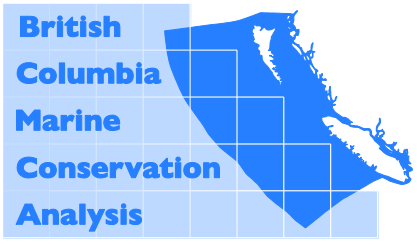
Draft Report | **BC Marine Conservation Analysis**



MARINE AND ANADROMOUS FISH EXPERT WORKSHOP REPORT

Draft with expert feedback
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1.0 Introduction

1.1 Objective of Report and Overview of Marine and Anadromous Fish Expert Workshop

The objective of this document is to summarize the recommendations from the Marine and Anadromous Fish Expert Workshop held in Nanaimo, October 17th 2007. The Marine and Anadromous Fish Expert Workshop was the fifth of several expert workshops to be conducted as part of the British Columbia Marine Conservation Analysis (BCMCA) Project. Previous workshops covered seabirds, marine plants, marine mammals, and invertebrates. A future workshop will cover the use of Marxan and additional reports for expert review will cover physical marine representation and the human use component of the project.

The intent of the Marine and Anadromous Fish Expert Workshop was to draw on the knowledge and expertise of scientists, resource managers and the conservation community to determine how to best represent fish species and fish habitat, or surrogates thereof, in subsequent conservation utility / optimization analyses for Canada's Pacific waters. Marine and anadromous fish are an important component of the BCMCA because of the diversity of species and related habitats present in Canada's Pacific. Marine and anadromous fish are important taxonomic groups in general, as their presence may be indicative of productive, functioning ecosystems and are integral to marine food webs.

After an introductory presentation to the group as a whole, participants of the workshop agreed to split into two working groups – 1) one focused on anadromous and pelagic species; and, 2) the second focused on groundfish and demersal species. The intent of splitting into two groups was to avoid redundancy in discussing features and targets. This division by groups of species is somewhat arbitrary, but was agreed upon by the participants attending the workshop.

1.2 Project Background

The overall purpose of the BCMCA is to collaboratively identify areas of high conservation utility/interest for the Pacific coast of Canada. The BCMCA Project will involve two main components/products: (1) An Atlas of Known Ecological and Human Use Values; and (2) a Marxan Spatial Analysis. The Atlas will map ecological data, human use data, areas where data is lacking, and a combination of areas of ecological value and human use hotspots. The Marxan Spatial Analysis component will iteratively identify: (1) areas of high conservation value using ecological data only; (2) areas of high conservation utility that minimize negative impacts to marine users and coastal communities; and (3) areas of high conservation value that incorporate reserve design principles. (For example, maximizing connectivity, minimizing edge to area ratio.)

To achieve these goals, the following are objectives of the BCMCA Project:

- Use the best available information, including the latest in marine conservation planning theory.

- Assemble and use the best available biological, ecological, oceanographic, and socio-economic data.
- Faithfully and transparently reflect the accuracy, scale and completeness of the data.
- Draw on the knowledge and expertise of governments (federal, provincial and First Nations), other resource managers, the conservation community, academics, and other scientists to develop sound, scientifically defensible methods and products.
- Utilize methods which are transparent in their application.
- Incorporate ecological, social and economic objectives in the analysis and balance these in a range of solutions.
- Work cooperatively to achieve project goals.
- Create products which are widely supported by partner organizations.

The BCMCA spatial analysis will be driven by six conservation objectives:

(1) represent the diversity of BC's marine ecosystems across their natural range of variation;
(2) maintain viable wild populations of native species;
(3) sustain ecological and evolutionary processes within an acceptable range of variability;
(4) build a conservation network that is resilient to environmental change;
(5) identify options that minimize negative impacts to marine users and coastal communities, while still meeting conservation objectives; and
(6) consider a variety of conservation scenarios and options.

Identifying areas of high conservation utility involves the consideration of multiple objectives and the use of large data sets that show the distribution of ecological, biological, and human use data. The BCMCA will use the decision-support tool Marxan to help achieve conservation objectives while minimizing negative impacts to marine users and coastal communities. Marxan was developed by researchers at the University of Queensland to help in the recent rezoning of the Great Barrier Reef (Ball 2000; Ball and Possingham 2000, Day 2002). The BCMCA Project will draw on the recommendations of the Marxan Best Practices Workshop, which was hosted by the Pacific Marine Analysis and Research Association (PacMARA) in April 2007.

The results of the BCMCA project are intended to help advance marine planning initiatives in BC by providing an up-to-date atlas of ecological features and human uses and by identifying priority areas for conservation.

2.0 General discussion

Several topics for discussion arose out of the workshop, which affect both groups in this workshop as well as previous and subsequent workshops. This discussion and suggestions for improving the project are outlined below, and **we invite your input**.

2.1 Atlas

- DFO has already come up with areas of ecological / biological significance in the Pacific North Coast Integrated Management Area (PNCIMA) study area (i.e. EBSAs); how will this atlas be different than that exercise? *Answer: It will cover the entire exclusive economic zone (EEZ), include the near shore marine waters and will use existing data to delineate high conservation value rather than employing a Delphic approach.*

2.2 Features and Targets

- Identifying a set of features that would represent the diversity of marine fishes in the Canadian Pacific is not a simple exercise.
- Considering individual species or even species groups does not seem tractable.
- A consistent system of identifying features should be used across all the ecological subject fields of the BCMCA. Along these lines, a layer representing relative biodiversity for each subject field should be included and the number of layers or features should be equal for subject field.

2.3 Planning units

- Does the size of the planning unit influence the result at all – how do you determine the planning unit scale? *Answer: Results will vary in terms of spatial accuracy and that will primarily be dictated by data resolution. Spatial data recorded with high accuracy and at high resolution supports finer scale planning units. We may use 2 different sizes of planning units that reflect the quality of the datasets (i.e better inshore data will result in smaller planning units and less precise offshore data will result in larger planning units).*

2.4 Data and data sharing

- Most data relevant to fish is fisheries data. Most fisheries target adults, therefore these data are not useful as early life stage or even juvenile data.
- Does the quality of the data, or lack of data, influence the outputs? Answer: *Yes*.

2.5 Other workshops/General

- It would be interesting to see how this project can influence the way data is collected and how it is used. Fisheries data is collected in a very specific way to answer specific questions, for the most part, and is not meant to be used in a generic sense. It would be great to see information on data gaps and recommendations for collection practices in the final report.

3.0 Anadromous and Pelagic Species

3.1 Introduction

This discussion considered species from several marine fish orders, but focused on those that exhibit anadromous or pelagic life history characteristics at various ontogenic stages. Anadromous fishes include those species that migrate from freshwater breeding habitat (i.e. streams, rivers, lakes) to salt water during their juvenile and adult life stages; pelagic species were characterized as those who occupy the mid to upper water column and may be nomadic or wide ranging. An example of anadromous fish species in BC are pacific salmon (5 spp.), whereas pelagic fish could include the numerous forage fish species, sand lance, herring, smelts, or larger predatory fish such as tuna or sharks.

Discussions focused on how to represent the diversity of these groups of species since, in some cases, they range over hundreds or thousands of square kilometres and many of the non-commercial species are not well understood with respect to life history, distribution or abundance. Similar to the marine invertebrate's workshop, the group focused mainly on defining important life history stages and associated physical or oceanographic habitats that could be mapped and targeted more accurately then individual species. Specific oceanographic and physical substrate combinations are more likely to create favourable conditions for a suite of species and some of these areas are well known to fisheries biologists and marine ecologists. Emphasis was placed on separating and identifying physical habitats that favour different life history stages during ontogenesis.

Participants in the anadromous and pelagic fishes group were:

- **Bruce Patten** – DFO, Head, Escapement and Fisheries Data Unit, Salmon and Freshwater Ecosystems Division
- **Kristen Daniel** – DFO, Herring Data Technician, Pelagics Section
- **Jake Schweigert** – DFO, Head, Conservation Biology *(at the time of the workshop)*
- **Charlie Short** (facilitator/note-taker) – ILMB province of BC, BCMCA Project Team member
- **Dave Nicolson** (facilitator/note-taker) – Nature Conservancy of Canada, BCMCA Project Team member

3.2 Sources of Anadromous and Pelagic Fish Data

Anadromous and pelagic fish data sources available in BC are summarised in Table 1.
The majority of discussion surrounding data sources had to do with systematic survey design and effort. The data sources vary with respect to the type of data (point, line, polygon), data provider, geometry, geographic extent, key attributes (presence, presence/absence, relative abundance / importance / habitat), and quality (precision and accuracy). For example, some datasets capture broad-scale systematic surveys (e.g., mid water trawl datasets), however are limited to where fishing activity is taking place and the targeted species, while others datasets provide in-depth systematic distribution and habitat surveys of smaller geographic areas (e.g., salmon bearing streams and holding areas). Other datasets consisted of species' distribution and abundance via ships of opportunity and random opportunistic survey design. Very little survey effort for non-commercial species was identified for the majority of BC's inshore and offshore marine waters. 403 Marine Fish species were assessed in 2005 by DFO to rank their general status and 77% of these were ranked as unknown status. Considering this, it becomes clear that source data for individual species are generally lacking and an approach based on targeting habitat surrogates was advised.

3.3 Features and Targets

A total of nine anadromous and pelagic fish features were identified (Table 2). Each feature represented different habitat types for the various life stages most fish go through during ontogenesis. There was no desire by the group to identify features and set targets on a species by species basis, as this would bias the atlas and analyses towards commercially important species, for which there are data, while non-commercially valuable species would be impossible to

represent as there is a lack of species specific data for these species. The group did acknowledge that priority should be given to species listed under SARA that have "critical habitat" maps available. Also, 100% of that identified critical habitat should be targeted, but targets were not discussed for identified "suitable" habitat. Time and cost permitting, more sophisticated methods may be undertaken to identify priority habitats. **Additional modeling exercises will require further follow-up with the expert participants after the datasets are assembled.**

One option for setting targets that was discussed would use a relative representative ratio of a particular habitat in a defined region compared to the entire EEZ. Regions with low representation could have higher targets and vise versa.

Ecological considerations (including minimum patch size, replication and separation distance) were generally not specified during the workshop due to the complexity involved in estimating these considerations in a meaningful way.

3.4 Assumptions/Limitations

Information on marine fishes in general in British Columbia is highly variable with respect to level of detail, quality and consistency of survey methods and spatial coverage. Generally, we lack complete data on the presence/absence, distribution and abundance and habitat associations for most species.

3.5 Recommendations

Although some data were identified for anadromous & pelagic fish in BC (Table 1), the expert sub-group recommended using habitat surrogates to capture the diversity of species that occur in BC (see section 5.0). Maps for these features will be created by assembling all the available data. These maps will be distributed to the marine fish working group for review and comment. Where additional modeling was suggested, BCMCA resources and priorities will need to be assessed before undertaking such modeling and statistical analysis.

Table 1: Anadromous and Pelagic Fish Data Sources

Marine Feature	Dataset/Layer	Description	Geometry	Data Custodian	Extent	Key Fields	Comments	Pre-Processing
Anadromous Fish Habitats (Pacific Salmon Spp. (5) + Steelhead & Eulachon)								
Stream Suitability / Classification	Stream Suitability / Classification	Biophysical assessment of value of stream, river etc for specific salmon spp.	Point, line	Dr. Mike Waldichuk	All province	Substrate, flow, barriers etc.	May not be completed in time for this project.	Combine data to rank or classify streams according to suitability for anadromous spp, target some of each class?
	Pacific Rim Rivers Typology Project	Assessment of rivers/watershed as potential habitat for salmon	?	Dr. Jack Stanford, University of Montana	All Pacific Rim			
	Escapement database	Indices of abundance, spreadsheet linked to stream river by stream ID	Counts linked to stream or river by ID	DFO, Vikki Wang	Selected rivers / estuaries. coast wide, certain rivers are chosen as index sites for larger area		Fallback option because data is spatially incomplete, not all rivers get surveyed; use stream assessment indices as primary dataset.	
Spawning / holding areas								
Habitat Classes								
Rearing / Juvenile staging areas	**Eelgrass Beds**	Distribution & size	Point, poly	Refer to marine plants workshop	Coastwide			
	Kelp Beds	Distribution & size	Point, poly	Refer to marine plants workshop	Coastwide			
	Estuaries	Distribution & size	Point, poly	Refer to physical marine workshop	Coastwide			
Rearing / Juvenile staging areas; *and* Near shore Habitats & Spawning areas	**Sandy Beaches**	Distribution & size	Line	Refer to physical marine workshop	Coastwide			

Near shore Habitats & Spawning areas	**Rivers (Province)**	Distribution & size	Line	Province of BC	Coastwide		Should include barriers upsteam.	
	Rivers (DFO)	Distribution & size	Line	DFO	Coastwide		Should include barriers upstream	
	Holding Areas	Distribution & size	Point, poly	DFO – Fisheries	Coastwide			
Intermediate and sub adult habitat near shore	**High current areas**	Distribution & velocity	Poly, line	Refer to physical marine workshop	Coastwide			
	Areas of high upwelling & zooplankton productivity	Distribution & size	Poly	Refer to physical marine workshop	Coastwide			
	Constricted Passes	Distribution & size	Line	Refer to physical marine workshop	Coastwide			
Offshore Adult Pelagic Habitat	**SST fronts**	Distribution & size	Line	Refer to physical marine workshop	Coastwide			
	Plankton surveys; zooplankton concentrations			DFO/IOS?	Coastwide			
	Chlorophyll data			Remotely sensed data	Coastwide		As a proxy for secondary production	
	Known migratory routes (DFO	Distribution	Line	DFO – fisheries	Coastwide			
	Known migratory routes (POST)	Distribution	Line	POST program?	Coastwide			
	Rocky Reefs, seamouts	Distribution & size	Line	Refer to physical marine workshop	Coastwide			
	Sablefish Surveys	Distribution & size	Line	DFO	Coastwide			Sablefish survey data will be included in the Ground Fish Bio survey database identified in table 4.
Other Data Sources								
Rare / uncommon species at international, national and local scales.	DFO marine fish status report and associated spatial data	Distribution & size	Line	DFO	Coastwide			
	Fishery Observer Data	Distribution & size	Line	DFO	Coastwide			This is being assembled as part of the BCMCA human use component
Locations / habitat for SARA listed species	**SARA registry**	Distribution & size	Line		Coastwide			

Table 2: Anadromous and Pelagic Fish: Data Preparation and Targets

Marine Feature	Rationale	Measure	Target	Comments/ Justification for targets	Ecological Considerations	Comment
1. **Stream Suitability / Classification**	Important breeding / spawning habitat for anadromous fish species.					
2. **Spawning / holding areas**	Important habitat for young anadromous fish species.					
3. Rearing / juvenile staging areas	Important habitat for young anadromous fish species.					
4. Near shore habitats & spawning areas	Important habitat for young pelagic fish species.					I.e. estuaries, eelgrass, kelp; herring spawn areas are not same areas where juvenile herring rear
5. Spawning areas for forage species	These are food for other species					i.e. sandlance capelin, smelt; beach spawners, looking for sandy areas
6. **Intermediate and sub-adult near shore habitat**	Important habitat for young pelagic fish species.					
7. **Offshore adult pelagic habitat**	Important habitat for adult pelagic fish species and essential for adult survivorship, where adult pelagics feed, migrate in and out of. (This includes adult salmon?)					May be represented by zooplankton concentrations
8. **Rare / uncommon species at international, national and local scales.**	Important to identify to ensure species do not become threatened or endangered.					

9. Locations/habitat for SARA listed species	Required by law to recover population of the species and protect "critical" habitat.					

4.0 Groundfish and Demersal Fish Species

4.1 Introduction

The discussion in this group was broad and although the group was tasked with considering groundfish and demersal species (those species that spent the majority of their lives either on or near the benthos), the discussion focused on the best way to represent fish in general and the diversity of BC's marine fish in the BCMCA. Considering that 403 Marine Fish species were assessed in 2005 by DFO to rank their general status and only 23% of these were ranked with known status, a habitat representation approach was recommended.

Participants in this group were:

- **Scott Wallace** – David Suzuki Foundation, Sustainable Fisheries Analyst
- **Cliff Robinson** – Parks Canada
- **Andy Lamb** – Ecologist, diver
- **Jonathan Martin** – SFU, School of Resource and Environmental Management
- **Karin Bodtker** (facilitator/ note-taker) – Living Oceans Society, BCMCA Project Team member
- **Glen Rasmussen** (facilitator/ note-taker) – Department of Fisheries and Oceans, BCMCA Project Team member

4.2 Discussion on ways to represent fish in the absence of data for each and every species

In the first breakout session, this group brainstormed some features that might be used to represent fish in the BCMCA. Some of these ideas are:

- Use survey data to identify hotspots of high diversity
- Consider diversity by guild or by species groups; could look at taxonomic relatedness
- Consider a map of summed Catch-per-unit-effort (CPUE) of all species (for which there are data) as a proxy for total biomass production, therefore relative importance to fish in general.
- Representation by habitat type:
    - For each life stage of each species/group
    - E.g., for inshore rockfish, map juvenile versus adult habitats, kelp beds versus pelagic habitats
    - Listing habitat types became problematic. The general view was that every marine habitat is used by some fish species at some life stage and our knowledge is not deep enough to rank relative importance. Examples given include eelgrass, kelpbeds, surf zone, bathypelagic, rocky subtidal, estuary, intersect depth zones with substrate type, intertidal, subtidal, off-shore pelagic, inside versus outside, etc.
- Representation by assemblage (related to habitat type)
    - Use the Californian work of Allen et al. (2006) as a template to identify the 'ecosystems' of the Canadian Pacific waters.

The group also discussed whether there were any species or species groups that warranted special consideration or individual attention in terms of specific features to represent them (for example, rare species). The examples of sixgill and basking sharks and brown rockfish inhabiting distinctive sites were mentioned, and also that cloud sponges provide good habitat. A point was made about the fact that 'rare' can mean many things. For example, rare in BC might not be rare in the Pacific Ocean or even rare in Canada, or, on the contrary, some species that are considered abundant in BC might be quite rare worldwide. The group suggested that principles be established for selecting certain species that require individual representation, to avoid favouritism or selection based on available data only.

The group agreed that one way to move forward would be to identify a method (approved by all) to choose habitat types or assemblages to target. It was agreed that some regionalization would be necessary and the province's ecosections could be used for this purpose.

4.3 Sources of data

Sources of data identified by the group are summarized in Table 3. Sources range from collection and count data to a habitat model. Most are coast-wide; but some have limited geographic coverage.

Datasets shown in red text probably do not currently exist in a GIS supported format but are included to document data gaps, priorities for future research and data collection.

4.4 Features and Targets

A minimal set of ground & demersal fish features were identified (Table 4). Features represented different habitat types or specific species deemed important. There was no desire by the group to identify features and set targets on a species by species basis, as this would bias the atlas and analyses towards commercially important species, for which there are data, while non-commercially valuable species would be impossible to represent as there is a lack of species specific data for these species. The group did acknowledge that features should be included for species listed under SARA that have "critical habitat" maps available. Also, 100% of that identified critical habitat should be targeted (or 'locked-in' Marxan analyses), but identified "suitable" habitat was not discussed in terms of setting targets. The group also agreed that setting targets for assemblages or habitat types should follow the principle of inverse proportional representivity. For example, common assemblages or habitat types could be targeted with lower percentages than rare assemblages (those that represent a small spatial area) such that in the end each assemblage is represented equally in terms of area. The rationale cited for this approach was to enable viable populations of all assemblages in all types of habitats.

Specifically this broad process was formulated as a method to identify diversity and species assemblages based on groundfish trawl and survey data. The group acknowledged that this is a method to identify features, rather than a list of features provided by the experts at this workshop.

- Divide into ecoregion and depth zones and do ordination/cluster analysis on that to see what species fall out. This should produce an arrangement of cells with similar species assemblages.

- Target areas represented by those assemblages using inverse proportional representivity.

Regarding shorezone units, the recommendation was to look at identified classes that are related to fish assemblages and target those in a similar fashion. It was suggested that untrawlable areas also be targeted in the same way because these are data poor and unknown. The 2005 DFO General Status Assessment of Marine Fish was identified as a foundation dataset for identifying features, especially for deep-water fishes, adult life stage.

Time and cost permitting, more sophisticated methods may be undertaken to identify priority habitats. **Additional modeling exercises will require further follow-up with the expert participants after the datasets are assembled.**

4.5 Assumptions/Limitations

Information on marine fishes in general in British Columbia is highly variable with respect to level of detail, quality and consistency of survey methods and spatial coverage. Generally, we lack complete data on the presence/absence, distribution and abundance and habitat associations for most species. Some recommended features will be based on survey data and this imposes necessary limitations. The area covered by surveys is less than the area commercially trawled. Also, areas surveyed are selected because they are fished and they do not represent a random sample of everything.

4.6 Recommendations

Although data were identified for ground and demersal fishes in BC (Table 3), the expert sub-group recommended using habitat surrogates to capture the diversity of species that occur in BC (see section 5.0). Maps for these features will be created by assembling all the available data. These maps will be distributed to the marine fish working group for review and comment. Additional modeling was suggested, however additional resources would be needed to complete such modeling and statistical analysis.

Table 3: Groundfish and Demersal Fishes: Data Sources

Feature	Dataset	Description	Geometry	Data Custodian	Extent	Key Fields	Comments	Pre-Processing
Diversity of groundfish and demersal species; *and* Total fish biomass (based on surveys not commercial catches)	Halibut surveys	Transect		International Halibut Commission; Claude Dykstra (Seattle).				
	Ocean dumping surveys	Point,		Environment Canada				
	GFBio database: Most groundfish surveys (bottom trawl, shrimp trawl, hook and line, dogfish survey)	Transects, points		DFO – Fisheries, Kate Rutherford				
Diversity of fish species	General Status Assessment of Marine Fish (2005)	Prepared for DFO, to fulfill obligations for the general monitoring of species under the Accord for SAR. Assessment results in spreadsheet form, preparation made use of range (presence/absence) of 250 species		Scott Wallace has spreadsheet with assessment by species; DFO has presence/absence shown in grid squares (5 km x 5 km) for 250 fish species (norm Olsen did data prep)			Could use these data to identify grid cells with greatest diversity and species richness; Could look at cells that had species in all years versus those that had species in only 1 year	
Rockfish habitat (juvenile)	Inshore rockfish publications	DFO Tech Reports	georeferenced	See: http://www.pac.dfo-mpo.gc.ca/sci/sa-mfpd/inshore_rockfish/inshore_rf_pubs.htm				
Rockfish habitat (adult)	Inshore rockfish publications	DFO Tech Reports						
Rockfish habitat (spawning)								
Sixgill & basking shark locations							Data gap?	

Groundfish assemblages (related to habitat type) Note: this will be a series of features	GFBio database: Most groundfish surveys (bottom trawl, shrimp trawl, hook and line, dogfish survey)	Transects, points		DFO – Fisheries, Kate Rutherford				
Frontier areas / untrawled areas								

Table 4: Groundfish and Demersal Fishes: Data Preparation and Targets

Marine Feature	Rationale	Measure	Target	Comments/ Justification for targets	Ecological Considerations	Comments
1. Diversity of groundfish and demersal species	Measure of species richness and evenness. May be able to assess frequency of occurrence.	Number of spp found per unit area		Target a percent of low, med, and high diversity areas	Any minimum size required for an area to be functional?	Creation of the this feature would be informed by all systematic surveys
2. Rockfish habitat (juvenile)	Important species in NE Pacific, need to represent habitat by life stage					
3. Rockfish habitat (adult)	Important species in NE Pacific, need to represent habitat by life stage					
4. Rockfish habitat (spawning)	Important species in NE Pacific, need to represent habitat by life stage					
5. Total fish biomass (based on surveys not commercial catches)	Index of abundance or productivity by area	Kg per unit area		Create biomass classes and target a percent of low, med, and high biomass areas		Creation of the this feature would be informed by all systematic surveys
6. Known habitat of Sixgill & basking sharks	Rare or possible extirpated species					
7. Groundfish assemblages (related to habitat type) Note: this will be a series of features	Represent the full range of groundfish without targeting species by species			Target proportionally		Use analysis similar to that of Allan et al. 2006 to identify particular assemblages and their related habitats.
8. Frontier areas / untrawled areas	Pristine or 'untouched' areas. Benchmark sites	Square km		Target proportionally based on amount of total seabed these frontier areas represent		Creation of this feature would be informed by Fisheries Catch data, assembled by the human use component of the BCMCA
9. Spawning area of broadcast spawners	Need to capture, to balance focus on spawning areas for salmon or herring					Represented by water column in general, may be a data gap but captured by physical marine representation

5.0 Generalized Marine Fish Assemblages & Habitat Associations

The paucity of marine fish assemblage data in BC, beyond commercial species, makes it difficult to individually identify species that can be mapped spatially. In a study by Allen et al. (2006), the diversity of marine fish and their habitats in California waters were classified through a systematic examination of ichthyofaunal studies along the California coast. Although there are numerous studies to draw from in California, many more than in BC, the method they used to classify the diversity of marine fish and their habitats may well suit the objectives of this project. Table 5 lists the major habitat divisions that were derived from quantitative clustering of species composition in California (Allen et al. 2006), with a few marine ecosystems unique to BC added.

Species composition in California waters will undoubtedly be different than those found in BC, however the northern California species assemblages will likely be similar in southern BC, whereas northern BC latitudes may contain sub-arctic and arctic species not found in California waters. The advantage of using this method in BC is that the fundamental datasets required are physical in nature. The report showed that three variables, substrate type, mean depth, and latitude, accounted for as much as 90% of the variance in the habitats and species groups. Data to represent these variables are available for BC.

Workshop participants suggested that we could use this study to define BC marine fish habitat more effectively than using the existing datasets on a few species. However, verification through known presence of species in a particular habitat type should be done in order to assess degrees of confidence in both species assemblages and habitat associations. This, however, would require additional analysis that may be beyond the scope of this project.

If this is the preferred method to represent the diversity of marine and anadromous fishes in BC, then modifications to the California classification system will be required to include the different marine ecosystems found in BC (i.e., fjords, inlets and/or inland waters). Also, the California study only included 244 species which clustered into 42 fish assemblages in 15 habitat types. This represents only 60% of the 403 known species in BC, many of which may not be found in BC waters (i.e., southern California species).

Table 5: Generic Marine Fish Assemblages & Habitat Types: Allen & Pondella (2006)						
Marine Feature	**Rationale**	**Measure**	**Target**	**Comments/ Justification for targets**	**Ecological Considerations**	**Comments**
Major habitat divisions for all life stages						
1. Pelagic						
2. Kelp bed rocky reef						
3. Surf zone						
4. Bay / Estuary **5. Coastal pelagic**						
6. Rocky intertidal						
7. Rocky subtidal **8. Inner shelf**						
9. Middle shelf						
10. Outer shelf **11. Mid-depth rocky reef**						
12. Deep rocky reef						
13. Shallow slope						
14. Deep slope						
15. Deep bank **16. Fjords (BC specific)** **17. Inlets (BC specific)**						

6.0 Conclusions

Overall, few marine and anadromous fish features were identified by expert participants including features that *should* be included for which data are lacking. Pre-processing will be necessary to combine datasets from different sources for many of these features. All participants agreed that it is crucial to document data gaps, relative quality and consistency of data, and any assumptions made, so that future iterations of the analysis can be improved. Workshop participants strongly recommended using species assemblages and habitat associations to better capture the diversity of marine fish in BC and suggested the California model (Allen et al. 2006) would be a preferred starting point.

There was no consensus at the end of the workshop as to whether even 'charismatic' species (i.e., salmon and herring, in particular) should be singled out to be represented and targeted individually alongside the more general habitat classes. The Project Team proposes to assemble available data on salmon and herring in addition to creating features for the habitat classes identified, and let the experts reconsider this question when all available data is compiled and mapped features are prepared for their review.

7.0 References

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Ball, I. R., and H. Possingham. 2000. Marxan (V1.8.2): marine reserve design using spatially explicit annealing, a manual.

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Appendix 1: Detailed expert feedback

Out of the seven experts that attended the workshop, three responded to requests for review of the Workshop Report and all felt that the Workshop Report adequately represented the proceedings of the workshop. Expert comments were added directly to the document by experts and have been incorporated into this Workshop Report. There are no other comments or suggestions to detail here.