DEVELOPING A FRAMEWORK FOR SCIENCE SUPPORT OF AN ECOSYSTEM APPROACH TO MANAGING THE STRAIT OF GEORGIA, BRITISH COLUMBIA

Figure 1. The Salish Sea marine ecosystem comprised of the Strait of Georgia, Juan de Fuca Strait and Puget Sound. Areas in coloured topography represent the watershed which drains into the Salish Sea. [Map of the Salish Sea & Surrounding Basin, Stefan Freelan, WWU, 2009]

Context :

The Strait of Georgia is a semi-enclosed marine basin between Vancouver Island and mainland B.C. (Fig. 1) that supports a rich and diverse ecosystem and is home to 75% of the human population of British Columbia. It is also experiencing environmental changes. Fisheries and Oceans Canada (DFO) is committed to developing an ecosystem approach to managing human interactions with marine systems. Several policies have been introduced to move DFO towards such an approach, including the Sustainable Fisheries Framework, policies on new fisheries for forage species and the impacts of fishing on sensitive benthic areas. The present assessment, based in part on the findings to date from the Strait of Georgia Ecosystem Research Initiative, develops a framework for DFO Science to provide the information necessary for an ecosystem approach to managing a specific marine system, the Strait of Georgia in British Columbia.

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Regional Advisory Process. Additional publications resulting from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

SUMMARY

- Canada’s Oceans Act (implemented in 1997), committed DFO to developing an ecosystem approach to managing human interactions with Canada’s marine systems.
- As perhaps the most human-dominated marine ecosystem in Canada, the Strait of Georgia is an appropriate system for which to develop an ecosystem approach to management.
- This assessment, based in part on the findings from the Strait of Georgia Ecosystem Research Initiative, provides strategic direction for DFO Science in support of an ecosystem approach to managing human interactions with the Strait of Georgia.
- The core elements for science support of an ecosystem approach to managing human activities in the Strait of Georgia include: developing indicators, monitoring programs, identifying baseline levels, employing spatial management, identifying anthropogenic stressors and thresholds, and developing modeling tools.
- The development of a comprehensive ecosystem approach, requires collaboration among other DFO Sectors and with external partners. The potential exists for collaborations with the process being developed for the Pacific North Coast Integrated Management Area.
- A workshop is recommended to develop a shortlist of ecosystem status and management indicators for the Strait of Georgia. This workshop should consider existing monitoring programs and propose new ones to provide the necessary data.
- A number of natural and direct anthropogenic stressors are impacting the ecosystem of the Strait. An evaluation of their impacts, as well as the determination of critical thresholds in an ecosystem framework, is needed.
- Models developed by DFO Science are being used to better understand the ecosystem of the Strait and to provide support to the management decision making process. An ecosystem approach will not rely on any single model.
- Long term monitoring programs are essential to provide the data for determining appropriate ecosystem baselines, status and thresholds of indicators, as well as model development and validation. Targeted research may be needed to understand ecosystem interactions that may be impacted as conditions move beyond their baselines.
- Spatial management, which accounts for interactions among ecological processes at a variety of nested geographic scales, is a key component of an ecosystem approach. It requires support from space-based modeling efforts, which should be integrated with monitoring programs.
- Many elements of an ecosystem approach are still in development and support is needed now so that ecosystem indicators, monitoring and field programs, and models can be available within 1-3 years, important knowledge gaps filled and critical thresholds determined (3-5 years), and operational ecosystem forecasts available (5+ years).

INTRODUCTION

Overview of ecosystem approaches to management

Traditional management of human interactions with marine ecosystems has focused on specific issues such as single species or single habitat alternations. Increasingly, however, this approach is seen as insufficient for the stresses and complexities of the demands placed on marine systems today. Modern marine management needs to take into account the interactions among stressors and components of marine ecosystems. The terms ‘ecosystem approach to management' (EAM) and 'ecosystem-based management' (EBM) have come to embody a more holistic and integrative approach to regulating human interactions with marine systems, i.e. an approach which recognises the importance and inter-connections among places and processes across an ecosystem (see Murawski, 2007, for a conceptual overview of ecosystem approaches to marine resources management). Although there are differences in the details of EAM and EBM, this assessment adopts the view that these terms reflect similar general concepts, i.e. an evolution in the management of human interactions with marine ecosystems, which includes more than single species analyses and takes into account their impacts on a number of aspects of marine ecosystem structure and function.

Mandated by Canada's Oceans Act (implemented in 1997), DFO is committed to developing an ecosystem approach to the management of human interactions with Canada's marine systems. Several policies have been introduced to move DFO towards such an approach, including the Sustainable Fisheries Framework, which includes policies on new fisheries for forage species and the impacts of fishing on sensitive benthic areas, and application of the precautionary approach to managing fisheries. DFO has identified eight priority themes for providing a sound basis for developing an ecosystem science framework (DFO, 2007): setting clear objectives; developing ecosystem indicators; developing risk-based frameworks; integrating information for fisheries management; identifying habitats of special importance; considering aquatic biodiversity; understanding the pathways by which stressors causes changes; and understanding the impacts of climate variability. Based on these policies and priorities, the present assessment develops a framework for DFO Science to provide the information necessary for an ecosystem approach to managing a specific marine system, the Strait of Georgia in British Columbia.

Strait of Georgia

The Strait of Georgia is a semi-enclosed marine basin between Vancouver Island and mainland B.C. (Fig. 1). It supports a rich and diverse ecosystem which is also intensively used by people; 75% of the population of British Columbia live within the watershed of the Strait. It is also experiencing important environmental changes, such as a warming of all depths (1970-2006) and declines in the concentration of oxygen in deep waters. Summer temperatures in the Fraser River have increased and its summer flow decreased (1942-2006), resulting in increased pre-spawning mortality of migrating sockeye salmon. The biomass of large cold-water Copepods has been low during the 2000s compared with the 1980s and 1990s and the peak of Zooplankton biomass has been shifting earlier to in the year. Such shifts in the seasonal marine production cycle could affect the survival rates of seabirds and of late-migrating juvenile salmon through the Strait of Georgia.

The populations of several fish species (e.g. Coho and Chinook Salmon, Lingcod, Pacific Cod, inshore Rockfish) have declined since the 1980s, whereas populations of other species (e.g. Spiny Dogfish, Chum Salmon) appear to have remained relatively stable or are increasing. Data suggest that species such as Pink Salmon have increased, whereas several populations of Sockeye Salmon from the Fraser River have been declining since the 1990s but with recent high variability. Populations of Harbour Seals and Sea Lions have significantly increased since the 1970s, although the Harbour Seal population has remained relatively stable since the late 1990s at a level which appears to be similar to that in the 1880s. The population of Transient Killer Whales has increased along the entire BC coast concurrent with the increase in Harbour Seals. Resident Killer Whales are threatened because of contaminants, marine traffic and declining availability of prey (primarily Chinook Salmon) and their population was stable or increasing until the mid-1990s, when they began to decline simultaneously with the decline in the population of Chinook Salmon.

Strait of Georgia Ecosystem Research Initiative

Studying how the Strait of Georgia ecosystem is structured and how it functions in an ecosystem context is one of the objectives of the DFO Strait of Georgia Ecosystem Research Initiative. This initiative began in January 2008 and concludes in 2011. Annual reports and additional information on the objectives and themes of this initiative are available on the Strait of Ecosystem Research Initiative website[1]. The objective of this assessment, based in part on the findings to date from the Strait of Georgia Ecosystem Research Initiative, is to provide strategic direction for DFO Science in support of an ecosystem approach to managing human interactions with the Strait of Georgia marine system. Detailed results of individual projects are nearing completion and will appear in separate publications. This assessment takes a narrower focus on a framework for science support to build an ecosystem approach to the Strait of Georgia. This is because developing a full ecosystem approach will require collaborations among other DFO Sectors and with external partners and interested parties to develop ecosystem-level management objectives and implementation protocols.

ASSESSMENT

Science Elements of an Ecosystem Approach to Managing the Strait of Georgia

A framework for DFO Science Sector support for an ecosystem approach to managing human interactions with the Strait of Georgia includes seven themes (indicators, monitoring, baseline levels, spatial management, anthropogenic stressors, thresholds, modeling), and two overarching topics (data management, knowledge gaps). These themes and topics are described below in a general sense; details on several of these themes will require clarification of the objectives for ecosystem management of the Strait of Georgia, and completion of the individual Ecosystem Research Initiative projects.

Indicators

Two broad classes of indicators are recognised: those that describe the ‘state’ of the ecosystem, and those that describe progress towards management goals or objectives, termed ‘management’ indicators. There is no single indicator that will synthesize the marine ecosystem of the Strait of Georgia. Selection of indicators needs to be based on an understanding of how the ecosystem works (‘state’ indicators), and on the management objectives (‘management’ indicators). Projects within the Strait of Georgia Ecosystem Research initiative have proposed potential indicators of the ‘state’ of this marine ecosystem, using a Driver-Pressure-State-Impact-Response and Bayesian Network approach. These include indicators of physical oceanographic conditions, the timing of key seasonal events, and the functioning of the food web such as prey and predator interactions. Other DFO programs have proposed other indicators, e.g. DFO’s Wild Salmon Policy (DFO 2005).

No consensus was reached on a short list of potential ‘state’ or ‘management’ indicators for the Strait of Georgia marine ecosystem. A workshop is recommended within Pacific Region with broad participation from relevant DFO Sectors (Science, Fisheries Management, Oceans, Habitat, Policy) to discuss both ‘status’ and ‘management’ indicators for the Strait of Georgia, based in part on the studies noted above. Since DFO is responsible for only certain aspects of the management of human interactions with the Strait of Georgia, the scope and size of this workshop needs to be carefully considered. The resulting list of potential indicators would then be analysed in terms of how well they represent broad system properties or management

[1] http://dev-public.rhq.pac.dfo-mpo.gc.ca/science/oceans/detroit-Georgia-strait/index-eng.htm

issues, availability of data, measurement properties, responsiveness to system changes, costs of providing the indicators, and public awareness (e.g. Rice and Rochet 2005). Clear definition of the management and conservation objectives for the Strait of Georgia will be necessary in order to identify the final set of 'management' indicators.

Monitoring

Monitoring refers to the scientific programs that regularly sample various components of an ecosystem to characterise the current status and trends of the quality and quantity of these components. Monitoring, although difficult to sustain over time, is essential to provide information to service ecosystem indicators. A number of monitoring programs are currently in place in the Strait of Georgia, many of which are conducted by DFO. The selection of ecosystem indicators for the Strait of Georgia will have to consider the availability of data from these monitoring programs. Details of how (e.g. the sampling protocols and sampling gears chosen), where, and how frequently to monitor also need to be discussed. Since monitoring is closely related to ecosystem indicators, it should also be considered during the recommended workshop on ecosystem indicators.

Selection of Baselines

"Baseline" refers here to the choice of a reference level against which values for an indicator can be compared, for example, to ascertain whether there is an increasing, decreasing, or no trend. For 'status' indicators, the baseline would be used only for reporting purposes, and would not represent 'desirable' target levels which management might want to achieve. This is in contrast to 'management' indicators for which the reference level may represent some management limit or target. The meteorological convention (also adopted for many oceanographic variables) is to use the mean over the past 30 years up to the most recent year ending in a "0", for example 1981 to 2010. While such an approach may be appropriate for some physical variables, it may not be appropriate for all biological variables, for example long-lived taxa such as some Rockfish and Dogfish. Selection of baselines should also consider abrupt changes, for example climate regime shifts or changes in management policies. A flexible approach to defining baselines is recommended for indicators that specifies the time period relevant to each particular analyses and which clearly reports the baseline period being used.

Spatial Management

Spatial management is a key component of an ecosystem approach. Spatial management includes specification of controlled activities in specific places, identification of locations critical to the healthy functioning of an ecosystem (such as Ecologically and Biologically Sensitive Areas), and spatial modeling of the ecosystem impacts of disturbances in these locations. Industrial activities that often have some element of spatial zoning in their management plans include fisheries, aquaculture sites, marine dumping, and log booming grounds. The Strait of Georgia already has some degree of spatial management, although usually based on single issues (i.e. generally not for their significance to the entire ecosystem), and not on a network context. Protected areas are important tools for managing human impacts in the Strait of Georgia and several have been designated, ranging from national wildlife areas to municipal parks. Such areas include locations in the northern Strait (southern end of Discovery Passage, Desolation Sound region), central Strait (Baynes Sound, Malaspina Strait), and the Fraser River Delta and Gulf Islands regions in the southern Strait. It is necessary to recognise that stressors on these local areas may come from local and remote sources within the Strait of Georgia and/or its terrestrial watershed, and beyond. A place-based modelling approach, which takes account of the interactions among processes at a variety of nested scales and which is integrated with monitoring programs, is recommended to quantify and formalise the impacts to these special areas and their connections with the larger Strait of Georgia.

Anthropogenic Stressors

There are two classes of potential stressors that could disrupt the Strait of Georgia ecosystem and prevent the conservation goals from being reached. These are from ‘natural’, and from direct anthropogenic, sources. ‘Natural’ stressors are defined to include environmental variability, from shorter (interannual) to longer (multi-decadal) time scales, as well as secular environmental change which may be forced in part by human activities (e.g. climate change, ocean acidification). Direct anthropogenic stressors include a range of pressures affecting habitats and living marine resources, such as fishing, invasive species, fish culture activities, contaminants, development and land use changes within the Strait of Georgia watershed (Table 1). Stressors and their impacts and management responses can be classified spatially (local, regional, global). For local stressors, cause-effect pathways tend to be linear and well understood, and their impact is often restricted spatially, e.g., eutrophication. These kinds of stressors may respond well to engineering solutions. Regional stressors have wider spatial scales of impact and cause-effect pathways tend to be non-linear and less well understood, e.g., estrogen-mimicking contaminants and organochlorine contaminants. Actions to address these stressors require a total systems approach and coordination over broad areas. Global stressors are planetary in scope, e.g., climate change, and are difficult to address effectively on local and regional scales. The response time scales of the ecosystem and its components also need to be compared with the time scales of the stressors. For example, physical properties of the Strait of Georgia are characterised by a long term trend due to a changing climate, which is often overwhelmed by medium term (decadal) variability (such as the Pacific Decadal Oscillation). It is this strong medium term variability, however, which is more closely matched with the response time scales of many components of the ecosystem. Further considerations include the significant forcing imposed by direct anthropogenic stresses (e.g. increasing human population), the time scales for management actions to be implemented and to take effect, and the inertia of management actions due to the need for adequate data to be collected and decisions made to change past practices.

Table 1. "High level" classification of 'natural' and 'direct anthropogenic' stressors that impact the Strait of Georgia marine ecosystem.

"*Natural*"	'Natural' environmental variability	- interannual changes - decadal changes
	Secular environmental change	- climate change - ocean acidification - sea level rise
"*Direct anthropogenic*"	Natural resource use	- harvest of marine living resources
	Introductions of non-native species	- shipping - aquaculture imports
	Fish culture activities	- aquaculture (shellfish; finfish) - hatcheries (salmonids)
	Contaminants	- eutrophication - agricultural runoff, industrial effluent - sewage and urban storm water - marine debris - hazardous materials spills - atmospheric transport of contaminants
	Development/land use	- residential development - commercial and industrial activities - tourism and recreation - shoreline modification - agriculture, silviculture - transportation infrastructure - shipping (noise, vessel strikes)

Thresholds

Thresholds are critical values of stressors that if crossed, would cause significant change to a marine ecosystem. Identification of such thresholds is necessary for the anthropogenic stressors defined above, since these would be potential candidates for management limit reference points. The concept can also be applied to 'natural' stressors to trigger management actions, for example when climate-driven changes in the timing of the marine production cycle indicate that changes are required in the release of hatchery-reared fish. An approach which identifies the "critical thresholds" that have an impact on ecosystem structure and function (e.g. Rockström et al., 2009) is recommended, and follows the precautionary approach used in Canadian fisheries management (DFO, 2006). This approach assumes that 1) for any ecosystem property there are healthy states in which some level of human impact can be sustained; 2) for any ecosystem property there is a maximum level of disturbance that can be sustained; 3) most ecosystem properties have some levels which can be considered to be seriously degraded or which represent irreversible harm (interpreted as having a low likelihood of recovery within biologically measureable time scales); and 4) by the time this degraded state is reached the human activities causing the impacts should be reduced as much as possible (Rice, 2009; Samhouri et al., 2010). Broadly stated, for each ecosystem stressor over which there is some degree of management influence, the threshold would be identified beyond which continued human actions are likely to have significant adverse impacts to the Strait of Georgia ecosystem. Periodic evaluations would be conducted of current conditions in relation to these thresholds and how management actions may change this relative position. Identification of these critical thresholds will require specific analyses for each of the stressors, likely using model-based approaches. An important elaboration on this approach once initial thresholds have been identified for single stressors will assess how these may change when multiple stressors are acting simultaneously. The sensitivity of these thresholds to changing conditions such as climate should also be evaluated.

Modelling

The proposed framework for an ecosystem approach relies on modelling since there are no alternatives to explore ecosystem management scenarios and to identify thresholds of effects in a multi-species and multi-habitat context. However, ecosystem models remain largely developmental and can be complex and difficult to validate (DFO, 2008). Such models developed by DFO include ocean circulation models, lower and upper trophic level biological models, and conceptual models that can assist with management decision making. The ocean circulation model is based on the Regional Ocean Modelling System (ROMS). The lower trophic level model is a nutrient-phytoplankton-zooplankton-detritus model coupled to the circulation model. Two upper trophic level models have been developed: Ecopath with Ecosim (EwE) and OSMOSE (Object-oriented Simulator of Marine ecOSystems Exploitation). The decision–support model uses a Bayesian Belief Network approach. Other models developed for the Strait of Georgia are able to predict distributions of non-native species and the distribution and fate of contaminants in the marine ecosystem, including their accumulation in top predators (e.g. DFO, 2010). Modelling is essential to integrate and synthesize existing information, to identify critical control nodes, to identify critical knowledge gaps, and to support decision making. An example of this synthesis would be the identification of critical thresholds for various anthropogenic stressors. An ecosystem approach to the Strait of Georgia will not rely on any single model but on a suite of models. Further work is needed on coupling the physical, lower trophic level and upper trophic level models to develop a 'full ecosystem', or end to end model, for the Strait. Such models would in assist in understanding or predicting a various ecosystem processes (e.g. identification of anomalous environmental conditions and their potential implications to upper trophic levels, prediction of harmful algal blooms) and are the only way to forecast potential impacts of climate change. Proper validation and testing of model results are essential in order to establish appropriate confidence intervals. Providing the data needed to build and validate these models is a significant issue, and is linked to the recommendations on monitoring. Model outputs are only as good as their input data. Modeling activities to explore alternate scenarios for the Strait of Georgia and identify thresholds for multi-species impacts do not replace or supersede the need for ongoing monitoring; rather these two activities are complementary.

Data Management

The availability of data to the many people involved in the Strait of Georgia is an important component of an ecosystem approach. A survey by the Strait of Georgia Ecosystem Research Initiative identified databases, monitoring programs, and associated metadata available within DFO relevant to the Strait of Georgia (Strait of Georgia Metadata Inventory). The following are recommended as data management practices to assist with an ecosystem approach:

1. Access to restricted and confidential data must be controlled. Creation of a separate repository of restricted datasets will assist those interested in analysing confidential data;
2. Many summary datasets have been created and are necessary components of the Canadian Science Advice Secretariat advisory process. Authors should be directed to deposit related datasets resulting from these reviews in electronic formats;
3. Metadata records should be created as new projects are funded;
4. Ideally only one copy of each database is maintained (with appropriate back-ups);
5. Flexible data extraction routines are needed;
6. DFO Science staff should provide summary datasets electronically for future reference, for example those datasets pertaining to projects published in publically-accessible formats (e.g. Centre for Science Advice Pacific Region (CSAP), published papers, etc.)

The DFO policy on data management is available at http://www.dfo-mpo.gc.ca/science/data-donnees/policy-politique-eng.htm.

Knowledge Gaps

Significant knowledge gaps for understanding the ecosystem of the Strait of Georgia that have arisen during studies from the Ecosystem Research Initiative include seal diets; and abundance and ecological roles of Pacific Hake, Walleye Pollock, and juvenile salmonids. Harbour Seals have increased significantly in abundance since the 1980s, when the last study of seal diets in the Strait of Georgia was conducted (which found that the majority of their diet was Pacific Hake and Pacific Herring during those months spent in the Strait). Given the changes that have occurred in the Strait, the diets of Harbour Seals and Sea Lions need to be re-investigated. Similarly, Pacific Hake have been described as having the largest biomass of resident fish in the Strait, although this has not been assessed recently. Given the importance of Hake as prey for Seals and as predators for many species of fish, a concerted effort is needed to determine the present biomass and feeding relationships of hake in the Strait. Salmon and Herring are important ecosystem components in the Strait of Georgia. They would provide an excellent study topic on how to integrate multiple species and management concerns into an ecosystem context, initially by considering impacts of ecosystem changes to the species but ultimately extending to how changes in the target species impact the ecosystem.

CONCLUSIONS AND ADVICE

As perhaps the most human-dominated marine ecosystem in Canada, the Strait of Georgia is an appropriate system for which to develop an ecosystem approach to management. This assessment focused on describing the necessary elements for DFO Science to provide the knowledge base and the advice for DFO to move towards an ecosystem approach to managing human interactions with the Strait of Georgia. Such an approach will be assisted by clearly identifying ecosystem-based management objectives (e.g. DFO, 2007). DFO Oceans Sector is developing a process to engage public discussion on ecosystem-level conservation objectives for the B.C. North Coast region. There is opportunity for collaboration to apply science tools for an ecosystem approach to management and Oceans Sector experience with developing ecosystem-level management objectives. Once objectives are in place, an operational ecosystem approach will require that trade-offs be made among competing and mutually-exclusive management outcomes. Science advice will be one source of information to assist with making these decisions.

Incremental development of an ecosystem approach to managing human interactions with the Strait of Georgia will supplement and support existing DFO policies, such as those on forage species and benthic habitats, and the Wild Salmon Policy. The ecosystem indicators that are being developed should be considered in tactical single species stock assessments. However, it is also clear that developing a framework for DFO Science Sector support of an ecosystem approach to managing the Strait will require adequate resourcing and a long-term commitment. There are significant challenges, but progress is being made. With adequate resourcing, the following is a potential timeline for providing science advice to support an ecosystem approach in the Strait of Georgia:

- Short-term (1-3 years): selection of ecosystem indicators; identification of necessary monitoring programs to provide information on these indicators; development and implementation of a decision-support tool based on (at least some of) these indicators; improvements to existing models, including coupling between lower and upper trophic level models; identification of additional knowledge gaps;
- Mid-term (3-5 years): progress on some of the significant knowledge gaps (e.g. Seal diets, Pacific Hake and Walleye Pollock abundances); identification of preliminary values of critical

thresholds for some of the anthropogenic stressors; determination of objectives for an ecosystem approach to the Strait of Georgia;

- Longer-term (5+ years): operational ecosystem models to forecast physical and ecological conditions and to establish clear thresholds for a variety of interacting stressors; ability to use these models to examine alternative management scenarios.

The following “next steps” are recommended to advance implementation of an ecosystem approach to managing the Strait of Georgia:

- Synthesize the results of the individual ERI projects describing the current state of the ecosystem of the Strait of Georgia and how it functions;
- Develop a collaborative process for the selection/evaluation of indicators and the monitoring programs needed to collect associated data. Continue to support existing monitoring programs that are likely to be critical for maintaining time series;
- Implement programs for the collection of data and reporting on indicators and their implications, as a significant and important activity of an ecosystem approach to management;
- Evaluate the anthropogenic stressors identified above for the Strait of Georgia and consider if any important stressors are missing;
- Continue to develop and evaluate the models developed under the Strait of Georgia Ecosystem Research Initiative, and consider and evaluate additional models for specific tasks/issues, for example to identify critical thresholds;
- Recognize that spatial management and spatial analyses are important components of an ecosystem approach to management, incorporate research on ecologically and biologically sensitive areas and vulnerable marine ecosystems within the Strait of Georgia;
- Ensure the archiving and accessibility of data and metadata for the Strait of Georgia, including sharing of data within and outside of DFO (subject to confidentiality requirements) and collaboration with non-DFO data collection programs. Resources for this activity are currently inadequate;
- Move from narrow topic-specific research programs to integrated planning and programming;
- Expand discussions on an ecosystem approach for the Strait of Georgia to include DFO Fisheries Management, Oceans, Habitat, and other Sectors; and,
- Collaborate with the process being developed in the PNCIMA region to identify ecosystem-level objectives for managing marine systems in Pacific Region. This would benefit both initiatives.

OTHER CONSIDERATIONS

Developing ecosystem approaches to managing marine systems is an active and current subject of research internationally. DFO can benefit from, and contribute to, these activities by facilitating discussions and collaborations with other agencies working in the Georgia Basin region. These include local university projects such as the Victoria Network Under the Sea (VENUS) run by the University of Victoria, the University of British Columbia project on “Reconstructing the Salish Sea: Linking historical ecology and future policy with local communities”, and proposals from the Pacific Salmon Foundation for enhanced ecosystem studies of Pacific salmon in the Strait of Georgia. The Georgia Strait Alliance is conducting a community mapping project for the Strait of Georgia to assist with participation of local community groups in developing an ecosystem approach to the Strait of Georgia. There are several other community groups with various interests in the Strait of Georgia (e.g. the Nile

Creek Enhancement Society). The Puget Sound Partnership and the Puget Sound – Georgia Basin Ecosystem Action Plan are developing similar concepts to those described here; both activities would benefit from enhanced collaborations.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Pacific Regional Advisory Meeting of February 16-17, 2011 on *The Strait of Georgia Ecosystem Research Initiative: developing an ecosystem-based approach for the Strait of Georgia*. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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