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Reflecting on issues of governance and social-ecological 'fit' in the Pacific Herring (*Clupea pallasaii*) fishery: Sitka, Alaska and Haida Gwaii, B.C.

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1. Context and the challenge of 'fit'

Pacific herring (*Clupea pallasaii*) is an important forage fish distributed along the North Pacific coastline from Baja California, Mexico to the Beaufort Sea, Alaska (NOAA 2016). Herring are of significant importance to the social, cultural and economic wellbeing of coastal indigenous communities of western Canada and the United States (see Thorton et al. 2010a; Levin et al. 2016). From the 19th century onward commercial fishing of herring has also contributed to the economic development of many communities (indigenous and non-indigenous) across the Northwest.

However, North American Pacific herring stocks have experienced persistently low abundance levels since the mid 1990s. In British Columbia, for example, low stock abundance has led to periodic and/or sustained closures of the fishery (commercial and subsistence) in some regions, federal court injunctions preventing a commercial harvest, and ongoing conflict over the assertion of harvest and management rights. Stock abundance levels in Alaska, alternatively, are said to be more variable[1] with some regions in decline and others maintaining reasonably steady stocks. Management here is concerned with finding an appropriate 'herring balance' among different priorities and user groups, and with other harvests and sectors. Governance of Pacific herring is thus at an important crossroads (Jones et al. 2016; von der Porten et al. 2016).

This working paper examines the management and governance of Pacific herring in two geographic areas with a long history in the herring fishery – Haida Gwaii, British Columbia and Sitka, Alaska. Our aim is to characterize the fisheries governance arrangements in these two jurisdictions, and to synthesize selected attributes and indicators with which to consider governance processes and outcomes. Specifically, we use the concept of 'fit' (see Galaz et al. 2008; Ekstrom and Young 2009; Epstein et al. 2015) to consider how management institutions and governance arrangements for Pacific herring can lead to better outcomes for resources and people. Management refers here to the operational decisions to achieve specific outcomes (e.g., setting harvest rates, allocation rules), while governance refers to the broader processes and institutions through which societies make management decisions that affect the use and conservation of herring stocks.

Our notion of social-ecological fit rests on the assumption that management institutions and governance arrangements for herring are best designed and most likely to be effective with attention to coupled systems of people and nature (Epstein et al. 2015; see also Levin et al. 2016). Accordingly, we use the concept of social-ecological fit to draw attention to several issues, including the roles and responsibilities of key actors in herring management and governance, related issues of accountability and legitimacy with respect to decisions being made about herring use and conservation, the manner in which different systems of knowledge are supporting management and governance processes, and the extent to which current arrangements for herring governance can adapt to an uncertain stock future.

In the following sections we: 1) briefly outline herring management and governance arrangements in both Haida Gwaii and Sitka; 2) summarize selected and ongoing management and governance issues in both settings; and 3) reflect on the implications of current management and governance arrangements with regard to challenges of fostering social-ecological fit. The insights are of direct relevance to ongoing management issues associated with herring in the Pacific Northwest. However, the lessons learned with regard to Pacific herring are also of broader importance given the need to sustain forage fish in Canada and internationally (see WWF 2016; Pikitch et al. 2012).

[1] There is no current consensus in the literature on herring stock levels as they existed before modern survey methods. Thornton et al. (2010a) have suggested that herring stocks were overfished prior to when herring counting began, and so our view of what is and is not depleted is not entirely accurate.

2. Herring Fisheries Management and Governance in Haida Gwaii, British Columbia

Haida Gwaii is an archipelago on the edge of the continental shelf off the north coast of British Columbia. Its waters are home to one of five major spawning stocks of Pacific herring in BC. The region supports some 4,400 individuals, residing primarily in six communities, of which roughly half are of Haida ancestry. In 2010, 30 percent of Haida Gwaii residents relied on the marine sector for their living (MaPP 2015). Today, nearly half of the land area and three-quarters of the shoreline are protected as Provincial Park, National Park Reserve, or Council of the Haida Nation – BC Conservancy.

Fisheries here include three main sectors (First Nations', commercial and recreational) and four main fisheries (herring roe, spawn-on-kelp[2], food and bait, and special use). First Nations harvest whole herring and herring roe for food, social, and ceremonial purposes. Whole herring are fished by seine, gillnet, rake, dip net and jig, and eggs are collected from several types of kelp, eel grass ("spawn-on-kelp") and tree branches ("spawn-on-tree"). Commercial fisheries are active for all of herring roe, spawn-on-kelp, and food and bait fisheries (although roe harvest is the largest). Gear type, commercial license, and fishing period vary for each of these (see specifics in DFO 2013a). However, periods of low abundance have lead to periodic or sustained commercial herring fishery closures in some regions from the mid 1990s to 2016 (DFO 2014; Jones et al. 2016). Whole herring may be fished for recreational purposes year-round with a license. As well, there is a limited 'special use' fishery for those who hold quotas for a unique purpose.

2.1 Legislative Context

Fisheries in Haida Gwaii fall under a mix of federal, provincial and First Nations jurisdictions and management authorities. The federal government has jurisdiction over sea surface, water column, and seabed from the high water mark to 200 nautical miles from shore, and the province has jurisdiction over coastal waters, including intertidal and inland waters. Thus, both provincial and federal agencies have many overlapping roles and responsibilities, which require 'harmonization' of effort. In addition, the Haida Nation never signed treaties or ceded rights, titles or jurisdiction over land and ocean areas. So, following the Canadian constitution, the rights of First Nations to harvest and manage natural resources are to be legally upheld, and are currently dealt with on a case-by-case basis. In 2011, the Province of BC and the Haida Nation signed the *Kunst'aa guu – Kunst'aayah Reconciliation Protocol* to pursue shared decision-making on lands and natural resources (although this does not explicitly deal with Pacific herring, nor does it cede Haida rights and title).

In general, fisheries management in British Columbia is guided by five key pieces of legislation: the *Oceans Act*, the *Fisheries Act*, the *Species at Risk Act*, the *Coastal Fisheries Protection Act*, and the *Canadian Shipping Act*. In particular, the *Oceans Act* lays out a policy framework and strategic approach for Canada's oceans based on principles of sustainable development, integrated management, and the precautionary approach. The *Fisheries Act* is the core piece of legislation guiding fisheries management, and has established provisions for habitat protection to conserve fisheries resources and provide for economically viable fisheries. Fisheries management efforts are also guided by a variety of other policies and regulations (see DFO 2013a,b for a complete list). In addition, the new federal *Sustainable Fisheries Framework* contains policies for adopting an ecosystem-based approach to fisheries that support conservation and sustainable use.

The herring fisheries in the Haida Gwaii are also situated in a number of concurrent initiatives. The Marine Planning Partnership for the North Pacific Coast (MaPP) initiative (http://mappocean.org) is an arrangement between the Province of BC and 18 First Nations to develop marine use plans for BC's North Pacific Coast using an ecosystem-based management framework. The Haida Gwaii Marine Plan was co-led by the Council of

[2] Spawn-on-kelp fishery is conducted by suspending lines of kelp in spawning areas, and use either an open (i.e. kelp fronds suspended in open water) or closed (i.e. fish captured and placed in an enclosure containing suspended kelp fronds) ponding technique. First Nations commonly use the open pond method on different types of kelp, eel grass and tree branches.

the Haida Nation and the Province of BC, and was released in 2015. The Pacific North Coast Integrated Management Area (PNCIMA) initiative (www.pncima.org) is an oceans collaborative planning process designed to better balance ecological, economic, social and cultural interests by developing an integrated management plan for waters of central-north coasts of BC. It brings together First Nations, commercial and recreational users, environmental NGOs, government agencies and coastal communities. The creation of Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site ("Gwaii Haanas") operates under its own marine management plan, and is jointly governed by the Haida Nation and DFO/Parks Canada. Lastly, the DFO-led Pacific Integrated Commercial Fisheries Initiative (PICFI) (http://www.pac.dfo-mpo.gc.ca/fm-gp/picfi-ipcip/index-eng.html) is aimed at supporting BC First Nations in integrated commercial fisheries via improved access, capacity building, co-management, and enhanced accountability.

2.2 Primary Actors and Their Roles/Responsibilities

Fisheries and Oceans Canada (DFO) has the lead federal role in managing Canadian fisheries on the Pacific coast, and has a broad mandate with authority to develop policy, regulate and enforce activities, provide services and manage programs in support of Canada's economic, ecological and scientific interests. It has an extensive scientific branch, as well as a large enforcement branch. The Haida Gwaii region falls under the Pacific administrative region of DFO.

The **Integrated Herring Harvest Planning Committee** (IHHPC) is a multi-stakeholder body that was established to provide input and advice on DFO's decision-making processes for this fishery. Its aim is to deliver a "more streamlined, representative, cross-sectoral advisory process" (DFO 2013a: 5) to support the development of fishing plans that are coordinated and integrated. Membership includes representatives from First Nations, the spawn-on-kelp fishery, the Herring Industry Advisory Board, the special use fishery, the Marine Conservation Caucus (MCC), the Sport Fishing Advisory Board, the Province of BC, and DFO. Note that the IHHPC does not deal with recommendations of food, social and ceremonial harvest plans; this remains within the scope of the bilateral relationship between First Nations and DFO.

As a result of various administrative and regulatory initiatives, some responsibilities for commercial and recreational fisheries have been delegated to the **Government of British Columbia** via the Ministry of Forests, Lands and Natural Resource Operations. This includes issuing some tenures, licensing marine plant cultivation, and managing business aspects of aquaculture such as work place health and safety within the province.

The **Council of Haida Nation** represents the roughly 2,500 members in the Haida Nation. The *Constitution of the Haida Nation* contends the rights of Haidas to have authority and responsibility to make decisions over the environment.

The formation of the **Herring Industry Advisory Board** (HIAB) was approved and supported by all license holders in 2004, and communicates with the DFO on behalf of BC's commercial herring industry. It provides advice to assist in the overall planning, management and enforcement of the commercial herring fishery, in part through its involvement in the IHHPC. In the same way, the **Sport Fishing Advisory Board** (SFAB) has been an advisory body to the DFO on recreational fisheries issues, and is part of the IHHPC.

Other key non-government agencies of relevance to the herring fishery include the **Herring Conservation and Research Society** (HCRS), an NGO that supports conservation and management of Pacific herring resources with DFO through research and assessment; and the **Pacific Marine Conservation Caucus** (MCC), a body of environmental NGOs that collectively provide input to DFO decision-making processes in an advisory role, as well as represent the interests of the conservation community.

Other key government agencies of relevance to the territory include **Parks Canada** (federal), who is jointly responsible for the planning, governance and operations of Gwaii Haanas through the Archipelago Management Board (AMB); and **BC Parks** (provincial), who is responsible for Naikkon Provincial Park.

2.3 Selected Management and Governance Issues

Selected management and governance issues in the Pacific herring fisheries, specific to the Haida Gwaii region, are outlined below. These issues are drawn from existing studies and documentation about the fishery, as well as insights from those engaged as practitioners or researchers in the herring fishery.

- Local participation in commercial fisheries has declined and the size of the resident commercial fleet on Haida Gwaii is currently very small in comparison to earlier estimates. As well, very few of the fish caught in Haida Gwaii waters are processed in local seafood plants. This has a negative impact on local economic benefits derived from marine resources.
- Herring are a valuable resource to coastal BC ecosystems and to many different user groups – commercial interests, First Nations, and recreational users. Thus, contention over the use and allocation of fisheries resources can be commonplace in some regions. Longstanding closures of commercial fisheries and unclear accommodation of Aboriginal Rights and Title have contributed to tension between resource users and the management agency. For example, coastal communities concerned about the status of stocks have sought intervention through legal action.
- Stewardship arrangements/programs to protect, restore and enhance herring fisheries in Haida Gwaii have yet to be formalized (although there are other governance arrangements such as MaPP and PNCIMA). Ongoing differences have been cited between DFO and the Haida Nation about herring allocation and conservation objectives.
- The federal, provincial and Haida Nation have differing views on a number of important issues related to Haida Gwaii fisheries, including: increasing presence of oil tankers, increased presence of large vessel traffic, possibility of oil and gas development offshore, and development of aquaculture through tenures in Haida Gwaii waters.
- Ongoing capacity issues within DFO and other groups involved in herring fishery management are related to the lack of staff, training, expertise and funding.
- Meaningful consideration of social and cultural dimensions/cost and benefits (that is, non-economic) by DFO and other decision-makers in goal setting, decision-making, and monitoring has been restrained. There is need for greater consideration of trade-off negotiations between uses and users in each of the fisheries. The growth of the recreational fishery over the last 25 years has raised questions about the potential impact on fish stocks for subsistence and commercial fisheries.
- While DFO has committed to an adaptive management approach to sustainable fisheries and habitat management, the approach is not widely practiced in Canadian fisheries and has only been attempted in a few cases in BC (see Ou 2008 for overview). There is lost potential where decision-making is not informed by or draws upon different knowledge systems.

3. Herring Fisheries Management and Governance in Sitka, Alaska

Located in the panhandle of Alaska, Sitka is one of nine primary herring spawning aggregates in the southeast and is known as the herring egg capital of the region (Brock and Turek 2007). Per a 2015 US Census, the population of Sitka City and its borough is 8,863 residents, of which nearly 16 percent[3] have self-reported as American Indian and Alaska Native.

Herring in the Sitka Sound area of southeast Alaska are harvested for commercial, subsistence, personal use, and research/cost-recovery uses. The primary commercial use is sac roe for foreign markets, where herring are harvested prior to spawning using purse seiners. Between 2005 and 2015, the average annual harvest of sac roe

[3] This percentage represents only those who self-reported as American Indian or Alaska Native alone, and does not include those who reported as two or more races.

herring in Sitka Sound was slightly over 13,000 tons/year – an increase[4] from the previous 10-year average of 8,200 tons/year (between 1995-2004; Thynes et al. 2016). Harvest for subsistence is available to all Alaska residents year-round, though a permit is needed to take subsistence herring spawn-on-macrocystis kelp (but not spawn-on-other kelp, spawn-on-branches or whole herring). Subsistence fisheries for herring include the harvest of eggs on hemlock boughs or kelp, and for consumption by subsistence users as fresh fish and for bait. Personal use bait for commercial fisheries (e.g., halibut, ground fish, crab, salmon troll fisheries) is allowed year-round, but requires a permit for harvest greater than a ton.

3.1 Legislative Context

Fisheries of Alaska fall under a mix of state and federal management jurisdictions and regulations. Enactment of the *Magnuson Fishery Conservation and Management Act* (MFCMA) in 1976 asserted federal authority over the Exclusive Economic Zone from three to 200 nautical miles offshore, and state jurisdiction over waters inshore of three nautical miles. In general, the State has management authority for all of salmon, herring, crabs and other invertebrates, whereas the federal government has management authority for the majority of groundfish fisheries (except those within three nautical miles of shore and those for which the federal government has deferred management authority to the state).

Fisheries are managed by the Alaska Department of Fish and Game (ADFG) based on policies and regulations that are made by a separate Board of Fisheries (both created by the State Legislature in 1949). This is overseen by the Commissioner of the ADFG charged with managing, protecting, maintaining, and improving resources in the interest of the economy and general well-being of the State (as per Alaska Statute 16.05.020). The management of State fisheries is guided by several sections of its constitution, particularly that on renewable resources (Article 8), which stresses management for the "maximum benefit of its people" and based on "the sustainable yield principle".

The herring fisheries of southeast Alaska are also subject to a number of federal laws applicable in the region, including the *Marine Mammal Protection Act* (MMPA) and the *Endangered Species Act* (ESC) that do not currently, but could potentially, restrict fisheries in some areas.

3.2 Primary Actors and Their Roles/Responsibilities

The **Alaska Board of Fisheries** ("Board") is the state regulatory authority that sets policies and direction for the management of fishery resources, including Pacific herring, consistent with the state constitution and enabling legislation. It is charged with making allocative and regulatory decisions, such as those to open and close seasons, set quotas/bag limits/harvest levels, and establish methods and means for taking fish (as per Alaska Statute 16.05.251). The Board consists of seven members appointed by the governor for three-year terms. It meets four to six times per year to consider proposed changes to fisheries regulations.

Board meetings are an open forum designed to receive public testimony and input in the management and allocation of Alaska resources. Meetings are open to the public, and provide a forum for local voices to meet, write proposals for regulatory change, provide formal comments, and testify at Board meetings. Board proposals can be submitted by any organization, individual citizen, or the ADFG, and public testimony can be provided by any individual or organization. The **Sitka Advisory Committee** is one of 84 committees throughout Alaska comprised of local volunteer groups that provide recommendations to the Board on fishing issues.

Whereas the Board is charged with making allocative decisions, the **Alaska Department of Fish and Game** (ADFG) is responsible for management based on those decisions. Its mission is to protect, maintain and improve resources, and to manage their use and development in the interest of the economy and general well-

[4] The appropriate harvest rate for sac roe fisheries is determined based on an annual assessment of herring populations. Hence, as biomass fluctuates (increases/decreases) so does the set rate of harvest (see Thynes et al. 2016).

being of the state (ADFG 2016a). The ADFG has substantial fisheries monitoring and research programs, and is comprised of six divisions (Administrative Services, Commercial Fisheries, Habitat, Sport Fisheries, Subsistence, and Wildlife Conservation).

Another state agency with regulatory authority is the **Commercial Fisheries Entry Commission** (CFEC), who can establish moratoria or limited entry systems for state-managed fisheries by controlling vessel licenses as well as permits. It regulates entry, establishes maximum numbers of permits, estimates optimum permit numbers, and implements buy-back and transfer of fishing permits (where needed). Similarly, the **Alaska Department of Public Safety**'s Division of Wildlife Troopers is responsible for enforcement of commercial and sport fisheries, and aquatic habitat regulation.

The **Sitka Tribe of Alaska** is a federally recognized Tribal Government representing Sitkan's that may be engaged in subsistence harvesting (e.g., of herring eggs), as well as those involved in the commercial herring fishery (see Thornton et al. 2010a,b for context and further information). The **Sitka Sound Herring Research Planning Group** was formed to make recommendations to Sitka Tribal Council regarding commercial and subsistence herring fishery issues. This group is intended to allow and encourage participation of Tribal Citizens in the collaborative management of the herring fisheries. In 2002, the Sitka Tribe and the ADFG entered into a Memorandum of Agreement to promote collaboration, communication, joint monitoring and data sharing. Specific collaborative responsibilities included: (1) participation in pre- and post-season stakeholder meetings, (2) early communication regarding potential commercial fishery openings and guideline harvest levels, and (3) conducting collaborative post-season subsistence monitoring (see STA-ADFG 2002). However, this MoA was terminated in 2009. Since termination of the MoA, two pre-season stakeholder meetings are held annually and are open to participation of Sitka Tribe of Alaska members, members of industry, and the public. Collaborative post-season subsistence monitoring has also continued by the Sitka Tribe of Alaska and the ADFG.

Resource use actors associated with the herring fishery include **industrial/commercial fishers** and **processors**, and **subsistence/personal use fishers**. Other key non-government agencies of relevance include the **Sitka Conservation Society**; the **Sitka Herring Conservation Alliance**, an organization of commercial fishers and processors; the **Sierra Club**, who previously petitioned to list the Pacific herring as threatened or endangered in some areas of Southeast Alaska; and the **Sitka Sound Science Center**, a research unit dedicated to understanding and awareness of terrestrial and aquatic ecosystems of Alaska.

Other key State and federal government agencies relevant to herring in the Sitka region include the **Alaska Department of Environmental Conservation's** (ADEC) Division of Water that establishments standards for water cleanliness, and regulates discharges to waters and wetlands; the **Alaska Department of Natural Resources** (DNR) that manages the use of tidelands and submerged lands seaward of mean high water; the **United States Forest Service** that manages Makhnati federal public waters within Sitka Sound; the **United States Coast Guard**; and the **National Oceanic and Atmospheric Administration** (NOAA) which is responsible for stewardship of ocean resources and habitats.

3.3 Main Issues and Key Governance Conflicts

The following highlights the ongoing, longer-term management and governance issues in the Pacific herring fisheries, specific to the Sitka region:

- Because herring are an important food source for other species, concerns about the implications of commercial herring fisheries for the ecosystem and for other harvests and sectors emerge from time to time. In addition to a Pacific herring fishery, Sitka waters are home to mixed stock halibut and salmon fisheries, some of which support the largest recreational marine fisheries in Alaska. The Board of Fisheries, therefore, plays a critical role in hearing and balancing evidence, and attempting to mediate the interests and concerns of a broad array of rights holders and other stakeholders.
- Different priorities and concerns exist within and among different herring user groups (primarily subsistence and commercial). Sitka subsistence harvesters prioritize the opportunity to gather good quality

herring roe deposited by spawning fish, ideally at traditional harvest sites easily accessible to the community. Considered a delicacy, the spawn on branch product is consumed locally as well as traded through larger social networks. There has been a 'subsistence harvest only' area designated in Sitka. Commercial harvesting of fish for roe takes place adjacent to many traditional sites in Sitka (within and outside of the designated subsistence area). Commercial openings are timed to maximize harvest quality and quantity (when the pre-spawn herring are congregating). It is easy to appreciate how adjacency and timing influence contrasting experiences and preferences held among user groups. Concerns over the 'herring balance' are regularly brought to the Board of Fisheries. In a 2015 meeting, for example, proposals had been submitted by tribal and village organizations to close portions of Southeast Alaska waters to commercial fisheries and raise levels of harvest for subsistence, and by a group of commercial herring fishermen to reopen an area from closed waters to allow for more harvest (all proposals were rejected – Summers 2015).

- Some have commented on the large number of allocation proposals being submitted to the Board of Fisheries (to allocate and/or reallocate fishery resources) and the complexity of allocation decisions – it is not uncommon to see a thousand proposals submitted to the Board in any given year (across all fisheries). The allocation process is challenging for two reasons. First, allocation concerns a broad spectrum of users and fisheries to which a growing Alaskan community desires access/entitlement (as above). The ever-increasing globalization of the economy (and markets), improved technology and transportation presents both new opportunities and new challenges. Second, allocation decisions have inherent economic or other benefits for some, while reducing opportunity or benefit to others. Still, decisions influencing the herring fishery are ultimately made (e.g., such as a 2012 decision to close the commercial herring harvest in 20 square miles of Sitka Sound).
- The integration of local traditional knowledge and experiential knowledge into planning and decision-making processes about Pacific herring (with regard to e.g., biomass estimates, harvest policy, restoration planning, long-term/historical ecology) has been slow to uptake (Thornton et al. 2010a,b; see also Brock and Coiley-Kenner 2009).

4. Discussion and Conclusion

Pacific herring fisheries in Haida Gwaii and Sitka reflect a range of economic, social and ecological uncertainties. These uncertainties pose significant challenges for effective governance. Here, we reflect on these challenges and issues through the lens of social-ecological fit, which we have defined as the interactions between institutions and the social and ecological attributes of linked systems of people and nature that contribute to successful outcomes (i.e., conservation, sustainable use, human wellbeing) (see Epstein et al. 2015). We draw attention here to management and governance attributes (and indicators) that ultimately influence prospects for enhanced social and ecological fit, and that are in need of further analysis (see Table 1). These attributes include:

1) *Knowledge co-production* which involves the extent to which information and knowledge about herring stocks and management decisions draw on a range of types and sources, and used to collaboratively produce shared insights. Processes of knowledge co-production and exchange are recognized as having value in drawing in a broader range of perspectives and values (Armitage et al. 2011);

2) *Learning and adapting* in which there are opportunities within existing herring management and governance regimes for learning in the context of stock uncertainty and changing institutional (i.e., rights assertions) and adapting management institutions and governance processes in ways that foster more durable outcomes (ecological as well as social);

3) *Actors roles and responsibilities* in decision making about herring are shifting with pressure for more collaboration in decision making, and in the context of further assertion of rights and authority regarding stock allocation and conservation.

4) *Accountability*, in the context of shifting roles and responsibilities, reflects the extent to which decisions and decision making processes are characterized as transparent and responsive to various interests involved in the herring fishery, and that there are consequences for decisions being taken by different actor groups. This also implies a relatively free flow of information that underpins other key attributes of fit (e.g., knowledge co-production and learning processes).

As summarized in Table 1, indicators for each of these governance attributes of social-ecological fit are available and can be used to provide initial insights from the two cases. In a some instances, the level of information and/or detail on these indicators has not been summarized, or is not available. However, these attributes and associated indicators can provide a framework for comprehensive assessment of social-ecological fit in the herring fisheries in Haida Gwaii, B.C. and Sitka, Alaska, and thus serve as a foundation for additional research.

Table 1. Attributes and indicators of social-ecological fit in Herring fisheries of Haida Gwaii, B.C. and Sitka, Alaska

**Note that the content in this table is based on literature review, and may not be fully representative of the present circumstances on the ground. DFO = Fisheries and Oceans Canada, ADFG = Alaska Department of Fish and Game, FN = First Nation and AN = Alaska Native

Attribute	Indicator	British Columbia (Haida Gwaii)	Alaska (Sitka)
Actors and Roles	Collaborative process involving resource users	No formal shared stewardship arrangements/programs for herring specifically; Integrated Herring Harvest Planning Committee a forum to "advise" DFO decision-making (except on matters related to the food, social and ceremonial fishery)	No formal shared stewardship arrangements/programs for herring specifically; Board of Fisheries, Federal Subsistence Board and ADFG public meetings are venues for AN/public comment and participation; Sitka Advisory Committee a pathway to inform Board of Fisheries decisions; Sitka Tribe and ADFG had Memorandum of Agreement for consultation and collaboration with regard to herring fishery (now expired)
	Inclusion of diverse stakeholders in decision-making (esp. local)	Managing authority: DFO Provides input and advice via IHHPC[5]: First Nations, the spawn-on-kelp fishery, the Herring Industry Advisory Board, the special use fishery, the Marine Conservation Caucus, the Sport Fishing Advisory Board, the Province of BC	Managing authority: ADFG All members of the public – including Sitka Tribe members, other ANs, commercial fishers and subsistence fishers – can provide input by submitting a proposal for changes to the Board of Fisheries or Federal Subsistence Board. As well, input is provided via Sitka Advisory Committee[6]: sport fishery, subsistence fishery, conservation, processing, recreation fishery, shellfish and other fisheries + meetings open to the general public
	Incentives and resources for participation	Possibilities – desire for or protection of stewardship rights; desire for access rights; desire for local voices/agenda to be heard; desire for health, trade and gifting; economic desire	Possibilities – desire for or protection of stewardship rights; desire for access rights; desire for local voices/agenda to be heard; desire for health, trade and gifting; economic desire
	Strong leadership	DFO, Council of the Haida Nation	Board of Fisheries, Federal Subsistence Board, ADFG, Sitka Tribe of Alaska, Sitka Herring Conservation Alliance
	Mechanism for conflict resolution	Judicial courts	Judicial courts, Board of Fisheries, Federal Subsistence Board
	Sources of and access to power	Includes courts, legislatures, public boards, citizen initiatives, etc. FN successful in asserting (some) rights through judicial system	Includes courts, legislatures, public boards, citizen initiatives, etc. AN successful in asserting (some) rights through Board of Fisheries

[5] See the Integrated Herring Harvest Planning Committee website for most up-to-date membership listings (http://www.pac.dfo-mpo.gc.ca/consultation/pelag/ihhpc-ccpih/index-eng.html)

[6] See the Sitka Advisory Committee website for most up-to-date membership listing (http://www.adfg.alaska.gov/index.cfm?adfg=process.acinfo&ac=sitka)

Knowledge co-production	Social norms (social obligation, cultural convention)	E.g., traditional spawn-on-kelp and spawn-on-branches practices	E.g., traditional spawn-on-kelp and spawn-on-branches practices
	Diverse goals/objectives (social, cultural)	Largely limited to biological and economic. The Province of BC also has a coast-wide allocation for FN for food, social and ceremonial (FSC) purposes in all stock assessment areas. After resource conservation, FSC has the next highest priority. Supporting subsistence allows for consideration of some social and cultural benefits.	Largely biological and economic. Alaska also has a 'subsistence priority' to protect subsistence harvests and allow the meeting of subsistence needs. Supporting subsistence allows for consideration of some social and cultural benefits.
	Incorporation of knowledges	DFO draws on 'expert knowledge' and specialized experience to inform management decisions, including an annual test roe fishery program led by HCRS; DFO preferences science-based monitoring; but FN provide info to DFO on herring behaviour, spawn timing abundance, ecosystem relationships and fishing methods	ADFG draws on biological and statistical experts and assessments on population size to inform management decisions, including active management of its roe fishery; preference for science-based monitoring; there has been limited incorporation of TEK (though multiple studies have been undertaken); The results of egg surveys, subsistence fishing locations, level of subsistence harvest, the amount needed for subsistence, and public testimony on social and cultural impacts of the commercial fishery are meant to be included in Board decisions
	External support (university researchers, NGO scientists, etc.)	Yes	Yes
	Social legitimacy[7]	Unknown	Unknown
Learning and adaptation	Evidence of learning by managing authorities and relevant actors over time (e.g., learning to include traditional knowledge in decision making)	Unclear. DFO is committed to an adaptive approach to fisheries, but it has only been tried a few times in BC	Unclear, however, there is evidence that management, assessments, and Board of Fisheries decisions are changing to draw on wider range of sources and support further collaboration among fisheries actors
	Monitoring for decision-making	Predominantly biological and economic indicators	Predominantly biological and economic indicators
	Flexibility in decision-making (e.g., ability to respond to new information as it arises)	Unknown	Somewhat – proposed changes to fisheries management may be submitted to the Board of Fisheries for consideration every three years for each region or out of cycle if necessary. Proposals may cover new fisheries/fishing areas, re-allocation of resources, or change in fishing regulation

[7] By 'social legitimacy' we refer to the perceived support/opposition or public opinion of managing authorities related to the Pacific herring fishery (i.e. DFO and Board of Fisheries/ADFG). This concept is often closely tied to processes of participation, accountability and transparency.

	Multi-level networks[8] / issue networks	The Integrated Herring Harvest Planning Committee includes individuals from multiple sectors and scales/levels; evidence of networks associated with other initiatives in the region (e.g., MaPP, PNCIMA)	Unclear
	Bridging / boundary organizations[9]	Unknown	Unknown
	Institutional strengthening/ rebuilding	DFO has funded the Pacific Integrated Commercial Fisheries Initiative to support BC First Nations in integrated commercial fisheries (not herring specific)	Unknown
	Sufficient resources, skills, and funding	Unclear – staffing constraints within FN Council; staffing constraints within DFO; uncertainty of short-term/project-based funding; funding limitations	Unclear – staffing and funding constraints within ADFG
	Flexibility to change allocations btw groups if needed	Unknown	Yes. The Board of Fisheries has the ability to allocate and re-allocate fisheries resources btw one or more users / btw one or more fishery through its public proposal process (every 3 years), with a petition process to take proposal up out-of-cycle)
Legitimacy	Equitably[10] deals with trade-offs (food security, culture, commercial, recreation)	Additional information needed given scope for different perspectives and criteria on what is 'equitable'. Past occurrences of subsistence failure and/or stock depression documented (1998, 2002, 2014) where traditional catch has been poor as a result over overfishing in other fisheries; commercial fisheries subject to longstanding closures	Additional information needed given scope for different perspectives and criteria on what is 'equitable'. Past occurrences of subsistence failure documented (2002, 2006, 2008, 2016) where the commercial fishery harvest levels were too high and/or said to have a negative consequences on the ability of subsistence users to meet their harvest quotas.
	Social capital, trust between relevant actors	Strained trust between FN and government given historical grievances around issues such as forestry, land title, etc. in the region	Unknown – it is important to clarify level of trust between quite diverse range of actors (e.g., among Sitka Tribe of Alaska (STA) and the Board, STA and ADFG, STA and commercial fishers, etc.
	Herring license types	Commercial roe herring license; commercial food and bait license; special use bait license; Aboriginal communal fishing license; recreational license; scientific and special purpose license	Commercial fishing license/permit; subsistence permit (only needed for spawn-on-Macrocystis kelp)[11]; personal use permit (needed for harvest of greater than one ton of bait for use in commercial fisheries)

[8] We define 'multi-level network' as a heterogeneous set of actors that are linked across scales and levels. The importance of multi-level networks has been broadly recognized in the work on natural resource governance (e.g., Armitage 2008, Carlsson and Sandström 2008).

[9] A 'bridging organization' is defined as an independent organization designed to connect diverse actors and groups through some form of bridging process, such as collaboration. A 'boundary organization' is more narrowly defined as an organization designed to connect diverse actors and groups for the purpose of linking science with policy (see Berdej 2017).

[10] Of importance to note, the perception of 'equity' is dependent on who is evaluating it. Here we base our evaluation in part on evidence of a 'herring balance' between commercial and subsistence fisheries.

[11] In Southeast Alaska 'subsistence' and 'personal use' fishing permits are only available to those individuals living in Alaska for at least one year

	FN/AN access to fish/roe for commercial purposes	Yes. However, FN individual ownership of commercial fishing licenses and quota has declined precipitously across Canada between 1994 and 2002[12]; as well, the size of the resident commercial fleet is currently very small	Yes, but it is unclear to what extent (see Sill and Lemons 2015 for insight)
	FN/AN access to fish/roe for food, social, ceremonial purposes	Yes	Yes
	FN/AN Inter-family/inter-tribe trade of fish/roe	Unknown	Yes
	Equitable allotment of benefits to stakeholder groups	Somewhat. FN fishery for food, social, and ceremonial purposes is given priority over commercial fishery. However, it is unclear if they are given priority in licensing and quotas.	Somewhat. All state residents are able to partake in the Sitka Sound herring subsistence fishery, through subsistence regulations differ by location and management authority (state or federal). Subsistence fisheries are established as the highest priority consumptive use.
	Access to adequate resource base for community development ventures	Unclear if there are policies that explicitly benefit communities. However, there is a limited 'special use' fishery that allocates quotas for unique purposes (applicable?)	Unclear if there are policies that explicitly benefit communities.

[12] Ecotrust 2004

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