Compilation of Planning Objectives and Data Sources for the Skeena Estuary

Report Prepared for WWF-Canada by:

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Project Scope

This project focuses on ecological values related to the Skeena Estuary. It does not consider values related to process, governance or gathering knowledge. Neither does it include values that are obviously distinct from the estuary (e.g. mountain goats), although it does include forest values that are potentially connected to the estuary. The report focuses on land-use and marine management plans and includes only a small subset of the available species-specific plans. The project assesses planning objectives for consistency with accepted ecological conservation and planning concepts. It provides a scan of useful data sources for follow-up, but does critically review the literature. It does not describe potential new development nor include the correlations and cause-effect relationships necessary to predict impacts of development.

Introduction

Proposed development in and near the Skeena Estuary (Carr-Harris et al. 2014, Faggetter 2014) poses uncertain risks to estuary integrity and wild salmon. No management plan currently exists for the Skeena Estuary (Figure 1). Developing a management plan requires identification of the values and services provided by the estuary, documentation of existing publicly-described objectives for values, and assessment of the cumulative risks posed to values and services by a variety of stressors over time and space. This project consists of two sections. Section 1 compiles existing values and objectives from land-use and marine plans applicable to the Skeena Estuary and describes potential conservation gaps; Section 2 describes preliminary models and sources of current, as well as historical, data that can be used to inform cumulative risk assessment.

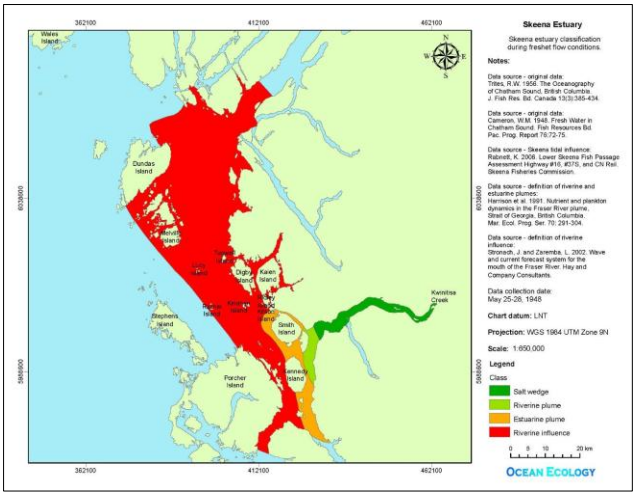

Figure 1. Skeena River Estuary (Faggetter 2014)

Section 1. Skeena Estuary Values

We reviewed 24 completed and draft land-use plans and marine plans applying to the Skeena Estuary for ecological values (Table 1). Strategic terrestrial land-use plans were developed for most of BC in the late 1990s and early 2000s. Strategic marine plans are currently being developed and are in draft form.

Table 1. Completed and draft land-use plans applying to the Skeena Estuary

Plan	Date/availability	Abbreviation
Terrestrial strategic		
North Coast LRMP	2004	NC
North Coast Ministerial Order	2007/ 2009	NCMO
EBM Handbook and Hydroriparian Planning Guide	2003	EBMH/ HPG
Coastal First Nations Land and Resource Protocol Agreement	2006	CFN
Metlakatla SLUPA	2006	MA
Lax Kw'alaams SLUPA	2008	LK
Kitselas SLUPA	2006	KS
Kitsumkalum SLUPA	2006	KM
Gitxaala SLUPA	2006	GX
Kalum LRMP	2002/2006	KA
Kalum SRMP	2006	KAS
Protected area plans		
Lucy Island Conservancy Collaborative Management Agreement	2014 draft (not yet publicly available)	LI
Kistson Island Marine Park MDS	2003	KI
Marine strategic		
Marine Planning Partnership Draft North Coast Plan	2014 draft (3.1)	MaPP
Pacific North Coast Integrated Management Plan	2013 draft	PNC
Species plans		
Wild Salmon Policy	2005	WSP
Northern Pacific Salmon Integrated Fisheries Management Plan	2014 draft	IFMP
SARA Recovery Strategies and Management Plans (North Pacific Humpback Whale, Resident Killer Whales, Steller Sea Lion, Marbled Murrelet, Rougheye Rockfish, Northern Abalone)	2013, 2011, 2011, 2014, 2012, 2007	SARA
Community plans		
Skeena-Queen Charlotte Regional District Planning Priorities	2013	SQC
Prince Rupert Quality of Life OCP	2010	PR
Waterfront East Land Use Plan	2012	WE
District of Port Edward OCP	2013	PE
Industry plans		
Prince Rupert Port Authority 2020 Land Use Management Plan	2010	PRPA
Green Marine Environmental Program	2013	GMO
Plans not available		**Contact**
Pacific Region Integrated Fisheries Management Plan Eulachon	No Skeena plan	R Kanno (DFO)
Skeena-Queen Charlotte Regional Growth Strategy	No strategy	Daniel (SQC RD)
Kennedy Island Conservancy Management Plan	Not started	D Brown (BC Parks)
Gitxaala Nii Luutiksm Conservancy Collaborative Management Agreement	Not started	D Brown (BC Parks)
Ecstall-Spoksuut Conservancy MP	Not started	D Brown (BC Parks)
Skeena Bank Conservancy MP	Some background	D Brown (BC Parks)
Ksgaxl/Stephens Island Conservancy MP	FN draft close	D Brown (BC Parks)
Smith Island Conservation Lease Management Agreement	Some background	D Brown (BC Parks)

The plans differ considerably in format, but generally include visions, goals, objectives and strategies in some form. We collated ecological goals and objectives from the various plans into groups, extracted values, and used the objective groups to build conceptual models for ecological integrity and community resilience. Three appendices describe existing objectives:

1. A **validation table** lists values and includes text quoted (with minor modifications for consistency and ease of reading) and page references from each plan. This table can be used to confirm a value and to provide further context (Appendix 1). The validation table describes dependencies and is ordered hierarchically to match conceptual models.
2. **Conceptual diagrams** model the links between broad goals and objectives identified in the planning documents (Appendix 2). More detailed existing models for salmon, including pressure and/or state indicators are included in Section 2.
3. An **Excel table** summarises the values as described in the validation table (Appendix 3; separate document).

We assessed gaps and inconsistencies in compiled objectives, as they relate to broad and fine filter conservation objectives as described in Vold and Buffett (2008; Ecological Concepts, Principles and Applications to Conservation; Box 1).

Box 1: Summary of ecological applications (Vold and Buffett 2008)

Conservation design considers coarse and fine filter approaches (though the distinction between the two can be fuzzy).

Coarse filter approaches focus on

- Ensuring ecosystem representation
- Representing ecosystems in protected areas
- Retaining large contiguous or connected areas
- Maintaining or emulating natural ecological processes
- Managing for resilience (includes considering climate change)

Fine filter approaches include

- Managing towards viable populations of native species, including maintaining habitat
- Preserving rare ecosystems, features and species
- Maintaining species with strong connections (keystone species)
- Minimizing invasive alien species

Planning processes include

- Setting objectives and targets in plans
- Managing at multiple levels and scales
- Zoning for uses that are compatible with an area's natural potential
- Avoiding conversion
- Avoiding, mitigating or, as a last option, compensating for impacts
- Maximizing learning through adaptive management, risk assessment and ecosystem-based management
- Making science-based decisions

Plan objectives vary in focus, scope and approach. Focus ranges from terrestrial, freshwater and marine ecosystems to communities and industrial activities. Scope ranges from strategic to operational and from species to ecosystem. Approaches range from traditional development-with-limits to credible attempts at achieving ecosystem-based management. Not surprisingly, consistency with ecological concepts varies among these groups.

Table 2 shows a subjective assessment of consistency with conservation and planning applications as described by Vold and Buffett (2008). The summary table should be treated with caution for several reasons: 1) some plans mention a concept, but do not include it in objectives (for example, coastal SLUPAs include a definition, but not objective, for adaptive management); 2) in some cases, application of a concept is unclear and open to interpretation—without in-depth knowledge of background documents, it is difficult to assess intent; 3) some applications are inappropriate for some types of plans (and hence lack does not imply inadequacy; e.g. coarse/fine filter is inappropriate for SARA recovery plans or for small parks).

Plans vary in the number of ecological concepts (as described by Vold and Buffett 2008) considered:

- Some plans include almost all ecological concepts in conservation applications (NC, EBMH, and MaPP).
- Several plans include more than half of the concepts (KA, PNC, WSP and LI).
- The remaining plans include less than half of the concepts. Community and industry plans include 0 – 3 concepts out of 14.

Plans vary in recognition of ecosystem services:

- Only four plans (NC, EBMH, MaPP and PNC) recognise all four categories of ecosystem services.
- Most plans recognise provisioning and cultural (not necessarily explicitly), but not regulating and supporting services.

Plans vary in applying ecological concepts to planning:

No plans include objectives to avoid land conversion, and two plans (PE and PRPA) encourage conversion, at least in some locations.

- Seven plans (NC, EBMH, G2G, MaPP, PNC, WSP and KA) include more than half of the planning applications.
- The remaining plans include less than half of planning applications, with community and industry plans as well as NCMO, KAS and KI with fewer than 3 of 10 applications.
- Interestingly, although the NC and KA plans consider many of the planning applications, the more operational follow-up plans (NCMO, KAS) include fewer (partly due to poor definitions of ecological concepts).

Table 2. Ecological and planning concepts described in Vold and Buffett (2008) used in various plans.

	Strategic terrestrial						Park plans		Strategic marine		Species plans			Community plans				Industry plans	
	NC	NCMO	EBMH	G2G[1]	KAL	KAS	LI	KI	MaPP	PNC	WSP	IFMP	SARA	PR	WE	PE	SQC	PRPA	GMO
Ecological concepts																			
Coarse/fine	✓[2]	✓	✓	✓	(✓)	✓	-	-	✓	✓	✓	-	-	-	-	-	-	-	-
Rep eco	✓	✓	✓	✓	✓	✓	✓	(✓)	✓	✓	✓	-	-	-	-	-	-	-	-
PAs	✓	-	✓	✓	✓	-	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	-
Connectivity	✓	-	✓	-	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-
Processes	✓	✓	✓	✓	(✓)	(✓)	-	-	✓	✓	-	-	(✓)	-	-	-	-	-	-
Resilience	✓	-	✓	-	-	-	-	-	✓	✓	-	-	(✓)	-	-	-	-	-	-
Native sp	✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-
Viable pop	✓	-	✓	-	✓	-	✓		✓	✓	✓	✓	✓	-	-	-	-	-	-
Rare/sens eco	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-
Rare sp	✓	✓	✓	✓	✓	-	-	✓	-	-	✓	✓	✓	-	-	-	-	-	-
Invasives	-	-	-	-	-	-	✓	-	✓	-	-	-	-	-	-	-	-	✓	✓
Keystone	✓	-	✓	-	✓	-	-	-	✓	-	✓	-	-	-	-	-	-	-	-
Habitat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	✓	-
Climate	-	-	✓	-	-	-	✓	-	✓	✓	✓	(✓)	✓	✓	-	✓	-	✓	✓
TOTAL	**12**	**7**	**13**	**7**	**9**	**5**	**8**	**5**	**13**	**9**	**8**	**5**	**5**	**1**	**0**	**2**	**0**	**3**	**2**
Recognition of ecosystem services																			
Provisioning	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-	✓	✓		✓	-	-
Cultural	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	-	(✓)	(✓)
Regulating	✓	-	✓	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-
Supporting	✓	-	✓	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-
Planning concepts																			
Objectives	✓	(✓)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	(✓)	✓	✓	✓
Targets	✓	✓	✓	✓	(✓)	(✓)	-	-	-	-	✓	✓	-	-	-	-	-	-	-
Multi-scale	✓	-	✓	✓	✓	-	-	-	(✓)	✓	✓	-	-	-	-	-	-	-	-
Conversion	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zoning	✓	✓	✓	✓	✓	-	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-	-	-
Mitigation	✓	-	✓	✓	✓	-	✓	-	✓	✓	✓	-	✓	✓	-	✓	-	✓	✓
AM	✓	(✓)	✓	✓	✓	(✓)	-	-	✓	✓	✓	-	-	-	-	-	-	-	-
Risk	✓	-	✓	-	✓	-	✓	-	✓	✓	✓	✓	✓	-	-	-	-	✓	-
EBM	✓	✓	✓	✓	(✓)	(✓)	-	-	✓	✓	-	-	-	-	-	-	-	-	-
Science	✓	-	✓	✓	(✓)	-	-	-	✓	✓	✓	✓	✓	-	-	-	-	-	-
TOTAL	**9**	**3**	**9**	**8**	**6**	**1**	**4**	**2**	**7**	**7**	**8**	**5**	**5**	**3**	**2**	**2**	**1**	**3**	**2**

[1] G2G plans are incremental to the NC, so although each plan does not include all applications, they theoretically include everything in the NC.

[2] ✓ = plan either includes application within an objective or clearly has considered the application; (✓) = plan may have considered the application or has included a poor definition; - = no evidence that plan has included the application.

Terrestrial land-use plans

LRMPs are strategic plans that focus primarily on land and freshwater systems. The Kalum LRMP (KA) includes coastal objectives but these apply outside the boundaries of the Skeena Estuary. The North Coast LRMP (NC) includes general objectives for estuaries and shoreline forests as part of its goal to maintain the integrity of all hydroriparian ecosystems. The Hydroriparian Planning Guide (HPG), which provides guidance for implementing the NC, notes that estuaries are both highly productive and sensitive; hence land-based strategies to maintain their integrity in the NC include complete retention of the adjacent terrestrial ecosystem. The NC does not address marine ecosystems, species or marine-based stressors unless they interact with freshwater and terrestrial ecosystems and species. Although there are objectives and strategies for riparian ecosystems adjacent to estuaries, there are no models or objectives that consider the complexity of the marine-freshwater-terrestrial system.

The NC uses ecosystem-based management to inform decisions and to design strategies that are likely to achieve objectives; hence it considers almost all of the ecological concepts and principles listed in Vold and Buffett (2008). The NC ecosystem-based model provides an excellent example of applying ecological concepts to conservation and planning in a co-management process over a large geographic area (Price et al. 2009). Along with background reports summarised in the Ecosystem-Based Management Handbook (EBMH) and HPG, the NC recognises all classes of ecosystem services and includes objectives that address all concepts except for invasive species. It also uses almost all planning applications, explicitly incorporating ecosystem-based management, adaptive management, risk assessment and science-based decision-making. It plans at multiple scales and provides clear objectives with explicit strategies. Background reports document the risk models used to design strategies and set targets. The major gap in the NC is the exclusion of climate change in risk models. Other gaps include exclusion of objectives for some ecosystems that were described in background documents (e.g. ocean spray forest, bogs and fens) and for connectivity along hydroriparian ecosystems from headwater to estuary.

Most LRMPs in BC have not included First Nations consultation. Many First Nations plan land-use on their territory: these plans may be subsequently incorporated into a Government-to-Government plan such as a Strategic Land-Use Plan Agreement (SLUPA). Government-to-Government plans for coastal First Nations (Coastal First Nations SLUPA, Metlakatla SLUPA, Kitsumkalum SLUPA, Kitselas SLUPA, Gitxa'ala SLUPA, Lax Kw'alaams SLUPA) take an ecosystem perspective. They take the NC as a starting point and include additional objectives and strategies for particular areas; hence they incorporate ecosystem concepts into planning.

Legal objectives included in the North Coast Ministerial Order (NCMO) are less consistent with ecological concepts. For example, the legal objectives rejected multi-scaled and flexible management approaches in favour of prescriptive, single target rules (e.g. stand retention changed from 15 – 70% to 15% retention) and morphed the definition of adaptive management into passive monitoring. The NCMO lost holistic multi-scaled concepts such as resilience and natural processes and added exceptions that increase uncertainty. The level of coarse filter representation, however, has increased since the interim 2007 agreement, ensuring closer consistency with ecological concepts despite these changes.

The KA applies only to a small portion of the Skeena Estuary on the Skeena Mainstem. This LRMP falls short of the NC in it application of ecological concepts to conservation and planning. It does not consider resilience or process as completely as does the NC. KA addresses many conservation concepts, as required by the LRMP planning framework, but contains few explicit targets. It does not base decisions on science or use ecosystem-based management; hence concepts may be empty and objectives not achieved. For example, although it claims to be piloting EBM in some undeveloped watersheds, "EBM"

consists solely of retaining 30% of the natural amount of old forest in these watersheds—a target described as a high-risk minimum in the NC. In addition, the Kalum SRMP notes that retention levels can be met outside the timber-harvesting-landbase, likely violating ecosystem representation.

Protected Area Plans

Protected area management plans are operational rather than strategic and hence, by design, include fewer ecosystem concepts. For example, a coarse/fine filter approach is less appropriate because, except for large protected areas, park plans generally provide fine filter management direction for particular values. Within the Skeena estuary, only the Kitson Marine Park MDS (KI) has been completed. KI is short and contains very few, general objectives (e.g. protect the park's ecological values)—the MDS document provides guidance in the absence of a full management plan. A draft plan is available for Lucy Island (LI); other conservancies await planning. The more recent LI includes more ecological concepts than KI, for example, considering invasive species and climate change. Protected area plans summarise values which can be embedded into larger strategic plans.

Strategic Marine Plans

Two high-level strategic marine processes, Pacific North Coast Integrated Management Plan (PNC), and the Marine Planning Partnership (MaPP) have completed draft plans for areas that include the Skeena estuary. Both plans describe ecological concepts and principles clearly. Both include few, very broad objectives. Under the goal of maintaining the integrity of marine ecosystems, PNC includes four well-articulated objectives that capture many coarse-filter ecological concepts. MaPP includes several general objectives to protect ecological components within and outside Marine Protected Areas. Neither PNC nor MaPP include specific objectives analogous to those in strategic terrestrial land-use plans; objectives to maintain marine ecological integrity are much broader, with many fewer explicit sub-objectives than are objectives to maintain hydroriparian and terrestrial ecological integrity. For example, hydroriparian objectives from coastal land-use plans separate out types of hydroriparian ecosystem by productivity and sensitivity; and terrestrial objectives separate stand-scale and ecosystem-scale functions. PNC aims to maintain ecosystem components, but does not describe the components. Similarly, MaPP gives little guidance for identifying values without further work to clarify "high ecosystem or social significance", although it does list some example habitats within strategies. Most MaPP objectives focus on management processes and resource-use activities rather than ecological values. The "themes" are frequently strategies to limit impacts (e.g. minimise pollution) rather than objectives (e.g. high water quality), and hence tend towards a standard management rather than ecosystem-based approach.

Neither PNC nor MaPP include targets, unlike the best strategic terrestrial plans. MaPP defines spatially-explicit zones, but otherwise, strategies in both plans are process- rather than target-based, simply describing how to design strategies: i.e. calling for further planning. Whereas terrestrial land-use plans provide targets for ecosystem representation (e.g. 70% of natural old forest for many ecosystems), MaPP does not. These plans suggest that either the information and models available for marine ecosystems are underdeveloped in comparison to knowledge available for terrestrial and freshwater ecosystems, and/or that agreement on targets given best currently-available knowledge is more challenging for these ecosystems. While there are few conceptual gaps in these plans, the lack of specific objectives and well-designed strategies is a gap that requires filling before the likelihood of achieving broad objectives can be assessed.

Species Plans

Some plans are fine-filter plans, considering a single species. The Wild Salmon Policy (WSP) initiated a move from managing salmon in isolation to considering them as part of functioning ecosystems. Hence,

it is consistent with many ecological concepts. The DFO annual Pacific Salmon Integrated Fisheries Management Plan (IFMP) is more operational and hence less consistent with ecological concepts in Vold and Buffett (2008). The IFMP focus on anthropogenic harvest of salmon limits consideration of ecological context. The IFMP does, however, provide links to relevant sources with objectives and strategies that address ecological concepts (e.g. SARA recovery plans and WSP itself). There is no IFMP for eulachon in the Skeena—a planning gap.

Human Community Plans

Community plans recognise provisioning and cultural ecosystem services, but do not generally base decisions on ecological concepts. Instead they focus on minimising or mitigating impacts to environmental values while optimising development. The Prince Rupert Official Community Plan (PR) describes elements considered essential for a high quality of life and provides a vision and indicators addressing the elements. The vision statements are essentially "objectives" related to particular values. This plan broadens the standard economic approach by considering processes and interactions that lead to a high quality of life as an overarching goal. Although the PR aims to improve quality of life, which opens the door to including regulating and supporting ecosystem services, it does not include associated strategies.

The Port Edward OCP has a more standard economic approach, and focuses on land use and associated jobs rather than processes and interactions. The considerable proposed development within the area is generally welcomed as providing a boost to the economy of the district. Ecological objectives are generally weak and summed by "protect the natural environment".

The Skeena-Queen Charlotte Regional District does not have a current growth strategy, and does not include any ecological concepts in their current planning priorities.

Industry Plans

The Prince Rupert Port Authority (PRPA) land-use plan is driven by the port's industrial partners, and hence does not reflect public consensus values. The plan only recognises cultural—primarily recreational—ecosystem services. The plan does not apply ecological concepts to conservation or planning, but follows the standard approach that considers ecosystem values as limits to development. There is little evidence that PRPA uses science to inform decisions of how much to limit. For example, it considers areas with moderate habitat as open for development and does not discuss potential impacts to adjacent areas. That the PRPA only included objectives and strategies in its plan following public review comments illustrates the lack of ecologically-based planning principles, as does a statement that the Port "does not anticipate any development on Kitson Island in the medium to long term"—suggesting that development on an established protected area is the realms of possibility. PRPA has committed to follow the Green Marine Objectives to minimise pollution and climate change impacts. These objectives require environmental baseline studies, which PRPA is planning.

Summary of gaps

Terrestrial land-use plans seem further along in the process of ecosystem-based management than do marine plans, while community and industry plans do little to consider ecological concepts. Some plans use the language of ecosystem-based management, but do not fulfill their promise. To develop EBM, marine plans will require modification of the terrestrial model, but can follow the same broad steps for general ecosystem function and focal species:

1. Set targets for minimum levels of undisturbed habitat (e.g. 60% for all ecosystem types with variation for productivity and vulnerability), considering natural disturbance and recovery. This requires
    a. A good classification of ecosystems (current description of habitat types within BCMEC ecosections—e.g. Okey et al. 2012—seems like a good start).
    b. Assessment of productivity, vulnerability, rarity and critical habitat for focal species
    c. Strategies that ensure that rare and/or critical habitat are fully protected and that other ecosystem have amount retained as undisturbed that increase with vulnerability
2. Include habitat that is secure from disturbance, displacement and mortality risk within this target
3. Maintain important features within altered habitat
4. Set precautionary harvest levels (considering cumulative effects).
5. Minimise anthropogenic mortality and stress (e.g. pollution, noise, collision) beyond harvest
6. Maintain prey (through sustainable anthropogenic harvest that considers other predators and through ecosystem representation)
7. Avoid increasing disease and introducing invasive species.

Without explicit targets, development will follow a shifting baseline. Without implemented targets, and supportive monitoring, there is no way to gather knowledge to confirm or improve management direction. Improving management requires a) clear objectives, b) strategies, including targets, designed to achieve objectives based on current knowledge, c) monitoring/adaptive management to determine effectiveness and d) feedback to managers. Many plans never get beyond "a)". The NC has achieved "b)". Reaching "b)" means designing targets based on incomplete knowledge. Very few processes have reached point "c)"; the Babine Watershed Monitoring Trust is a local-scale exception. Although terrestrial plans include sections that describe monitoring and adaptive management and promise updates as knowledge improves, the record is abysmal. Monitoring is not funded, and government lacks the appetite to re-open public processes. Actually changing management "d)" requires political power and is a wicked problem.

As well as missing targets, many plans are missing objectives for particular ecosystems (e.g. bogs and fens) and species, although it is difficult to assess these gaps in the marine plans as they lack sufficient detail (for example, they do not include objectives for eelgrass or kelp ecosystems, but likely will as planning develops). Many plans are missing objectives related to invasive species. Climate change is only included in recent plans—this gap means that risk models in the strategic terrestrial plans will need to be updated. The lack of integration among terrestrial and marine plans is another gap that will be challenging to fill.

A challenge to our analysis is that comparing ecological criteria (such as those listed in Vold and Buffett 2008, or from any other conservation planning document) to objectives does not give a full picture. Within plans, applications of conservation concepts are generally described by strategies rather than objectives; hence assessing gaps by reviewing broad objectives with no strategies can be problematic. We considered strategies informally as we compiled objectives from the documents; a formal examination and assessment of strategies was beyond the scope of this project.

References (Section One)

Carr-Harris, C. N., Gottesfeld, A. S., & Moore, J. (2014). Migratory bottlenecks as integrators of species-and population-level diversity: the Skeena River estuary, its salmon, and industrial development (No. e375v1). PeerJ PrePrints.

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Price K, Roburn A, MacKinnon A. 2009. Ecosystem-based management in the Great Bear Rainforest. Forest Ecology and Management 258:495-503. doi:10.1016/j.foreco.2008.10.010

Vold T and Buffett DA (eds). 2008. Ecological concepts, principles and applications to conservation, BC. 36pp. Available at www.biodiversitybc.org.

Section 2: Skeena Estuary Data

This section lists sources of information on historical and current status, provides a brief synopsis of historical trends, focusing on salmon, outlines human activities and stressors in the estuary, and develops draft knowledge models for salmon and eelgrass.

We interviewed key people and organizations (Table 3) to gather knowledge and references. We also searched for key words (Skeena, estuary, Prince Rupert) on the web and in the literature cited by the gathered references. We reviewed and annotated selected references (Appendix 4: separate file).

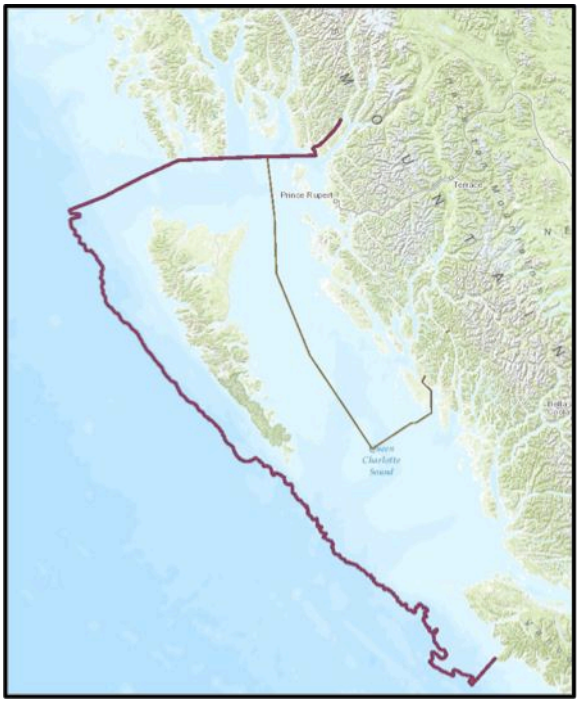
Table 3. List of contacts.

Name	Organization
Greg Knox	Skeena Wild, Terrace
Katrina Conners	Pacific Salmon Foundation, Vancouver
Jo Smith	Marine Planning Partnership for the North Coast (MaPP)
Craig Outhet (not reached)	North Coast First Nations Stewardship Society and MaPP
Kenny Rabnett (not reached)	Suskwa Research, Suskwa
James Casey and Mike Ambach	World Wildlife Fund—Canada, Prince Rupert
Richard Overstall	Buri-Overstall, Smithers
Rick Budhwa	Crossroads Cultural Resource Management, Smithers
Barb Faggetter	Ocean Ecology, Prince Rupert
Kevin Koch	Gitanyow Fisheries, Gitanyow

Sources of information

Information relevant to the Skeena estuary comes from a variety of sources including university-based research, local research and monitoring, Fishery and Oceans Canada (DFO) research and monitoring of salmon stocks and summaries of research by environmental non-government organizations (e.g., Pacific salmon Foundation, World Wildlife Fund, Canadian Parks and Wilderness Society, Living Oceans, Sierra Club, Skeena Wild).

Because estuaries lie at the interface between marine, freshwater and terrestrial ecosystems, information must reflect these ecosystems. Hence, information about the estuary comes from geographically broader studies of marine ecosystems and of the Skeena watershed as well as from finer-scale studies of the estuary itself (Figure 2 and 3).



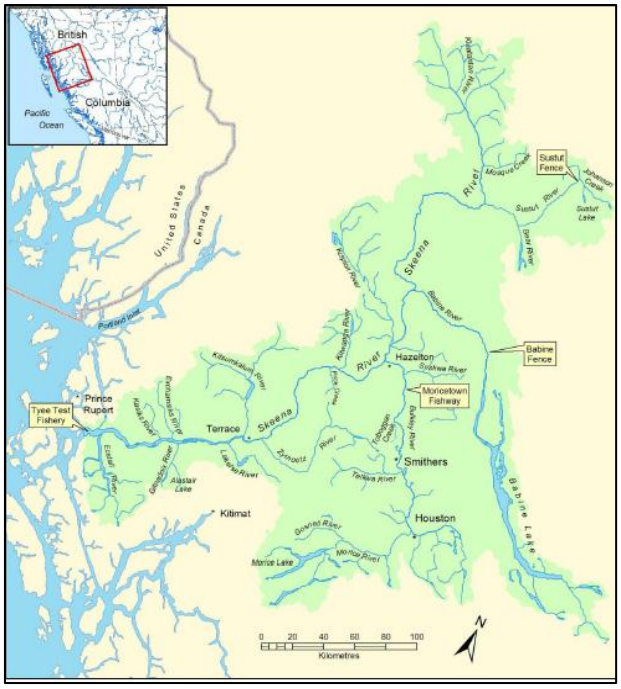


Figure 2 (left). Boundary of PNCIMA (red line) and Marine Planning Partnership for North Coast (brown line). Retrieved from MaPP Marine Planning Portal.

Figure 3 (right). Skeena watershed (Walters et al. 2008)

Marine Information Sources

Two recent, high-level planning processes have compiled information that encompasses the Skeena estuary:

- **PNC**: The collaborative (First Nations, federal and BC governments) Draft Pacific North Coast Integrated Management Area Plan (2013) responds to Canada's Oceans Action Plan (2005) by outlining a framework for ecosystem-based management for the North Pacific area. The PNC website (**www.pncima.org**) provides links to many useful references. **Lucas et al. (2007)** is the principle reference for the PNCIMA process.
- **MaPP**: The Marine Planning Partnership for the North Pacific Coast is a collaborative process between First Nations and the BC Government that aims to produce coastal and marine plans for sub-regions within the North Pacific. The North Coast sub-region includes the Skeena Estuary. Planning priorities include an ecosystem-based management approach that identifies protected areas and considers cumulative effects. The MaPP website includes a link to an interactive map of the North Coast via the Marine Planning Portal (**mappocean.org/science-and-planning-tools/marine-planning-portal/**).

Appendix 5 provides a list of mapped information that applies to the Skeena Estuary generated by PNC and MaPP.

Skeena Watershed Information Sources

Fisheries and Oceans Canada (DFO) and other organisations, including the Skeena Fisheries Commission, the Pacific Salmon Foundation, and Skeena Wild, provide information about the status of salmon stocks in the Skeena watershed.

- **Gottesfeld and Rabnett (2007)** provide a good overview of Skeena River salmon population trends and pressures on salmon habitat.
- The **Pacific Salmon Foundation website** (www.psf.ca) includes report cards and snapshots describing salmon stocks and their habitat.
- **DFO annual management plans** describe stock status and management issues (e.g., DFO 2013). In addition, the **DFO website** (www.dfo-mpo.gc.ca/index-eng.htm; see science and research) includes many older reports and a good search facility.

Skeena Estuary Information Sources

Much of the research in the Skeena estuary was or is related to development proposals. Early work identifies the Skeena estuary and Flora Bank as critical habitats (Hoos 1975).

- **Faggetter (2014 letter)** describes important salmon habitats, shows maps of the Flora Bank eelgrass beds and outlines threats faced by salmon in relation to development.
- **Gottesfeld et al. (2008)**, and **Carr-Harris et al. (2014)** (with Jonathan Moore, SFU) identify areas of high salmon density in the vicinity of proposed development.

Appendix 6 shows information by region and topic.

Overview of Historical Trends

Information in this section is excerpted from several important references (shown in **bold** text). Please refer to these documents for further information and references within.

Marine Trends

Major historical trends in the North Pacific noted in literature include

- Decline in salmon, herring and sardines due to over-fishing
- Decline in eulachon, potentially related to climate-change
- Loss and re-establishment of sea otters
- Decline in whales due to over-harvest
- Loss of foreshore habitat due to land conversion and forestry
- Pollution

Lucas et al. (2007) Appendix I describe trends in salmon: Salmon harvesting in the North Pacific boomed in the 1900s and has recently declined. Aboriginal harvest of Pacific salmon was substantial prior to European settlement, with harvest of 18K tonnes (about 5.2 million fish). Subsistence use of salmon by fur traders and settlers from the early to mid-1800s was small (likely <200 tonnes). By the late 1800s, a canned salmon industry boomed, with 20 canneries in 1880, increasing to more than 80 throughout the BC coast, and 14 on the Skeena, by 1917. By 1910 all five species of salmon and steelhead were included in steeply increasing catches. Annual salmon catch in the North Pacific peaked above 40K tonnes around 1928, fluctuated between 20 – 35K tonnes from 1930-1980 and peaked above 40K tonnes again in the mid-1980s. Catch declined steeply in the 1990s, attributable to a complex set of factors including changes to management to conserve overfished populations, environmental degradation in some and climate-induced declines in the productivity of marine and/or freshwater ecosystems.

Okey et al. (2012) describe herring, sardine and eulachon trends: Pacific herring have been heavily overfished in BC, including during a period of climate-related poor recruitment. Pacific sardines supported the world's largest fishery early last century, but collapsed likely due to cumulative effects of ocean variability and overfishing. Sardines were absent from Canadian waters for almost 50 years, until

1992. Eulachon populations have declined over the past 20 years in the central coast, possibly because spawning is impaired by a shift in timing of freshets from spring towards fall.

Lucas et al. (2007) Appendices F and J describe trends in sea otters: By 1929, sea otters were hunted to extirpation in BC. Around 1970, 89 sea otters were re-introduced to Vancouver Island. By 2001, over 2,500 sea otters lived along the west coast of Vancouver Island and over 500 on the central coast of the mainland. Habitat predictions suggest that that Lucy Island kelp beds in the Skeena Estuary will become inhabited with semi-permanent rafts of sea otters (Draft Lucy Island MDS). Sea otters are the keystone species in a well-documented relationship between sea urchins, sea otters (predator on sea urchins) and kelp beds.

Lucas et al. (2007) Appendix J describe trends in whales: Intensive commercial shore-based whaling took place in the North Pacific between 1910-1943, and 1948-1967 with long-term population-level consequences.

Lucas et al. (2007) Appendix C list pollution-related studies conducted by the Canadian Department of the Environment, by DFO and studies funded by the Province of BC on topics related to aquaculture.

Skeena Watershed Trends

Gottesfeld et al. (2002) and Gottesfeld and Rabnett (2007) may provide the most complete description of historical trends in the abundance of salmon species in the Skeena Watershed. They also describe anthropogenic and natural pressures. Appendix 4 provides an overview of Gottesfeld et al. (2002).

Price et al. (2013) describe historical returns in Skeena chum salmon. The estimated historical annual returns of Skeena chum (325K based on 1916–1919) are about ten times larger than estimates for 1982–2010 and about 40 – 50 times larger than those for 2007–2010. Intense harvest pressure is the most probable factor explaining the sustained decline.

Pacific Salmon Foundation, **Price (2012)** and **Price et al. (2014)** describe trends in Skeena sockeye (Figure 4) and potential effects of enhancement.

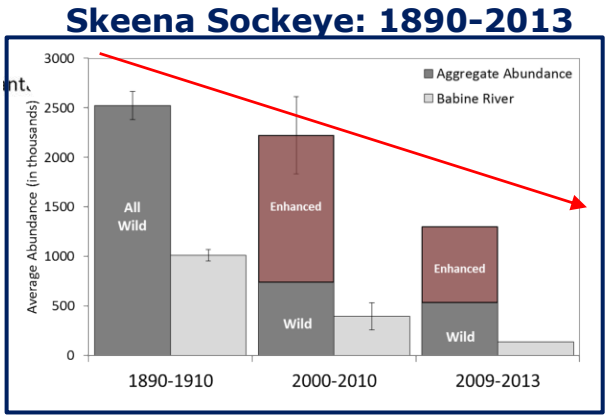


Figure 4. Decline in wild Skeena sockeye over time. Retrieved from Status of Skeena Sockeye Populations Poster (Pacific Salmon Foundation).

Cleveland et al. (2006) document a decline in salmon abundance from the Kitwanga River, a tributary of the Skeena River: Oral histories speak of salmon obscuring the bottom of Kitwanga River. Fishery inspector reports support the oral histories, with an estimated First Nations' harvest of 40K sockeye over 10 years (1935–1945). DFO staff estimated the 1945 run at greater than 6,000 and the 1946 run at about 4,000. A fence operation at the mouth of the Kitwanga River in 1959 suggested a run of about 5,000 sockeye. Elders recall that declines in salmon returns began in the 1960's and that most fishing sites were abandoned along the Kitwanga by the early 1970's.

Estuary Trends

Richard Overstall described early use of the Skeena estuary in an interview: The Skeena estuary was an important area for First Nations prior to contact. Archaeological work indicates that Metlakatla and Prince Rupert harbour were important village sites. Coastal First Nations harvested seaweed, seabird eggs and herring roe on kelp around the Tsimsian peninsula. The Tlingit First Nation harvested sea mammals from Dundas and Stephens Islands. Tsimsian and Tlingit First Nations travelled from Metlakatla and Dundas Island to fishing sites on the Nass River. The Nass supported the largest eulachon harvests, followed by the Kitlope and Kemano; fishing for eulachon in the Skeena is not recorded as a major use. Pre-contact salmon fishing in the Skeena occurred mainly outside of the estuary in canyons (e.g., Kitselas Canyon) and tributaries (e.g., Ecstall) that allowed the use of weirs. Post-contact development includes settlement, canneries, ports, railways, roads and a major pulp mill.

Faggetter (2014) describes the status of salmon shoreline habitat in the estuary. The northwest and southwest shores of Kaien Island and the southwest shore of Ridley Island are poor habitat for all salmonid species as a result of industrialization.

Gottesfeld and Rabnett (2007) and **Okey et al. (2012)** describe pollution and vulnerability, respectively. The Port Edward sulphite pulp mill, constructed in 1950, severely impacted water quality, with near sterilization of Wainwright Basin. In the 1970s, the mill was renovated to a Kraft process, which greatly decreased pollution problems. Dungeness crabs have been historically vulnerable to pulp mill pollution. **Greg Knox, Skeena Wild** suggested examining the potential toxicity of a train derailment in the estuary.

Current status

Pacific Salmon Foundation and ESSA Technologies provide report cards and snapshots that describe the status of salmon species and their habitats in the Skeena watershed. The Habitat Report Card for the Skeena Estuary provides maps of eelgrass and other habitats. The Habitat Report Card for the Skeena River Basin documents historic trends in flows for major rivers and shows trends in snowpack and glacier loss at selected locations. It shows escapement for major water bodies. Conservation Unit Snapshots describe trends in abundance and related habitat and survival information by salmon species and conservation unit; they describe development activities and risk for a set or pressure indicators.

WWF (2013) evaluates the health of the Skeena Watershed based on hydrology, water quality, fish and benthic macro-invertebrates. Lack of data limit some aspects of the assessment.

DFO annual reports describe the status and trends for salmon species and important management issues.

Faggetter (2014) describe important habitats for salmon in the Skeena estuary (at a finer scale than report cards): Flora Bank is excellent habitat for epibenthic feeding salmonid species (e.g., pink, chum, and Chinook). It is in the direct path of over 300 million juvenile salmon outmigrating from the Skeena River, of which about 279 million are epibenthic feeders. Stapledon Island is a high value habitat for all six salmonid species, and is also in the direct path of outmigrating Skeena River juvenile salmonids. The southwest shore of Lelu Island and Delusion Bay are highly valuable habitats for neritic feeding species (e.g., Coho, sockeye, and steelhead). The shoreline segments in the basins on the east side of Kaien Island and on southeast shore of Prince Rupert Harbour provide important nursery and rearing habitats for salmon outmigrating from the local natal streams.

Human Activities and Stressors

This section lists stressors to a variety of ecosystem components, and then provides a more detailed look at the pressures to salmon.

Stressors in the North Pacific

Clarke-Murray et al. (2012), in a pilot ecological risk assessment for the North Pacific, identify the human activities and stressors affecting significant ecosystem components (Table 4). The assessment clearly distinguishes human activities from the stresses they cause and lists major stressors. The broad scale of this assessment does not adequately address the current issues facing the Skeena estuary. Importantly,

Okey et al. (2012) list further references on stressors and assessment: Kimmel (2009); Ban and Alder (2008); Okey and Loucks (2011); Ban et al. (2010).

Table 3. Stressors, the significant ecosystem components they affect and the human activities that cause the stress (adapted from Clarke-Murray et al., 2012).

Stressor	Ecosystem components affected*	Human activities
by catch	cold water coral, sponges, spiny dogfish Dungeness crab, herring, prawn	trawling
habitat disturbance	cold water coral, sponges, geoduck clam lingcod, Dungeness crab, prawn, clam	trawling
sedimentation	cold water coral, sponges, geoduck clam Dungeness crab, clam	trawling
disruption of wildlife	Orca, humpback whale, Steller's sea lion	trawling, marine tourism
direct capture	salmon, herring	gillnet
debris	Cassin's Auklet	human settlement
acoustic	humpback whale, Steller's sea lion	large and small vessel use, ports
persistent organic pollutants	Cassin's Auklet, zooplankton, Orca, salmon	Long-range contamination
contaminants	Cassin's Auklet, seagrasses, zooplankton, Orca	human settlement, land-based activities
marine debris	Cassin's Auklet	Long-range contamination
invasive species	cold water coral, Dungeness crab, kelp, phytoplankton, seagrasses, zooplankton	large and small vessel use
--large-vessel invasives	cold water coral	marine tourism
--small-vessel invasives	sponges, kelp	shellfish aquaculture, trap
shading	kelp	shellfish aquaculture
change in freshwater flow	prawn	land-based activities
oil spill	Orca	large vessel
large-vessel oil	Orca	ports, marine tourism

*in approximate order of risk to component within each row

Land and marine plans identify additional stressors and related human activities including aquaculture, climate change, log booms, oil spills, contaminants, tourism, recreation, over-fishing, bycatch, entanglement, reduced prey, vessel strikes, disturbance/disruption and acoustic disturbance. Log booms, recreation, entanglement, reduced prey, vessel strikes and climate change add to the list in Table 4 above.

Faggetter (2014 Letter) identifies stressors including overwater structures, affecting juvenile fish, and acoustic impacts to non-mammal species.

Okey et al. (2012) review literature related to climate-related changes in marine ecosystems, and outline pathways by which climate affects organisms. They conclude that some commercially and culturally important species may undergo major changes in distribution and abundance, phenology (timing of migration or other seasonal patterns), and physiological condition or resilience.

Pressures on Salmon

Salmon are an obvious candidate for cumulative effects assessment for several reasons. They are critically important to First Nations' culture and the regional economy. They are an umbrella species that can indicate changes in the freshwater, marine and estuarine environments. Salmon need estuaries for a critical period of growth before leaving for the open ocean, and as a staging area where they await appropriate river conditions.

Nelitz et al. (2007a and b) and **Stalberg et al. (2009)** reviewed literature and engaged experts to develop indicators for assessing impacts to salmon within freshwater ecosystems and estuaries (Table 5). Nelitz et al. (2007a) uses concept maps to show linkages amongst indicators (Figure 5). The most recent paper (Stalberg et al., 2009) may have the most parsimonious set of indicators. These indicators do not cover stressors in the marine environment (e.g. fishing). Papers and recent work by the **Bulkley Valley Research Centre (Daust and Morgan 2014)** also describe stressors in freshwater ecosystems.

The **Pacific Salmon Foundation and ESSA Technologies** Skeena habitat report cards also outline pressures. The papers listed in Table 5 informed the selection of indicators. The Skeena Estuary Report Card outlines stressors including human activities (potential wind power tenures, harbour development, anchorages), and climate change (temperature, UV and acidification of surface waters and bottom habitats).

Table 4. Indicators with potential for use in assessing impacts to salmon in estuaries, based on Stalberg et al. 2009 (R1); Nelitz et al. 2007a (R2); Nelitz et al. 2007b (R3).

Type*	Pressure and status indicators	R1	R2	R3
S	resident fish			x
S	micro and macro algae		x	x
S	aquatic invertebrates		x	x
S	detrital organic matter			x
S	estuary habitat area			x
S	stream discharge into estuary			x
S	accessible off-channel habitat area			x
S	habitat area (riparian, sedge, eelgrass and mudflat habitats)	x		
S	eelgrass habitat extent		x	x
S	spatial distribution of wetlands/mudflats, and riparian vegetation		x	x
P	habitat disturbance	x		
P	foreshore habitat disturbance		x	x
P	inshore habitat disturbance		x	x
P	offshore habitat disturbance			x
P	riparian disturbance			x
S	chemistry and contaminants (water chemistry/quality)	x	x	x
P	waste discharge	x		
S	dissolved oxygen	x		
S	sediment		x	x
P	marine vessel traffic	x	x	x
P	invasives		x	x

*Indicator type refers to **S**tatus or **P**ressure, based on Nelitz et al. 2007b.

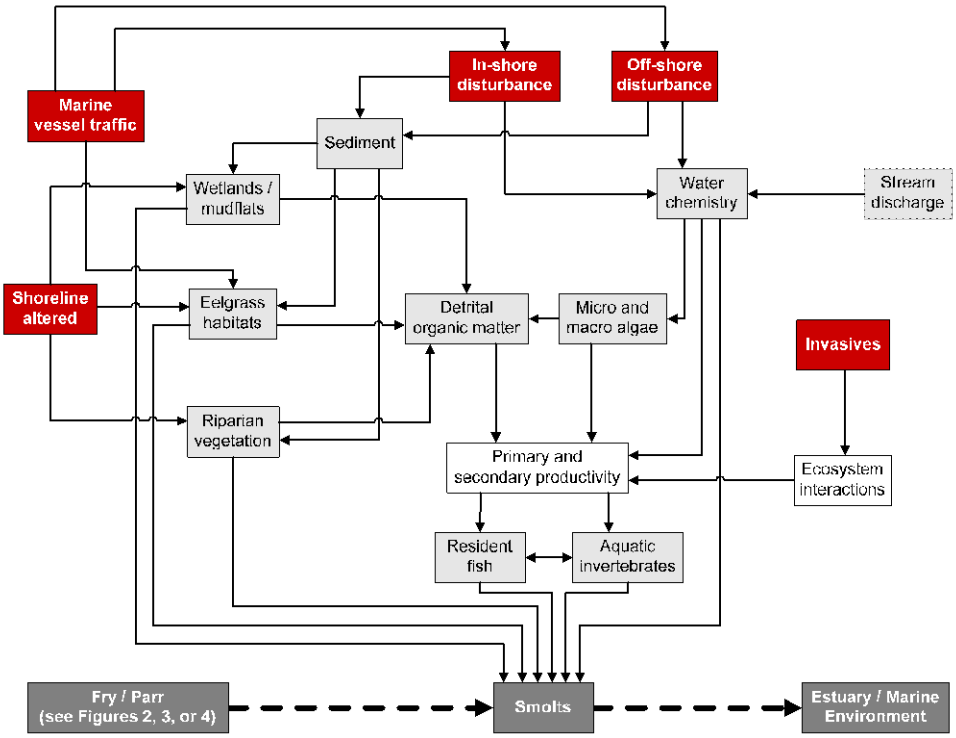


Figure 5. Summary of the linkages among habitat pressures (dark red boxes), habitat status (light grey boxes), and salmon life stages (dark grey boxes) in estuary habitats (Nelitz et al., 2007a).

The human activities and stressors described above provide a good basis for developing assessment models, but do not address the ecological and development context of the specific area.

Faggetter (2014 Letter) discusses the stressors faced by salmon and eelgrass ecosystems related to LNG facility development in the Skeena Estuary. We captured these stressors in draft knowledge maps for salmon and for the eelgrass ecosystems that salmon depend on (Figure 6 and 7). Direct stressors to salmon include increased toxins, increased turbidity, eelgrass habitat alteration and shoreline habitat alteration (including overwater structures). Eelgrass ecosystems may be altered directly by dredging, by erosion related to dredging and by sediment deposition related to port operation and potentially maintenance-dredging.

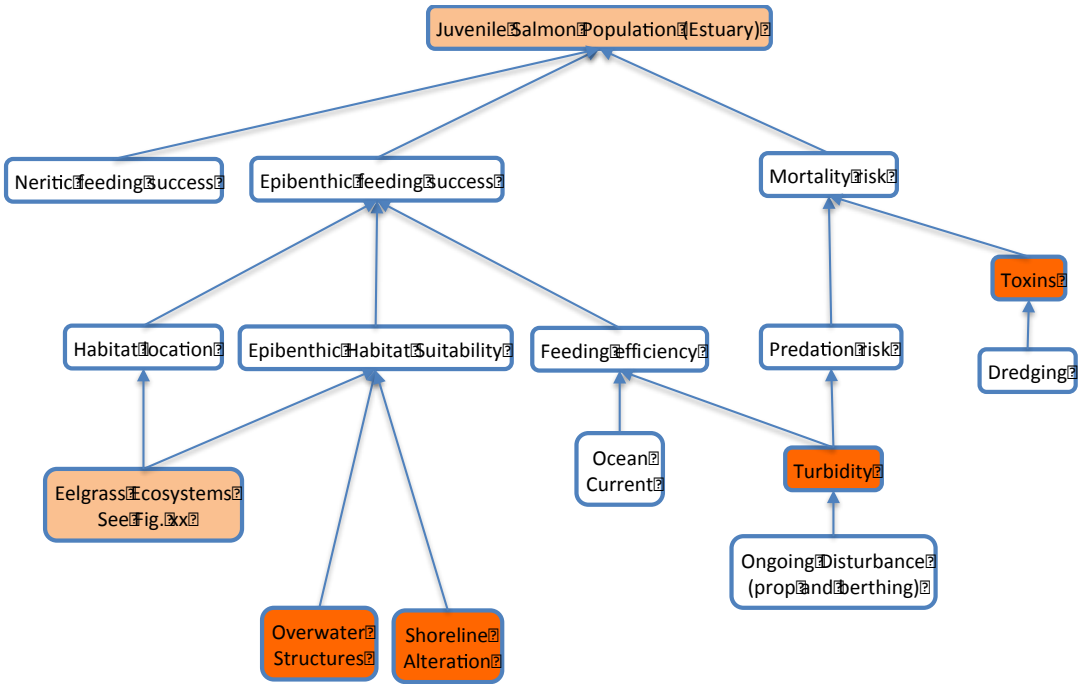


Figure 6. Draft knowledge model showing stressors faced by juvenile salmon in the Skeena estuary (based on Faggetter 2014 letter).

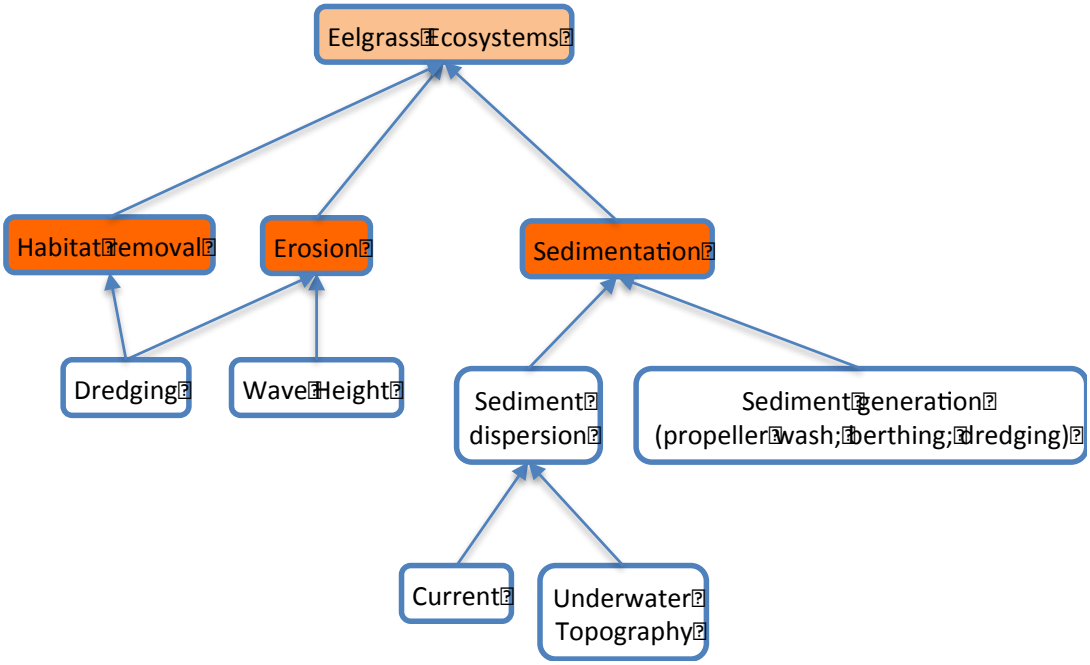


Figure 7. Draft knowledge model showing stressors faced by eelgrass ecosystems in the Skeena estuary (based on text of Faggetter 2014 letter).

Discussion

A series of questions helps to focus information gathering for ecological risk assessment of the Skeena Estuary:

1. What species, ecosystems and processes are valued by the public?
2. Which of these values are sensitive to pressures arising from existing and potential development?
3. What additional natural and anthropogenic pressures (e.g., from outside the estuary) affect the values identified as sensitive?

This report informs question one in relation to terrestrial and hydroriparian ecosystems, species and processes. Terrestrial plans provide specific objectives for some of the valued species and ecosystems associated with the Skeena estuary (e.g., grizzly bears). Marine plans do not yet provide sufficient detail—at least in their objectives—to list publicly-valued species and ecosystems. The MaPP process has an objective to protect habitat for species with high ecosystem and cultural significance, but only provides examples: including kelp forest, rocky intertidal, clam and cockle bearing beaches, salmon bearing streams, salmon, eulachon and herring spawning habitat, critical habitat for humpback whale, herring, macroinvertebrates, and benthic habitat (strategy 3.1 of MaPP Draft Plan); background documents for the strategic marine plans suggest additional important values to consider in assessment. In addition to the plans reviewed, two reports identify valued species and ecosystems. **Tesluk et al. (2012)** reports the ranked value of socioeconomic and environmental resources for the communities of Lax Kw'alaams, Prince Rupert and Terrace. **Mahboubi et al. (2014)** used local experts to generate maps of values for the North Coast. Similarly, in a pilot ecological risk assessment for PNCIMA, **Clarke-Murray et al (2012)** identify the following significant ecosystem components (based on importance assigned by ecologists rather than by society): phytoplankton, zooplankton, kelp, seagrass, cold-water coral, sponge, geoduck clam, Dungeness crab, prawn, salmon, spiny dogfish, lingcod, Pacific herring, humpback whale, resident orca, Steller's sea lion and Cassin's auklet.

Our review of references for this project allowed us to begin to address question two by subjectively assessing the sensitivity of selected values based on pressures associated with estuary development (Table 6). Salmon, eelgrass ecosystems, foreshore ecosystems and water chemistry (a coarse filter indicator related to ecosystem function) all face risk from existing and proposed estuary development. Resident orcas and grizzly bears rely heavily on salmon for forage and are thus sensitive to any impacts to salmon populations.

Table 5. Preliminary assessment of interactions among existing and proposed activities and selected values in the Skeena Estuary.

Activity	Stressor	Eelgrass habitat	Foreshore habitat	Salmon	Orca	Grizzly	Water quality
Port facility development	Habitat alteration	x	x				
Dredging	Habitat alteration	x					
Port use and dredging	Sediment	x		x			x
Overwater structures	Disturbance			x			
Vessels	Noise				x		
Vessels	Disturbance				x	x	
Dredging	Toxins in sediment				x	x	x
Secondary effect	Eelgrass alteration			x			
Secondary effect	Foreshore alteration			x			
Secondary effect	Salmon pop. decline				x	x	

This report begins to address question three by outlining pressures faced by salmon and by presenting knowledge models for salmon (salmon are obviously valued and sensitive). It also summarizes current status and historical trends for some salmon species. These models are intended to stimulate thought, rather than produce a definitive answer.

References (Section Two)

See Appendix 4.

Appendix 1: Validation Table

This appendix lists objectives included in management plans that apply to the Skeena Estuary and provides language from each plan for validation. Wording in the table may be slightly modified from the original plans for ease of reading.

Ecological Integrity

Level	Value	Depends on	Text from plan
1	Ecological integrity	Marine Ecological Integrity Hydroriparian Ecological Integrity Terrestrial Ecological Integrity	
2	Marine Ecological Integrity		
2	Marine ecological integrity	Water quality Species diversity Habitat	• Protect and sustain coastal zone aquatic ecosystems (EBMH p32) • Achieve integrity of marine ecosystems, primarily with respect to their structure, function and resilience (PNC p 25) • Conserve the productivity and trophic structure of ecosystems so their components can play their natural role in the food web (PNC p 27) • Mitigate negative cumulative effects that affect ecosystem components (PNC p 27) • Support the maintenance of natural resource systems that deliver marine goods and services at multiple scales (PNC p 28) • Protect important marine ecological components (MaPP p 5) • Minimize and mitigate ecological impacts of logging-related activities in marine areas (MaPP p4) (Stressor = log booms) • Minimize and mitigate the negative ecological impacts from aquaculture activities (MaPP p5) (Stressor = aquaculture) • Manage for ecological changes due to climate change (MaPP p 4) (Stressor = climate change) • Maintain … ecosystem integrity (WSP p9) • Respect environmental features within the Port's jurisdiction (PRPA p 56) • Each objective of the Canada/US Green Marine Environmental Stewardship program is met (PRPA p 56): reduce the risk of introducing and propagating aquatic organisms and harmful pathogens by means of ship's ballast water; reduce

			greenhouse gas and air pollutant emissions; reduce spills and leakages of dangerous chemicals into the environment (GMO) **Area-specific** • Protect **Kitson Park's** ecological values, [including] the …portion of **Flora Bank** within the park (KI p7-8). (Stressors = oil spill, recreation) • Protect identified Sensitive Natural Areas in **Port Edwards** including marine foreshore (PE p 19) • Maintain conservation …values of **Kennedy Island** (MA C p7)
3	Water quality		• Conserve water quality of the ecosystem (PNC p 27) • Minimize and mitigate ecological impacts of marine pollution (MaPP p4) • Protect marine and coastal values in the event of an oil spill (LI p23) • Each objective of the Canada/US Green Marine Environmental Stewardship program is met (PRPA p 56): reduce spills and leakages of dangerous chemicals into the environment (Green Marine objective) **Area-specific** • Protect marine and coastal values in the event of an oil spill in **Lucy Islands Conservancy** (LI p 23) (Stressor = oil)
3	Species diversity	See **Species Diversity**	• Conserve the diversity of species, viable populations and ecological communities and their ability to adapt to changing environments (PNC p 26)
3	Habitat		• Adjacent to high value fish habitat, maintain a reserve zone with an average width of 1.5 times the height of the dominant trees and do not alter or harvest the forest in the reserve zones (NCMO[3] p7); High value fish habitat includes … marine interface areas (shallow intertidal areas, kelp beds, herring spawning areas, and other nearshore habitats used by marine invertebrates for reproduction and rearing) (NCMO p2) • Maintain [wild salmon] habitat (WSP p9) • Conserve habitat of the ecosystem (PNC p 27) **Area-specific** • Protect eelgrass habitats/beds on **Lucy Island Conservancy** (LI p 23)
2	Hydroriparian Ecological Integrity		
2	Hydroriparian ecological integrity	Functional estuaries Functional fluvial ecosystems Functional lakes	• Sustain natural healthy ecological functioning of the complete range of hydroriparian ecosystems (NC p 77); See HPG for further guidance (NC p44) • Protect and sustain freshwater ecosystems (EBMH p32) • Protect critical and sensitive hydroriparian ecosystems (EBMH p42) • Maintain [wild salmon] habitat and ecosystem integrity (WSP p9)

[3] Wording differs between 2007 and 2009 NCMO. The table includes the amended wording, but refers to pages in the 2007 document (the amendment has no easy way to reference pages in context).

		and wetlands	**Area-specific** • Protect identified Sensitive Natural Areas in **Port Edwards** including steep slopes, floodplain, marine foreshore, lakes and streams, (PE p 19)
3	Functional estuaries		• Adjacent to high value fish habitat, maintain a reserve zone with an average width of 1.5 times the height of the dominant trees and do not alter or harvest the forest in the reserve zones (NCMO p7); High value fish habitat includes … estuaries (including eel grass beds and salmonid and eulachon rearing areas) (NCMO p2) • Maintain the natural ecological function of estuaries (CFN B p6, GX F p 6); low-risk target 0% reduction in the natural amount of old riparian forest within buffer (CFN B p6, GX F p6) (high-value fish habitat) • Maintain >90% of natural riparian forest next to estuaries (NC p47)
3	Functional fluvial ecosystems	Natural channel morphology Natural water quantity and hydrology Natural water quality	• Adjacent to high value fish habitat, maintain a reserve zone with an average width of 1.5 times the height of the dominant trees and do not alter or harvest the forest in the reserve zones (NCMO p7); High value fish habitat includes … wet floodplains (including main channel salmonid and eulachon spawning habitats and off channel habitat used for rearing and spawning) (NCMO p2) • Retain active fluvial units and retain 90% of the adjacent natural riparian forest in a [buffer] (NC MO p10) • Retain 90% of natural riparian forest adjacent to S1 – S3 streams (NC MO p8) • Maintain the natural ecological function of active fluvial units (CFN B p6, GXF p 6); Low-risk target < 10% reduction in the natural amount of mature and old riparian forest (CFN B p6, GX p6) • Reserve all active floodplains, active fluvial units and high value fish habitat including buffer (NC p48) • Maintain the natural ecological function of streams (S1 – S3) (CFN p6, GX F p 6); Low-risk target < 10% reduction in the natural amount of mature and old riparian forest (CFN B p6, GX F p6) • Maintain the natural ecological function of upland streams (CFN p6, GXF p6); Low-risk target < 30% reduction in the natural amount of functional riparian forest (CFN B p6, GX F p 6)
4	Natural channel morphology		• Maintain bank stability and channel integrity (NC MO p10) • Minimize potential for erosion and sedimentation (NC p95) • Maintain channel characteristics within range of natural variation (EBMH p42)
4	Natural water quantity and hydrology		• Sustain natural hydrological and fluvial processes (NC MO p 7) • Sustain natural hydrological and fluvial processes in the source zone (NC MO p 10) • Maintain water … quantity within the range of natural variability (NC p 75) • Maintain water … quantity within the natural range of variability in identified anadromous fish-bearing and/or sensitive watersheds (CFN B p5, GX F p5) • Avoid development that simultaneously modifies both sides of streams (NC p 75) • Maintain hydrological stability (KA p60) • Maintain < 20% ECA for the watersheds in Schedule 3 (NC MO p7)
4	Natural water quality		• Maintain natural water quality within the range of natural variability (NC p 75) • Consider activities that create risk of erosion and slope failure (NC p 75) • Protect unstable slopes (EBMH p42) • Maintain water quality within the natural range of variability in identified anadromous fish-bearing and/or sensitive

			watersheds (CFN B p5, GX F p5) • Manage resource development activities to minimize negative impacts on surface and ground water quality (KA p59) • Maintain or enhance water quality and minimize water pollution (KA p62)
3	Functional lakes and wetlands		• Retain 90% of natural riparian forests…around lakes > 1 ha (NC MO p8) • Maintain the natural ecological function of lakes (CFN B p6, GX p6); Low-risk target < 10% reduction in the natural amount of forest within buffer (CFN B p6, GX p6) • Retain 90% of the natural riparian forest in [buffers] adjacent to … wetlands … > 1 ha (NC MO p8) • Maintain the natural ecological function of wetlands (CFN B p6, GX p6); Low-risk target < 10% reduction in the natural amount of forest within buffer (CFN B p6, GX p6) • Maintain the natural ecological function of forested swamps (CFN B p6, GX p6); Low-risk target < 30% reduction in the natural amount of riparian forest (CFN B p6, GX p 6) • Retain forested swamps > 1ha…and retain 70% of the natural riparian forest in a buffer (NC MO p8)
2	Terrestrial Ecological Integrity		
2	Terrestrial ecological integrity		• Maintain ecological integrity (NC p43); Apply provisions of the EBM Handbook and Hydroriparian Planning Guide (NC p44) • Maintain the natural diversity of species, ecosystems and seral stages (EBMH p32) • Preserve the integrity of ecological values and physical features in areas used for tourism (NC p147) Stressor = tourism **Area-specific** • Protect **Kitson Park's** ecological values, [including] the natural values of a small outer coast island, significant wildlife species and their habitats (KI p7-8). Stressors = oil spill, recreation • Maintain conservation values within **Kennedy Island PA** (GX E p5) • Protect the natural environment in **Port Edwards** (PE p5) • Protect and maintain healthy populations of flora and fauna on **Lucy Islands Conservancy** (LI p 23); Ensure recreational use of **Lucy Islands Conservancy** does not unduly impact the flora and fauna values (LI p 28)
3	Ecosystem representation	Rare ecosystems Old forest	• Manage the amount of early seral … in a manner that is generally consistent with natural disturbance (CFN B p7, GX F p7) • Conserve the diversity of … ecological communities and their ability to adapt to changing environments (PNC p 26) • Maintain a range of seral stages across the landscape (KA p34); • Maintain a diversity of habitats (KA p99) • Maintain a frequency distribution of seral stages …consistent with the natural disturbance regime (NC p91) • Design harvest to approximate natural disturbance pattern and distribution (EBMH p41)
4	Rare and sensitive ecosystems		• Maintain the structural and functional integrity of red-listed and selected blue-listed plant communities (CFN B p8, GX F p8) • Maintain the structural and functional integrity of rare ecosystems (NC p92) • Maintain the structural and functional integrity of karst ecosystems (NC p94) • Protect known red- and blue-listed and regionally rare ecosystems (EMBH p23)

4	Old forest		• Maintain representation of old forest ecosystems (CFN B p7; NCMO p11) [amount retained varies from >30 – >70% by ecosystem] • Maintain representation of old forest ecosystems by site series and/or surrogate (NC p90) • Maintain site series/old seral representation (EBMH p41) • maintain old growth forest attributes (KA p 36) • Maintain old seral stage forest within each undeveloped watershed listed [target 30% of natural] (KAS p10)
3	Diverse stand structure		• Retain forest structure and diversity at the stand level (CFN B p8) • Provide or restore important structural attributes (KA p38) • Maintain structural diversity in managed stands by retaining wildlife tree patches [target 0 – 11%] (KAS p15) • Promote the recovery of structural and functional characteristics of old forest (NC p90) • Retain sufficient structural attributes within harvested areas to maintain substantial habitat quality (NC p93) • Maintain biological legacies (e.g. wildlife tress, snags, CWD, understory vegetation; EBMH p52)
3	Biodiversity	See **Species Diversity**	
3	Connectivity		• Maintain mature and old forest linkages within and between hydroriparian and upland areas (NC p91) • Maintain ecosystem connectivity (NC p81) • Reserve key wildlife migration/movement corridors (NC p91) • Maintain linkages and connectivity (KA p99) • Minimize potential problems of fragmentation of habitats and populations (KA p37)
2	Species Diversity		
2	Species diversity		• Conserve the diversity of species, viable populations and ecological communities and their ability to adapt to changing environments (PNC p 26) • Sustain First Nations' traditional resources (wild plant foods, botanical medicines, wildlife etc.) (CFN B p3, GX F p3) • Conserve the natural species abundance and diversity (KA p 37) • Enhance or restore lowered biodiversity values where appropriate (KA p39) • Maintain naturally occurring species and their habitats including plan communities (KA p97) • Conserve vulnerable species and their habitat and plant communities (KA p98) • Maintain the natural biodiversity including the full range of functional and healthy ecosystems (KAS p5) • Allow the ecosystem processes on islands to continue within their natural range of variability (NC p94) **Area-specific** • Protect **Kitson park's** ecological values, [including] … significant wildlife species and their habitats (KI p7-8). Species include salmon, waterfowl, harbour porpoises, humpback whales, orcas and Dall's porpoises. Stressors = oil spill, recreation
3	Rare and focal species (molluscs, fish, turtles,	Seabirds Whales	• Maintain healthy, well-distributed populations and subpopulations of focal species (EBMH p32); protect known red- and blue-listed and regionally rare species (EBMH p32) • Prevent wildlife species from being extirpated…and provide for the recovery (SARA)

	seabirds, sea mammals)	Grizzly bear Black/Kermode bear	• Minimize exposure of Steller Sea Lions to pollutants; minimize exposure to acute sound levels; minimize anthropogenic prey limitation (SARA MP p34) • Follow shark code of conduct (IFMP p 46) Stressor = bycatch, entanglement • Maintain all known goshawk nest area and post-fledging areas (NC p135); maintain sufficient foraging habitat (NC p135) • Maintain the Rougheye Rockfish and Blackspotted Rockfish population ranges (SARA MP p34) • Increase density of wild northern abalone to sustainable levels (SARA RS p 14) **Area-specific** • Re-establish abalone in **Lucy Islands Conservancy** (LI p23)
4	Seabirds		• Maintain the quantity and quality of marbled murrelet nesting habitat (NC p121) • Maintain quantity and quality of optimal [marbled murrelet] nesting habitat in core areas (NC p121) • Retain 68% of suitable nesting habitat (SARA RS p22) • (Stressor = salmon gill net fishing (IFMP p 50)) **Area-specific** • Protect seabird habitat in **Lucy Islands** (MA C p8) • Protect seabird habitat in **Lucy Islands** from damage (LI p22); prevent lights that disorient rhinoceros auklets (LI p 22); prevent introduction and/or increase in populations of auklet predators (LI p 23) • Ensure recreational use of **Lucy Islands Conservancy** does not unduly impact the rhinoceros auklet values (LI p 28)
4	Whales		• Ensure the long-term viability of resident killer whale populations (SARA RS p47); ensure that resident killer whales have an adequate and accessible food supply to allow recovery (p48); ensure that chemical and biological pollutants do not prevent the recovery of resident killer whale populations (p49); ensure that disturbance from human activities does not prevent the recovery of resident killer whale (p50); protect critical habitat and identify additional potential areas (p51) (Stressors = contaminants, oil spills, reduced prey, disturbance, underwater noise) • Maintain, at minimum, the current abundance of humpbacks; observe continued growth of the population and expansion into suitable habitats (SARA RS piv) (Stressors = entanglement, vessel strike, acoustic disturbance, prey reduction) •
4	Black/Kermode bear population		• Maintain adequate foraging habitat and critical denning habitat for black/Kermode bears (NC p84) • Minimize impacts to black/Kermode bears from land, water and air based wildlife viewing (NC p85) • Prevent black/Kermode bear mortality resulting from negative bear-human interactions (NC p87) •
4	Grizzly bear population	Grizzly bear habitat	• Bear mortality from all human causes will not exceed 4% of the estimated population (KA p76) • Minimize mortality risk to bears related to motorized road access (NC p110) • Minimize road-induced displacement and mortality risk of bears within or adjacent to critical habitats (NC p111) • Minimize impacts to bears from wildlife viewing (NC p113) • Prevent bear mortality resulting from negative bear-human interactions (NC p116)

			Area-specific • Minimize disturbance to bears in **Sommerville** (MA C p1)
5	Grizzly bear habitat		• Protect grizzly bear critical habitat (CFN B p9, GX F p9) • Maintain or restore grizzly bear habitats in identified watershed (KA p71); protect critical stand-level patch habitats (KA p74) • Maintain landscape level forage supply (NC p111) • Maintain integrity of and linkage amongst critical grizzly bear habitats (NC p112) **Area-specific** • Maintain the quantity and quality of grizzly bear habitat in **Sommerville** (MA C p1)
3	Wildlife habitat		• Protect known critical wildlife habitat features (NC p95) • Maintain adequate and sufficiently distributed habitat to maintain healthy populations and individuals of red-and blue-listed and focal species (EBMH p42) • Conserve habitat (PNC p 27) • Protect marine habitat for species valued for high ecosystem and cultural significance (MaPP p 5) • Improve habitat around priority areas that have been impacted by marine-related pollution (MaPP p5) • Activities within the Port's jurisdiction with high habitat value reflect at least minimum baseline levels (PRPA p 56)
3	Sustainable fish populations	Sufficient fish habitat	• Restore and maintain healthy and diverse salmon populations and their habitats (WSP p 8) • Safeguard the genetic diversity of wild Pacific salmon (WSP p9) • Manage fisheries for sustainable benefits (WSP p9) • Maintain sustainable stocks of Skeena River Sockeye that meet Wild Salmon Policy objectives and support First Nations food, social and ceremonial requirements, commercial and recreational harvests (IFMP p 54). Stressor = catch • Rebuild Skeena chum and improve Skeena chum stock status (IFMP p 151). Stressors = catch • Continue conservation strategies that will ensure stock rebuilding over time for inshore rockfish (Rockfish Conservation Areas) (IFMP p 57) • Protect and restore freshwater fish populations (NC p 228) • Maintain healthy populations/sub-populations of harvested fish (EBMH p34) • Maintain high quality fish habitat in watersheds with abundant salmon and sustain adequate levels of adult returns and population age structure of aquatic species (NC p 228) • Limiting access may be important to maintain local fish populations (NC p 228) • Minimise effects of development activities on fish populations (KA p55) • Manage existing populations of vulnerable and/or distinct fish stocks and species for their healthy perpetuation (KA p56) • Enhance fisheries sustainability and viability (MaPP p6)
4	Productive fish habitat	See **hydroriparian ecological**	• Protect and restore freshwater fish … habitats (NC p 228) • Maintain the integrity of salmon habitat in watersheds that are of cultural importance to the Gitxaala (GX E p3) • Maintain the diversity of salmon habitat (KA p44) • Minimize effects of development activities on fish habitat (KA p55)

		integrity	• Conserve habitat and water quality of the ecosystem (PNC p 27) • Maintain [wild salmon] habitat and ecosystem integrity (WSP p9) • Adjacent to high value fish habitat, maintain a reserve zone with an average width of 1.5 times the height of the dominant trees and do not alter or harvest the forest in the reserve zones (NCMO p7); High value fish habitat includes estuaries, wet floodplains and marine interface areas … (NCMO p2) • Adjacent to high value fish habitat, where …forest has been previously altered, recruit functional riparian forest (NC MO p7) • Maintain the natural ecological function of streams, lakes, wetlands, and estuaries classified as high-value fish habitat (CFN B p6, GX F p6); Target 0% reduction in the natural amount of old riparian forest (CFN B p6, GX F p6) • Maintain the productive capacity of all high-value fish habitat (NC p76); Upslope forested habitat may be important to maintaining productive capacity (NC p 76) • Protect marine habitat for species valued for high ecosystem and cultural significance (MaPP p 5) • Improve habitat around priority areas that have been impacted by marine-related pollution (MaPP p5) • Minimize and mitigate negative ecological impacts to fish habitat (MaPP p6) • Activities within the Port's jurisdiction with high habitat value reflect at least minimum baseline levels (PRPA p 56) • **Area-specific** • Maintain the productive capacity of fish habitat in **Baker Inlet** (MA C p4, KM C p10, KS C p11, GX E p1) • Protects important salmon habitat on **Flora Bank** (KI p2)

Stable Resilient Communities

Level	Value	Depends on	Text from plan
	Stable Resilient Communities		
1	Stable resilient communities	Cultural heritage High quality of life Sustenance opportunities Economic diversity Well-managed growth Participation in planning Functioning ecosystems (ecological integrity)	• Promote human well-being (NC p43) • Sustain cultures, communities and economies within the context of healthy ecosystems (NC p43) • Promote stable or growing population in North Coast Plan Area (CFN C p3, GX G p3) • Support an economically and ecologically sustainable and viable forest sector … that promotes stability and long-term benefits to local communities (NC p180) • Empowered and healthy communities (NC p64)
2	Cultural heritage	See **Cultural Heritage**	
2	High quality of life	See **High Quality of Life**	
2	Sustenance opportunities	Wildlife Botanical medicines Wild plant food Marine resources	• Sustain First Nations' traditional resources (wild plant foods, botanical medicines, wildlife etc.) (CFN B p3, GX F p3) • Enhance First Nations food security (MaPP p6) •
3	Sustainable marine resources		• Increase First Nations and local community access to marine resources (MaPP p6)
3	Sustainable fish populations	See **Ecological Integrity**	• Maintain consumptive and non-consumptive uses of fish (KA p56)
3	Sustainable wildlife populations	See **Ecological Integrity**	• Maintain consumptive and non-consumptive uses of wildlife (KA p99)
3	Sustainable botanical forest products	See **Economic Diversity**	
2	Economic diversity	See **Economic Diversity**	
2	Adaptability to climate change		• Reduce community vulnerability to climate change impacts and support community resilience (MaPP summary p4) • Manage for impacts to cultural and social and economic changes due to climate change (MaPP p4) • Commit to climate action in **Prince Rupert** (PR p19); reduce consumption in **Prince Rupert** (PR p49) • Reduce **Port Edward's** carbon footprint (PE p 19)

			• Meet each objective of the Canada/US Green Marine Environmental Stewardship program in **Port Authority Jurisdiction** (PRPA p 56): reduce greenhouse gas and air pollutant emissions (Green Marine objective) • Adapt to changes in fisheries and aquaculture systems due to climate change (MaPP p4) Stressor = climate change •
2	Local participation in planning		• Provide avenues for meaningful consultation or engagement for all significant development projects (PRPA p 57) • Empowered and healthy communities (NC p64) • Expand on opportunities to address community needs (NC p176)
2	Well-managed growth		• Effectively manage growth in **Port Edwards** (PE p 14)
2	Ecological integrity	See **Ecological Integrity**	
2	Cultural Heritage		
3	Cultural heritage resources and features	Archaeological sites Traditional use areas and activities Culturally modified trees	• Protect culturally and spiritually important marine customs, practices, traditions, areas, sites and cultural resources (PNC p 28) • Maintain the integrity of First nations' cultural heritage resources (CFN B p3, GX F p3) • Protect important cultural components and First Nations values (MaPP p4) • Protect heritage resources and archaeological sites (MaPP p6) • Respect cultural and archaeological features within the Port's jurisdiction (PRPA p 56) • Avoid or mitigate known cultural and heritage features (PRPA p 56) • Conserve selected cultural heritage resources (KA p51); minimize negative impacts to cultural heritage resources (KA p51) • Protect heritage and cultural resources (NC p101) **Area-specific** • Preserve…major First Nations' cultural features from development in **Baker Inlet** (KM C p10, KS C p11, MA C p4, GX E p1) • Maintain cultural heritage features and values in **Kinahan, Lawyer and Rachael Islands** (MA C p3 • Maintain cultural heritage values within **Port Essington** (KM C p 11, KS C p12, MA C p6, GX E p3) • Maintain the integrity of herring egg gathering camp at **Island Point** (Porcher Island) (KM C p11, KS C p12, MA C p9, GX E p6) • Maintain cultural heritage values of **Kennedy Island** (MA C p7, GX E p5) • Maintain the integrity of cultural/archaeological values at **Digby Island** (MA C p9) • Maintain the integrity of archaeological sites and cultural areas in **Porcher Inlet** (GX E p6) • Celebrate arts, culture and heritage in **Prince Rupert** (PR p14) • Protect **Port Edwards'** heritage facilities (PE p 5) • Maintain Coast Tsimshian cultural values including heritage features and archaeological sites on

			Lucy Island Conservancy (LI p 25) • Foster Coast Tsimshian social, ceremonial, economic and cultural uses that are compatible with biological diversity and the natural environment in **Lucy Islands Conservancy** (LI p 26) • Maintain the historic status of **Lucy Island** light (LI p 27) • Ensure recreational use of **Lucy Islands Conservancy** does not unduly impact the archaeological values (LI p 28)
4	Archaeological sites		• Protect … archaeological sites (MaPP p6) • Respect … archaeological features within the Port's jurisdiction (PRPA p 56) • Maintain the integrity of archaeological values at **Digby Island** (MA C p9) • Maintain the integrity of archaeological sites … in **Porcher Inlet** (GX E p6)
4	Culturally modified trees		• Protect culturally modified trees (CFN B p5)
4	Traditional use areas and activities	Botanical forest products Cedar Sustainable fishing Marine harvest opportunities Wildlife	• Sustain First Nations' traditional resources (wild plant foods, botanical medicines, wildlife etc.) (CFN B p3, GX F p3) • Sustain cultural/traditional resources (cedar, foods, medicines and other plants and animals) for First Nations' domestic use (CFN C p3, GX F p3) • Protect First Nations use of territories and resources for community benefit (MaPP p6) • Protect First Nations uses and values from the impacts of aquaculture activities (MaPP p 5) • Maintain trapping opportunities (KA p87) • Maintain integrity of First nations' traditional use resources, sites, and cultural landscapes (NC p103) • Protect and improve understanding of Aboriginal fisheries (MaPP p6) **Area-specific** • Maintain opportunities for sustenance and traditional activities in **Kinahan, Lawyer and Rachael Islands** (MA C p3) • Maintain opportunities for sustenance and traditional activities (kelp harvest) in **Stephens Island** PA (GX E p4, MA C p7) • Maintain the integrity of First Nations traditional use sites and cultural landscapes on **Digby Island** (MA C p9) • Maintain the integrity of First Nations traditional use sites and cultural landscapes on **Island Point and Arthur Island** (MA C p9, KM C p11, KS C p12) • Maintain the integrity of First Nations traditional use sites and cultural landscapes on **Porcher Inlet** (KM C p11, KS C p12) • Provide for and promote Coast Tsimshian traditional and sustenance uses and harvesting activities on **Lucy Islands Conservancy** (LI p 26)
5	Cedar		• Conserve monumental cedar for First Nations' cultural use (CFN B p3, GX F p2) • Maintain a supply of cedar for cultural/social purposes (CFN B p4, GX F p2) • Retain cedar within harvest units (CFN B p4, GX E p2)

5	Sustainable fishing opportunities		• Manage fisheries to ensure that, after conservation… First Nations' food, social and ceremonial requirements and treat obligations have first priority in salmon allocation (IFMP p 58) • Maintain sustainable stocks of Skeena River Sockeye that meet Wild Salmon Policy objectives and support First Nations food, social and ceremonial requirements, commercial and recreational harvests (IFMP p 54). Stressor = catch •
5	Sustainable botanical forest products	See **Economic Diversity**	
5	Sustainable marine resources	See **Economic Diversity**	
5	Sustainable wildlife populations	See **Ecological Integrity**	
2	High Quality of Life		
2	High quality of life	Clean air High quality water Diverse recreational opportunities High quality recreational values Sustainable fishing opportunities Access to waterfront Public safety	• Improve the standard of living and quality of life (NC p176) • Retain the distinctive natural character of **Prince Rupert** (PR p 19) • Protect and develop diverse public places in **Prince Rupert** (PRCOP p19) • Ensure that the interests of **Port Edward** residents are considered regarding the development of Prince Rupert Port Authority lands (PE p 38) • Meet each objective of the Canada/US Green Marine Environmental Stewardship program in **Port Authority Jurisdiction** (PRPA p 56): reduce the amount of noise, dust, odour and light to which people residing close to port facilities are exposed (Green Marine objective)
3	High air quality		• Ensure clean air in **Prince Rupert** (PR p19); Good air quality is an essential quality of life attribute (PR p 3) • Meet each objective of the Canada/US Green Marine Environmental Stewardship program in **Port Authority Jurisdiction** (PRPA p 56): reduce greenhouse gas and air pollutant emissions; reduce the amount of noise, dust, odour and light to which people residing close to port facilities are exposed (Green Marine objectives)
3	High water quality		• Ensure quality water in **Prince Rupert** (PCOCP p 19); Good drinking water and a clean harbour are essential quality of life attributes (PR p 3) • Meet each objective of the Canada/US Green Marine Environmental Stewardship program in **Port Authority Jurisdiction** (PRPA p 56): reduce spills and leakages of dangerous chemicals into the environment (Green Marine objectives) • Minimize negative impacts on surface and ground water quality (KA p59)

3	Diverse recreational opportunities		• Manage for a wide range of outdoor recreational activities and experiences (KA p78) • Provide opportunities for outdoor recreation through the development of new infrastructure such as trails and sites (KA p79) • Support a wide range of outdoor recreational activities and experiences (NC p129) • Maintain and enhance non-commercial recreation opportunities (NC p183) **Area-Specific** • Opportunities for physical activity and protection of natural areas and landmarks are essential quality of life attributes in **Prince Rupert** (PR p3) • Maintain park, recreation and community facilities in **Port Edwards** (PE p5) • In development of waterfront areas especially the **shoreline of Ridley Island** create, where possible, within the framework of security and safety, provision for public access to section of waterfront (PRPA p57) • Promote recreation opportunities and access along **Highway 16** (NC p132)
3	High quality recreational values	High visual quality Wilderness values Sustainable fishing opportunities	• Manage for a quality angling experience on classified waters (KA p 57) • Protect the quality of recreational experiences including visual quality and an abundance of fish and wildlife (NC p129) **Area-Specific** • Protect **Kitson Marine Park's** recreational values, [including] a destination for kayakers and boaters, a sandy beach, angling opportunities, SCUBA diving and scenic viewing. (KI p 2, 8)Stressors = oil spill, recreation • Maintain recreation values of **Kennedy Island** (MA C p7, GX 3 p5) • Maintain the quality of the recreation experience in **Sommerville** (MA C p1) • Maintain the quality of the recreation experience in **Kinahan, Lawyer and Rachael Islands** (MA C p3) • Maintain quality of wilderness recreation experience on **Lucy Islands Conservancy** (MA C p8; LI p 28)
4	High visual quality		• Maintain visual resources of importance to recreation/tourism (KA p86) • Retain existing scenic values in areas of importance to communities (KA p95) • Maintain the quality of visual experiences (NC p170) **Area-Specific** • Maintain … a wild scenic experience in **Sommerville** (MA C p1) • Retain pristine viewscapes along Highway 16 and 599R transportation corridors in **Port Edwards** (PE p 19)
4	Wilderness values		• Maintain a semi-primitive recreation experience in **Kinahan, Lawyer and Rachael Islands** (MA C p3) • Protect the quality of recreational experiences including visual quality and an abundance of fish

			and wildlife (NC p129)
4	Sustainable fishing opportunities		• Manage fisheries for sustainable recreational and commercial benefits (IFMP p 58) • Provide a range of opportunities for consumptive and non-consumptive use of fish (KA p56) **Area-Specific** • Protect **Kitson Park's** recreational values: Recreational fishers intensely fish the area for salmon, halibut and Dungeness crabs (KI p2, 8). Stressors = oil spill, recreational use
4	Access to waterfront		• Recognize access to waterfront as an essential quality of life element in **Prince Rupert** (Waterfront E LUP p 21)
4	Public safety		• Promote safety in **Prince Rupert** (PR p 33); Public safety is an essential quality of life attribute (PR p 3) • Improve the effectiveness of emergency management for the Region (SQC RD p4) • Protect life and property from hydrological events (e.g. plans for settlement on floodplain) (KA p61)
2	Economic diversity		
2	Economic diversity	Corporate contributions to community Business and employment opportunities	• Support First Nations and local communities in benefitting from the ecosystems in which they live (PNC p 30) • Create more stable and sustainable First Nations and local community marine-based economies (MaPP p6) • Support sustainable economic opportunities, livelihoods and economic diversification among ocean-related businesses, industries and coastal communities (PNC p 28) • Retain a diverse economy and jobs close to home in **Prince Rupert** (PR p25); an improved local economy that benefits the people who live here is an essential quality of life attribute (PR p 3) • Encourage a diversified, local economy (PE p5); increase local employment opportunities (PE p5) • Enhance the diversity of large and small scale commercially viable businesses (NC p177)
3	Corporate contributions to community		• Advocate for more revenue sharing for our communities based on the natural resources that are being extracted from the area (S-QC RD priorities p2) • People have a fair share of the benefits from the ecosystems in which they live (NC p44) • Increase the flow of benefits to local communities from resource rents (NC p177) • Increase the flow of economic benefits to First Nations (NC p178) • Provide for economic benefits for First Nation governments from mineral, aggregate and energy development (NC p179)
3	Business and employment opportunities	Sustainable fishing Shellfish aquaculture Marine resources Botanical forest products	

4	Sustainable fishing		• Increase local economic benefit from sustainable fishing activities (MaPP p6) • Improve the infrastructure required by marine fisheries (MaPP p6
4	Shellfish aquaculture		• Increase First Nations and local community economic benefits from shellfish and marine plan aquaculture activities (MaPP p5) **Area-specific** • Maintain opportunities for shellfish aquaculture in **Banks Nii Luutiksm** PA (GX E p5), **Stephens Island PA** (MA C p7, GX E p4) and **West Porcher Island** PA (GX E p4) • Adapt to changes in fisheries and aquaculture systems due to climate change (MaPP p4)
4	Sustainable marine resources		• Maintain opportunities for commercial harvest of seabed vegetation in **West Porcher** Island PA (GX E p4)
4	Sustainable botanical forest products		• Manage for the ecological sustainability of botanical forest products (KA p42) • Maintain opportunities for non-timber forest products industries in a manner consistent with EBM (NC p181)
4	Port-based industry		• Attract new industrial development in **Port Edwards** (PE p 5) • Support industrial development within designated areas in **Port Edwards** (PE p 15) • Encourage development of industrial lands that are constructed in support of container shipment, container storage, natural gas and other commodity exports, warehousing and loading in **Port Edwards** (PE p 35) • Achieve appropriate Port land and marine development by considering locational and physical attributes of the various areas administered by the Port (PRPA p56) • Facilitate general industrial development in areas along **Porpoise Harbour** (PRPA p 56) • Retain the west and south portions of **Ridley Island** primarily for bulk terminal operations (PRPA p56) • Provide for general cargo and storage on **NE Ridley Island and Watson Island** (PRPA p56)
4	Mineral and energy resources		• Maintain the opportunity to develop geological and energy resources (KA p64) • Allow access for mineral, aggregate or energy activities outside PAs (NC p125) • Encourage a variety of mineral, aggregate and energy-based economic opportunities that are consistent with EBM and that promote stability and long-term benefits to local communities (NC p180) • Encourage a variety of low impact energy sources (NC p180) **Area-specific** • Support for the proposed LNG facility on **Lelu Island** (PE p 9) •
5	Marine-based renewable		• Promote the viability of the marine renewable energy sector (MaPP p5)

	energy		• Increase First Nations and local community economic benefits from marine renewables energy activities (MaPP p5)
4	Forestry		• Enhance local understanding of a viable and sustainable log handling industry (MaPP p5) • Manage for a sustainable rate of timber harvest (KA p81) • Provide opportunities for value-added manufacturing (KA p81) • Maintain productivity of the forest landbase (KA p81) • Maximize a sustainable annual harvest … consistent with EBM and TEK (NC p139) • Support an economically and ecologically sustainable and viable forest sector (NC p180)
4	Tourism		• Explore opportunities for appropriate tourism development in the North Coast (MaPP p6); assess opportunities for marine tourism and encourage local tourism development (MaPP p 6) • Promote **Port Edward** as a tourist destination (PE p 41) • Encourage development of cultural heritage interpretative facilities and programs (KA p51) • Maintain recreation/tourism features, facilities and activities (KA p85) • Provide opportunities for recreation/tourism use in both frontcountry and backcountry settings (KA p85) • Support a wide range of culturally and ecologically appropriate tourism (NC p144) • Protect the quality of experience in tourism areas (NC p145) • Maintain opportunities for bear viewing (NC p147) • See Table of Tourism values (NC p148) • Encourage a variety of ecologically and economically sustainable tourism development opportunities (NC p181) • Promote and increase First Nations participation in tourism and ownership of tourism businesses (NC p181) • Promote local ownership in the tourism industry (NC p182) • Promote cultural tourism at **Port Essington** (KM C p11, KS C p10, MA C p6) • Support efforts for Coast Tsimshian members to engage in compatible commercial, cultural and tourism opportunities on **Lucy Islands Conservancy** (LI p 26) • Share **Lucy Islands'** rich cultural heritage (LI p 27)
4	Archaeology		• Develop First Nations' capacity to be involved in archaeology (NC p105)

Appendix 2. Value Maps

The following conceptual diagrams show relationships among values identified in goals and objectives of marine and land-use plans.

1. Stable resilient communities
2. Cultural heritage
3. Marine, hydroriparian and terrestrial ecological integrity
4. Species diversity

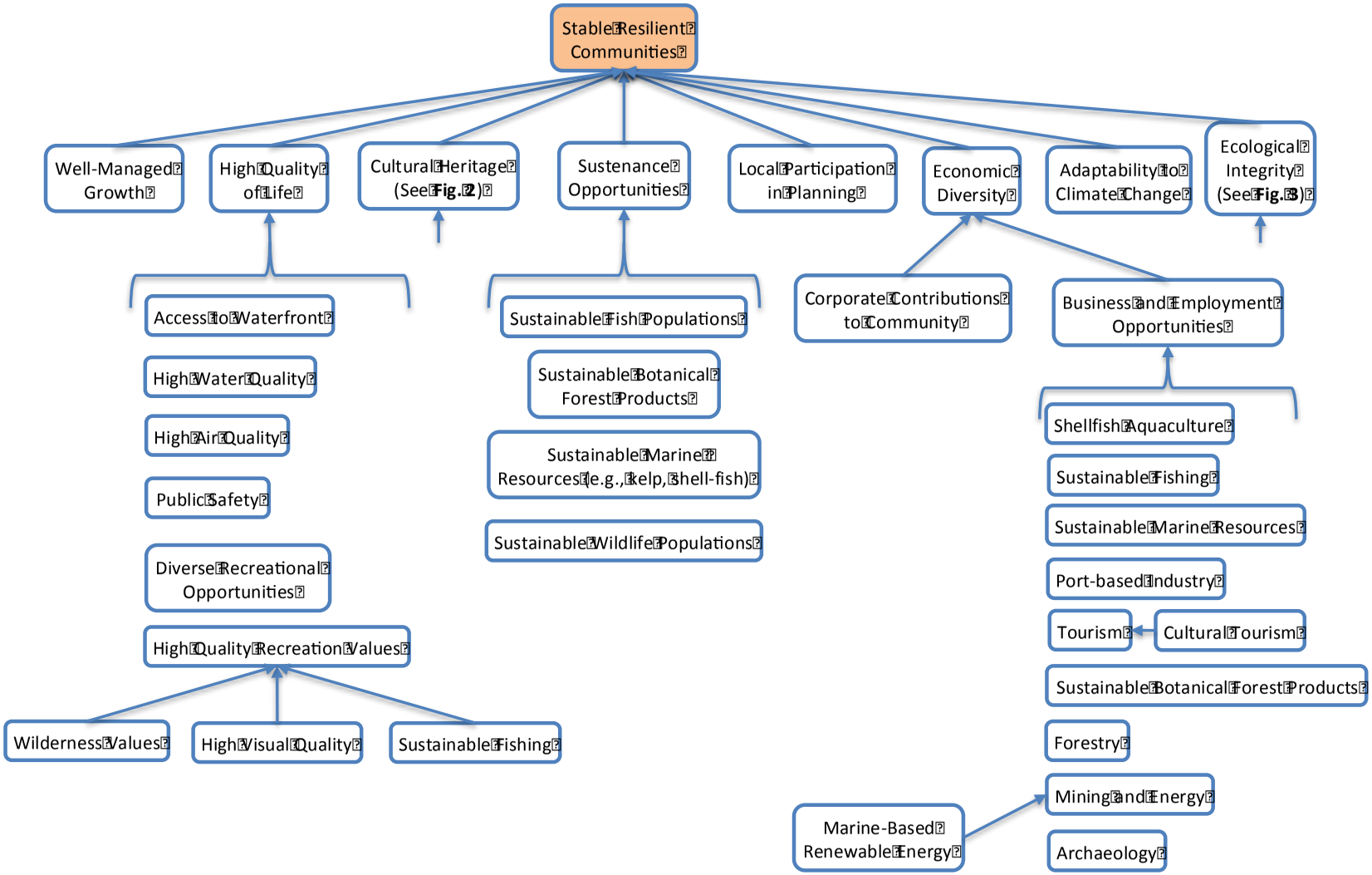


Figure 1. Value map for **stable resilient communities**, showing how subordinate values influence broader values. Boxes show values identified within plan goals and objectives. Note that sustainable fishing occurs three times here and once in Figure 2.

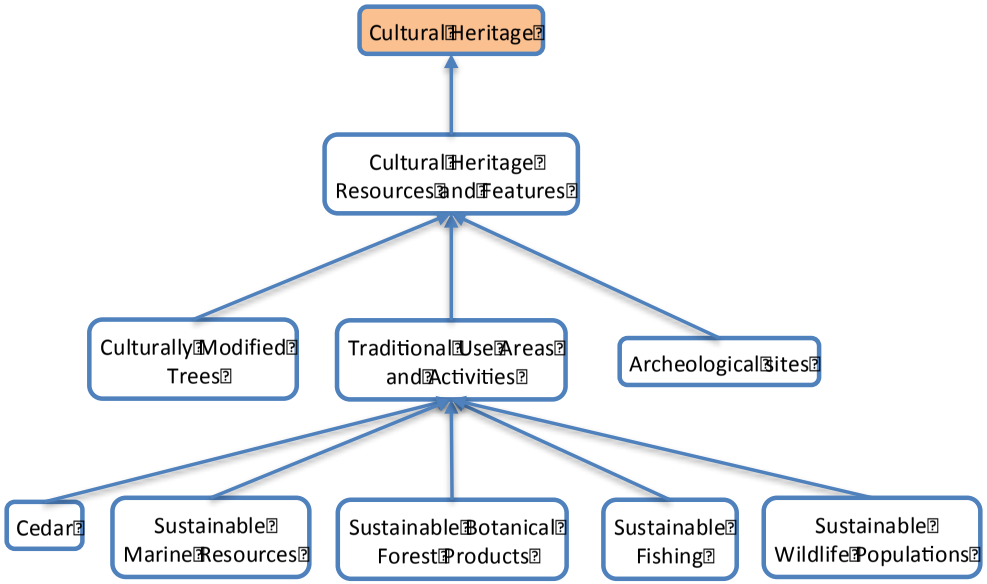


Figure 2. Value map for **cultural heritage**, showing how subordinate values influence broader values. Boxes show values identified within plan goals and objectives.

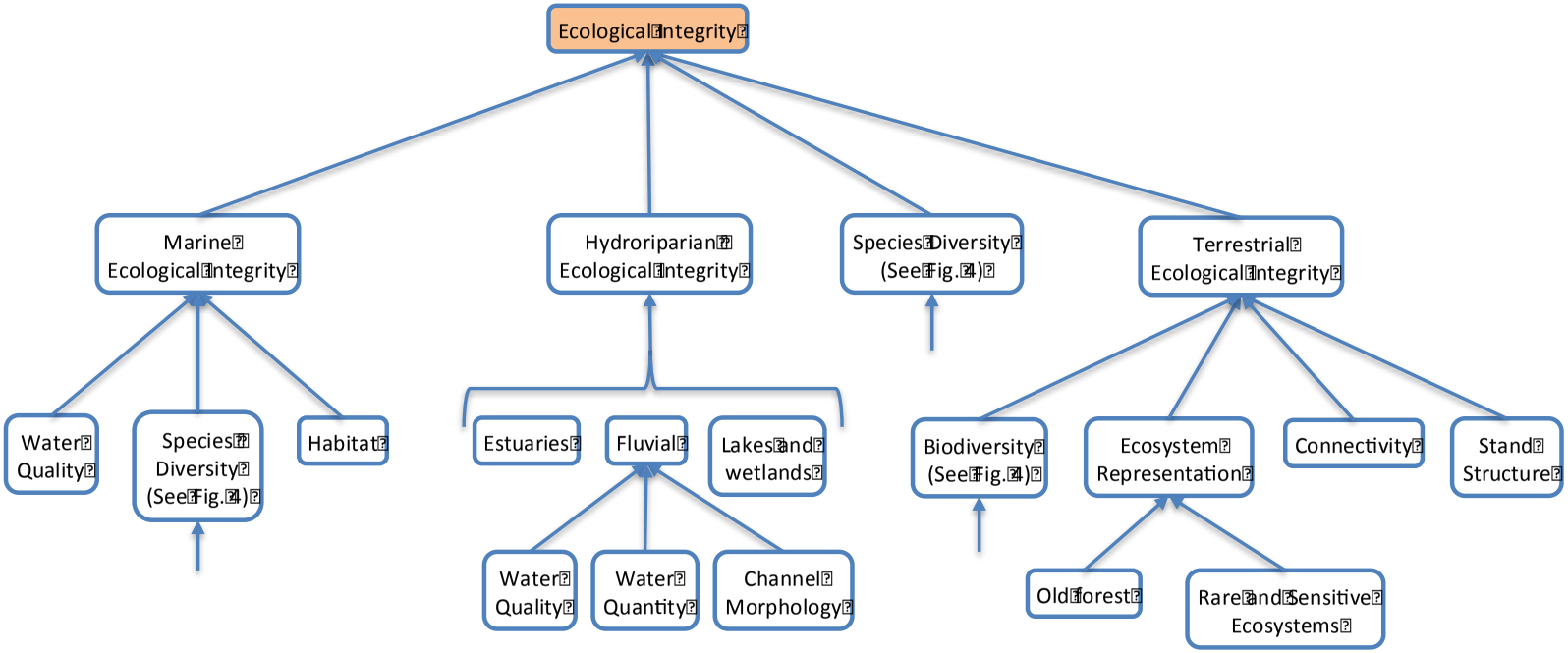


Figure 3. Value map for **marine, hydroriparian and terrestrial ecological integrity**, showing how subordinate values influence broader values. Boxes show values identified within plan goals and objectives.

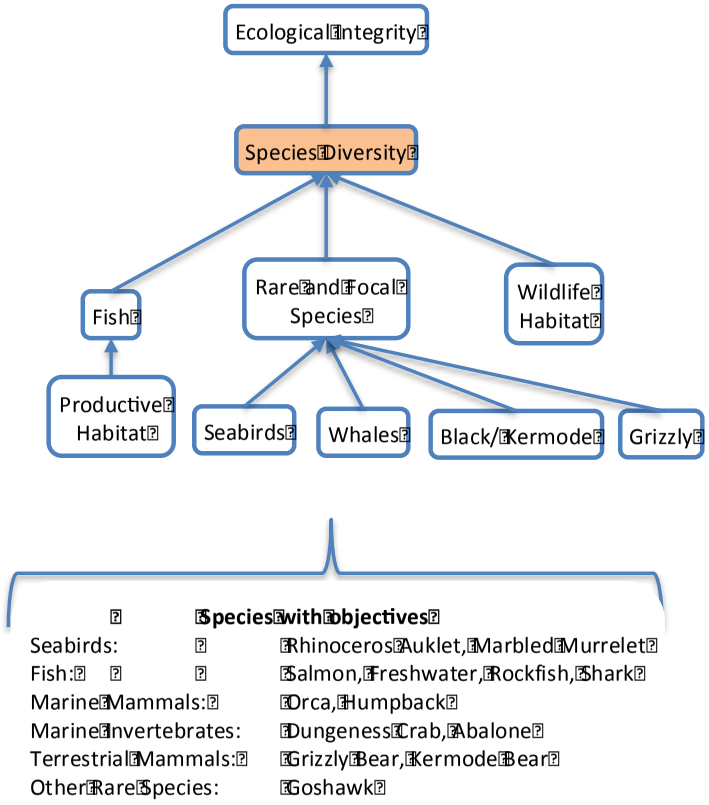


Figure 4. Value map for **species diversity**, showing how subordinate values influence broader values. Boxes show values identified within plan goals and objectives. Note that fish habitat includes hydroriparian ecosystems; estuaries are considered to be high-value habitat (Figure 3).

Appendix 3. Table of Values and Source Plans (separate Excel file)

Appendix 4. Table of References (separate pdf file)

Appendix 5. List of maps relevant to the Skeena Estuary

PNCIMA and MaPP provide maps showing the distribution of selected biophysical attributes. Attributes that fall within the estuary are included in the table below.

Biophysical attribute	Reference
Kelp	Lucas et al. 2007
Sponge and coral functional habitat use (limited surveys)	Lucas et al. 2007
Dungeness crab functional habitat use	Lucas et al. 2007
Rockfish conservation areas	Lucas et al. 2007
Herring functional habitat use	Lucas et al. 2007
Eulachon functional habitat use	Lucas et al. 2007
Humpback whale functional habitat use	Lucas et al. 2007
Killer whale functional habitat use	Lucas et al. 2007
Stellar sea lion functional habitat use	Lucas et al. 2007
Leatherback turtle functional habitat use (one sighting)	Lucas et al. 2007
Black Oystercatcher nesting colonies	Lucas et al. 2007 App K
Marine waterfowl habitat	Lucas et al. 2007 App K
Moulting scoter important marine habitat	Lucas et al. 2007 App K
Moulting Harlequin duck important marine habitat	Lucas et al. 2007 App K
Parts of Area 4 and 5 of Pacific Fisheries Management Areas	MaPP
Marine and terrestrial conservancies	MaPP
Provincial ecological reserves	MaPP
Provincial parks	MaPP
Bull Kelp Bioband	MaPP
CASI Eelgrass survey	MaPP
Chlorophyll concentration	MaPP
Eelgrass Bioband	MaPP
Eelgrass Chatham Sound Study	MaPP
Eelgrass distribution	MaPP
Giant Kelp Bioband	MaPP
Giant Kelp Distribution	MaPP
Prince Rupert Eelgrass Survey 2007 to 2009	MaPP
WWF Prince Rupert Eelgrass Survey	MaPP
Bathymetry shading and contours	MaPP
DFO Marine Bioregions	MaPP
BCMEC Marine Ecosections (e.g., northern shelf)	MaPP
BCMEC Pelagic Marine Ecounits (e.g., north coast fjords)	MaPP
BCMEC Benthic Marine Ecounits (low, medium and high roughness)	MaPP
BCMCA Benthic Classes (e.g., muddy ridge, muddy flat, muddy depression, hard flat and sandy flat)	MaPP
Parks Canada Oceanographic Regions (e.g., Dixon Entrance Coastal Flow, Mainland Fjords)	MaPP
Alcid distribution	MaPP
Important bird areas—marine birds	MaPP
Marbled Murrelet distribution	MaPP
Marine bird survey footprint	MaPP
Rhinoceros Auklet Colony Sites	MaPP
Sooty Shearwater observations	MaPP
Seaduck mounting sites (mainly unidentified scoter)	MaPP

Biophysical attribute	Reference
Eulachon important areas	MaPP
Eulachon run sites	MaPP
Herring important areas	MaPP
Pacific salmon migration routes	MaPP
Herring spawning habitat index	MaPP
Crab local knowledge	MaPP
Tanner crab important areas	MaPP
Gray whale distribution	MaPP
Harbour porpoise distribution	MaPP
Harbour seal haulouts	MaPP
Humpback whale distribution and important areas	MaPP
Killer whale distribution and important areas and potential critical habitat	MaPP
Pacific white-sided dolphin distribution	MaPP
Oceanography EBSA (Chatham Sound)	MaPP
Surface sea temperature	MaPP
Marxan high priority conservation areas	MaPP