixed gear inshore boats, especially in fishing-dependent regions such as St. Anthony and Port aux Choix regions. As mentioned by one fisheries manager, these initiatives were spurred by "The Dave Decker Plan," initiated on behalf of FFAW to redistribute unused mobile offshore quotas to inshore fixed gear fishers to deal with transitional periods. Some fish harvesters interviewed in both 4R and 3Pn regions were happy about these measures but were doubtful about future allocations with cod-shrimp predator prey relationships and resource abundance. Community quotas provided to regions such as St. Anthony were lauded for their regional economic impact through the creation of the St. Anthony Basin Resources Inc. (SABRI) to sustainably manage the resource. In contrast, there was skepticism about the relative poor performance and eventual demise of the North of Fifty Thirty Association (NOFTA) in Port Aux Choix region, because of the lack of leadership and governing initiatives for dealing with the impact on other facets of the economy as compared to SABRI.

Another key post-collapse change is the opening of a recreational food fishery amidst concerns about stock health. The recreational food fishery, which lasts about 5 weeks in the summer, is considered important for food security and cultural heritage. According to the Survey of the Recreational Fishery in NL conducted in 2007,[1] about 191 tonnes of cod fish were caught in the 4R3Pn region in Newfoundland. Although this represents about 6.5 % of the total cod caught by both youth and seniors alike, there is concern about the lack of control measures and an adequate dock-side monitoring system, which could jeopardize the successful rebuilding of an already threatened stock. These

[1] http://www.dfo-mpo.gc.ca/stats/rec/can/NLCod2007/cod-eng.htm last accessed Sept 10th 2013.

post-collapse changes highlight the need for alternative governing arrangements among stakeholders recognizing social–ecological interactions and precautionary principles. New policy measures in one stage of the production chain could impact rebuilding outcomes through stewardship ethics and compliance to harvest decision rules during rebuilding.

Post-harvest Stage: Disconnects Between Local Seafood and Global Supply Chains

The post-harvest is the final stage in the fish chain, concerned with various types of processing activities, coastal community inter-linkages, labor markets, quality control, labeling standards, marketing strategies, and distribution channels that spans across spatial boundaries. It pays attention not only to the supply side but also to the demand side and the role of various institutions in brokering policy options through harvesting practices such as sustainable gear use, eco-certification, and consumer awareness.

One of the biggest changes identified by key informants especially fish harvesters, processors, and managers was the rapid shift in target species from groundfish to shellfish and corresponding changes in processing infrastructure and a move toward global consumer markets. The processing sector in rural fishing communities has been restructured with corresponding loss of jobs and a transformation from labor intensive to mechanized infrastructure. About half of the groundfish processing plants have closed their operations in this region, which used to be the highest employer within coastal communities (Khan 2012). This loss of employment opportunities and the lack of new licenses to youth have spurred an out-migration to other provinces especially in Alberta and Ontario and creating labor market and human resource concerns for regional development (Macdonald et al. 2006).

In the pre-collapse period, cod in the form of blocks was mainly exported to the US with seafood merchants playing a greater role in the supply chain (O'Reilly 1993). A shift to global consumer markets has been observed after the collapse as a result of the involvement of brokerage firms and international retail stores playing a key role in seafood distribution, particularly for high value shellfish (Dean 2001). Moreover, the changes in target species and product substitution in the "white fish" trade pose supply chain governance concerns for local producers and retailers. These changes also affects dock-side harvesting prices and processing operations across the fish chain, as each stakeholder incurs cost and wants to maximize their benefits, in the absence of adequate information among chain players. The risks and benefits vary for different stakeholders and this has caused many conflicts and missed opportunities for collective action toward price setting mechanisms, branding, and other marketing programs (Vardy and Team 1998). In the past, the price for cod fluctuated around $1 a pound (about 0.5 kg) in the late 1980s and early 1990s. In the post-collapse period, the retail price for cod ranged from $5 to $8 a pound as fish fillet goes through many stakeholders (Fig. 4).

The post-harvest stage is highly regulated by various market-based policy instruments that influence the viability of fishing operations. For instance, direct fish sale to consumers is prohibited and buyers from outside the province are not allowed to participate in local marketing compared to other provinces in eastern Canada. Key informants in the processing and marketing sectors highlighted numerous changes in the groundfish value chain from a shift in high volume and low value to high value and low volume targeting niche lucrative markets. These changes pose a marketing concern if cod stocks were to be rebuilt as the value of the catch is not comparable to other targeted stocks such as shellfish.

Other key concerns include the increasing production cost and low returns for groundfish stocks, problems with branding, and the poor attention to coastal community needs in fisheries policy and regional planning. These issues are often overlooked and have not been fully integrated in current fisheries rebuilding initiatives, posing missed opportunities for institutional capacity and stakeholder collaboration (Gibson 2013). Although governing mechanisms that respond to harvesting and marketing linkages have been advocated to deal with stewardship and sustainable practices, little has been achieved provincially to deal with global competition and empowerment of resource users and regional planners for a long-term viable and sustainable fishery.

DISCUSSION

The fish chain analysis used in this paper is an attempt to bridge disciplinary and methodological gaps through holistic human–nature interactions, as well as highlighting

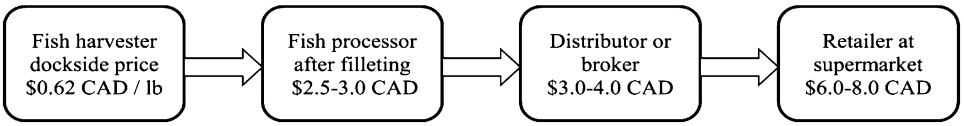

Fig. 4 Key stakeholders across the marketing chain for domestic cod fillet (Khan 2012)

the theoretical contribution of interactive governance in fisheries rebuilding efforts. As argued earlier, fisheries rebuilding is a wicked problem partly because of the multiple linkages between the ecological, economic, social, and political dimensions that are often not considered in an integrated manner. Most times, fisheries management is undertaken at the federal level by DFO, marketing and processing policies at the provincial level by the Department of Fisheries and Aquaculture in NL, and the municipalities have little or no formal inputs into fisheries decision-making regardless of the fact that fishers and processors and the various livelihood activities are transacted at local community level. The harvest and post-harvest stages of the fish chain are governed by different agencies with policy measures that are not often in synergy with the reality on the ground. Hence policy prescriptions and management panaceas that ignore theses cross-scale linkages do have domino effect across the entire fish chain from ecological changes, fishing activities and access rights, to markets and broader institutional mechanisms. Furthermore, the term "rebuilding" means different things to various stakeholder groups, which add to the complexity of definitive outcomes and expectations. For instance, while fisheries scientists and managers are concerned with stock health and limit reference points, resource users and coastal community residents are concerned about TACs and sustainable livelihoods, and retailers are concerned with new markets and consumer behavior. These differences in problem definition and value conflict are part of the challenges in addressing wicked problems and getting the necessary inputs for collective action (Baatie 2008).

We argue that getting diverse perspectives along the fish chain as to what constitutes rebuilding and getting inputs from various stakeholders in dealing with these problems is necessary and overdue. Be it scientific contributions through tagging studies and habitat protection, socioeconomic studies on livelihood security and value addition, or recreational fisheries and cultural tourism synergies. These could all be parts and parcel of the process of rebuilding the fisheries and the communities they are embedded in. The pre- and post-collapse analysis of the fish chain underscores the complexity and diversity in both the natural and social systems that are often managed in silos with little feedback mechanisms for policy exploration. Although the concept of integrated management has been part of fisheries policy in Canada for a long time, most coastal activities are still undertaken through sectoral approaches, and highly influenced by provincial rural policies rather than federal ocean policies. Based on the response from key informants, several opportunities exist to reconcile fisheries and coastal activities through a broader agenda that includes various stakeholder partnerships (public–private, community–university, community–industry, etc.) that could bridge these institutional silos and sectoral approaches. Leadership is paramount to such institutional and transformative changes as indicated in knowledge mobilization initiatives, bridging science and policy, adequate funding resources, public engagement, as well as incentives for behavioral change either through education or stimulus packages (Olsson et al. 2008; Chapin et al. 2009). In the Northern Gulf, fishers and the FFAW have initiated public forums in partnership with the university. They have also identified spawning areas for closure and collaborated with DFO in tagging and sentinel surveys. In addition, collaborative federal government policies toward dock-side monitoring and observer programs on larger fleets have also curtailed discarding and under-reporting to a large extent. Although discarding and by-catch issues are not easy to monitor in a multispecies fisheries, there are opportunities to explore voluntary landings as in the Norwegian context, as well as flexible quotas to deal with TAC overages (Hall et al. 2000). Community quota allocations to SABRI also involved industry partnership in the processing sector as well as youth development in the provisioning of scholarships. These examples demonstrate various models of partnership and governance arrangement in addressing the rebuilding challenge, albeit not sufficiently enough toward transformative changes and dealing with intergenerational rebuilding. What is however needed, in addition to day-to-day solutions or problem-solving, is an effort to build institutions that can enable these transformative changes, as well as nurturing principles and values that guide governors and non-governors alike (Song et al. 2013). In the context of Newfoundland, these could mean opportunities toward community-based or co-governance arrangements as illustrated by the impact of initiatives such as SABRI in western Newfoundland.

Despite current management initiatives and policy changes over the past two decades as indicated in Table 1, Northern Gulf cod is still considered endangered as of 2010 (DFO 2011). To date, future projections in stock abundance and in achieving rebuilding are discouraging; with expected increase in SSB in the short-term but subsequent decrease in the long-term (DFO 2011). This brings forth arguments of what stocks are to be rebuilt (species), for whom (stakeholder group), and when (temporal and intergenerational concerns). Regime shifts from cod-dominated food webs to invertebrates tend to prolong recovery timeframes for groundfish species as these affect their growth rates, sexual maturity, as well as increased predation from seals (Morissette et al. 2009). It also highlights demographic changes during the rebuilding transition that warrants procedural and distributional equity questions and labor markets. Gear impacts, by-catch, and discard issues remain central issues for sustainable practices and multispecies approach that may lead to successful cod

rebuilding. Integrating global seafood market dynamics and local seafood production measures across various scales of governance is necessary for creating synergies toward rebuilding efforts with various stakeholder groups and across sectors (Khan 2012). From the consumer end of the fish chain, the biggest challenge is institutional rigidity in responding to change, as evident by Newfoundland and Labrador's provincial marketing policies for non direct sales or allowing out of province buyers. One key example is policy measures that restrict direct wharf sales to local residents despite high local seafood demand and concerns about community health (Lowitt 2013). Moreover, the continuous levying of minimum processing requirements to local processors regardless of consumer demand provides lessons about missed opportunities for exploring niche markets and value-addition strategies.

Although institutional mechanisms across the fish chain are crucial factors toward rebuilding, the collapses of the groundfisheries did not lead to any significant legal changes to the *Fisheries Act*, which is the key legislation that governs fisheries in Canada (Hutchings and Festa-Bianchet 2009). Furthermore, the lack of a rebuilding plan and harvest control rules that address risks and uncertainties with stock structure demonstrates serious shortcomings and institutional inertia toward rebuilding success. To date, there are no rebuilding targets to be linked with decision control rules under current management policies, although harvesting quotas and TACs are set every year. Evidence from the North Sea and Grand Banks cod rebuilding efforts demonstrate the need for ecosystem and precautionary approaches, and stakeholder involvement for livelihood and equity issues (Gray et al. 2008; Davies and Rangeley 2010). Aligning the various federal Acts in Canada (*Fisheries*, *Oceans*, and *SARA*) and corresponding federal–provincial policy initiatives are necessary for coherence and synergy and integrated management. Although SARA has been very successful for non-commercial species such as marine mammals (Lotze et al. 2011; Dawe and Neis 2012), it has been challenging for cod and other groundfisheries because of trophic interactions, by-catch issues, and livelihood concerns (DFO 2005). These shortcomings are opportunities for ecosystem-based management and for the inclusion of other marginalized community actors such as municipal councilors and regional economic planners in addressing livelihood and governance options during rebuilding transition.

The dilemmas raised by trying to achieve multiple conflicting objectives in rebuilding efforts necessitate a move toward a coupled human and natural systems approach commonly called social–ecological systems (SES) as reflected in a growing body of literature (Berkes and Folke 1998; Folke et al. 2005; Liu et al. 2007; Ommer et al. 2011; Perry et al. 2011). A SES approach pays attention to transitional management initiatives and feedback mechanisms necessary for ecological integrity, sustainable harvest rates, incentives for behavioral change, as well as effective institutions (Olsson et al. 2008; Osterblom et al. 2011). We concur with this perspective, which also aligns well with the interactive governance theory that we draw on in the analysis of the Northern Gulf cod fisheries. We argue that many policy instruments are required toward rebuilding, particularly those that consider the diversity, complexity and dynamic linkages across both the social and natural systems and the level and scale of decision-making from government agencies to harvesters and their unions, processors, retailers, and consumers.

CONCLUSION

Fisheries rebuilding is challenging because they entail complex and dynamic ecosystems, diverse stakeholder interests, globalized seafood markets, and multi-scaled governing institutions. Rebuilding also necessitates consideration of current and future generations because of regime shifts, demographic changes, and the timescale for the recovery of long lived species such as cod (Hutchings 2000; Lotze et al. 2011). A theoretical and analytical approach that is holistic and systematic is necessary to understand wicked rebuilding problems and to explore possible governing options with various stakeholders. Defining fisheries rebuilding as a wicked problem provides opportunities to better understand and address the multi-faceted concerns along the entire fish chain in a collective and participatory manner.

Answering the two questions posed earlier, our analysis illustrates that rebuilding is not only about improving stock health in the natural systems (MSY targets) but also paying attention to social and governing systems since socioeconomic and sociopolitical factors could delay rebuilding. The comparative analyses in the pre- and post-collapse periods underscored challenges in all three production stages. These include: (i) ecological constraints due to the complexities and dynamics of marine ecosystems; (ii) evolutionary and trophic changes; (iii) changes in fisheries policies and their effect on equitable resource allocation and stewardship ethics; (iv) the impact of restructuring on livelihoods; (v) cross-scale dynamics in global seafood trade and its implication for local communities; and (vi) inadequate institutional capacity to support successful rebuilding at the local level.

Stock collapses could also be symptoms of larger problems beyond fisheries management; such as globalization, environmental change, and cultural shifts, which require a holistic approach and interdisciplinary attention. These cross-scale interactions do affect the viability of

local fisheries as well as spur the formation of stakeholder alliances and networks for power sharing, compliance, behavioral changes, and institutional innovation (Berkes 2002; Adger et al. 2005; Cudney-Bueno and Basurto 2009). Moreover, collapse could lead to potential ecosystem shift that brings in scientific uncertainty, stakeholder conflicts, and transitional obstacles for adequate responses and institutional changes (Gelcich et al. 2010; Osterblom et al. 2010; Berkes 2011). We suggest therefore that rebuilding efforts require governance approaches, not only for daily problem-solving but also catering to institutional building and cultivating values and principles that guides stakeholders and decision makers across the fish chain. The diverse stakeholder interests along the fish chain imply that a high level of coordination is required across the various production stages, along with effective institutional mechanisms at various governing scales.

In eastern Canada, none of the groundfish stocks that collapsed two decades ago have recovered to historical sustainable levels (FRCC 2011). There are continuous issues relating to compliance to rules, high transaction costs of management and budget cuts, concerns about provisioning ecosystem services especially seafood protein, and polarization in decision-making. The findings also demonstrate how social–ecological rebuilding could be achieved through various institutional partnerships. Notable examples include the sentinel surveys between DFO and FFAW, protected areas for spawning spurred by harvesters, and regional economic development linkages through the creation of SABRI. The pre- and post-analysis of the fish chain also draws attention to the importance of ecosystem-based approaches considering predator–prey relationships; in addition to cross-scale institutional dynamics for strategic planning on livelihoods and stakeholder involvement in day-to-day fisheries management. These lessons underscore various opportunities along the fish chain for employing multiple policy instruments and inclusive decision-making in dealing with rebuilding problems. Future research on synergies and trade-offs with multiple stakeholders for rebuilding various commercial fish chains could contribute to our understanding of interactivity among governing institutions and its local manifestations.

Acknowledgments Funding for this research was provided by the Social Science and Humanities Research Council (SSHRC) of Canada through the CURRA and Coastal Connections projects and SSHRC Doctoral award to the first author. We acknowledged the field assistance from Laura Genge and insights from 50 key informants. This manuscript is part of a PhD thesis that was co-supervised by Professor Barbara Neis, who provided useful comments on an earlier draft. We thank Charlie Conway for producing Fig. 1 and to participants at Congress 2012—CAG Session on Oceans Governance for constructive comments. Two anonymous reviewers provided helpful comments and suggestions that improved this paper.

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