Draft Report **BC Marine Conservation Analysis**

MARINE INVERTEBRATES EXPERT WORKSHOP REPORT

Draft with expert feedback
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1.0 Introduction

1.1 Objective of Report and Overview of Marine Invertebrates Experts Workshop

The objective of this document is to summarize the recommendations from the Marine Invertebrates Expert Workshop held in Nanaimo on October 15th, 2007. The Marine Invertebrates Expert Workshop was the fourth of several expert workshops to be conducted as part of the British Columbia Marine Conservation Analysis (BCMCA) Project. The first workshop covered seabirds, the second covered marine plants, the third covered marine mammals and the others will cover marine physical representation, fish, human use, and the use of Marxan.

The intent of the Marine Invertebrates Expert Workshop was to draw on the knowledge and expertise of scientists, resource managers and the conservation community to determine how to best represent marine invertebrate species and marine invertebrate habitat, or surrogates thereof, in a subsequent conservation utility / optimization analysis for Canada's Pacific waters. Marine invertebrates are an important component of the BCMCA because some species play an integral role in marine ecosystems, are sensitive to physical anthropogenic disturbance and are commonly used as indicators for the health and condition of the marine environment. Marine invertebrates are also an important focal taxonomic group whose presence may be indicative of specific oceanographic conditions and unique ecological communities.

Participants of the workshop were initially divided into two groups in order to address the diversity of invertebrate species. However, after some initial discussion both groups came to the conclusion that a species by species approach would be untenable, and the focus shifted to identifying habitat surrogates for invertebrate communities. Therefore, participants worked together in one large group for most of the remainder of the day. The results of these discussions are reported in two distinct sections: 1) foundation species or community types; and, 2) threatened and endangered species and habitats.

Participants at this workshop were:

Scott Wallace – David Suzuki Foundation, Sustainable Fisheries Analyst
Juanita Rogers – DFO- Fishery manager
Heather Holmes – Parks Canada
Leslie Barton – DFO – Science – Shellfish data coordinator
Brenda Waddell – DFO – Assessment Technician, Shellfish Section (Green sea Urchin)
Bill Austin – Executive Director, Marine Ecology Centre, Sponge taxonomist
Andy Lamb – Retired Ecologist, diver
Phil Lambert – Royal BC Museum, Curator of Invertebrates
Kim Conway – Scientist, Marine Studies Section, Natural Resources Canada
Sean MacConnachie – DFO – Oceans

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) the 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 impacts to marine users and coastal communities; and (3) areas of high conservation value that incorporate reserve design principles. (i.e., maximizing connectivity, size requirements, 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 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 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 subsequent workshops. This discussion and suggestions for improving the project are outlined below, and **we invite your input**.

2.1 Atlas

- There will be cases where data may not exist for particular taxa in particular spatial areas so it should be very clear that an absence of data does *not* infer an absence of ecological value. With an estimated 10,000 species of marine invertebrates in BC waters this will the case for most of them. For output maps it will be important to identify areas where data is missing or N/A.
- In most cases the data available are a reflection of the value of certain invertebrate species to our species. Data will also decrease with increasing depth; e.g., intertidal, SCUBA Zone, sub SCUBA zone--a reflection of cost and number of data gatherers. Data will increase with proximity to user groups, e.g., to Bamfield Marine Station,
- A data gap analysis, perhaps run for each of the ecological components, should be part of the mapping study. *The BCMCA project team has discussed this suggestion and agreed to include this as a component of the Atlas product.*

2.2 Features and Targets

- Are the features meant to include a species, community or habitat; and are we only concerned about native species? *Answer: Features could be any of the above and yes, we are only interested in native species.*
- How do we compensate for variability between features that contain single species or multiple species? *Answer: Layers can be weighted and thus adjusted. Marxan focuses on the individual planning unit rather than an individual species layer.*
- What do you mean by ecological considerations? *Answer: We use this in reference to spatial conservation planning – specifically in terms of size of conservation units, spacing between them, replicating sites and representation.*

2.3 Planning units

- What size of planning units? *Answer*: *We have not determined this yet for the BCMCA analysis. It may be variable depending on resolution of data in different areas*.

2.4 Marxan flexibility

- Does Marxan bin data temporally? *Answer: Data has to be prepared (binned) before it's entered*.

- Can you lock in an area by species or aggregates of species? *Answer: Yes, for example, if we have data which shows areas where an endangered species is found, Marxan can lock in those areas.*

2.5 Other workshops/General

- Will areas that are not identified as having high ecological value be seen as locations where MPAs should not be placed and as areas undeserving of enhanced management activities? *Answer: It depends on whether these areas were not identified as a result of insufficient data or absence of value. We will make it clear where data was lacking.*

3.0 INVERTEBRATE FOUNDATION SPECIES and INVERTEBRATE COMMUNITIES

3.1 Introduction

It became clear at this workshop that a species by species approach would be untenable for invertebrates; the discussion then shifted to identifying habitat surrogates for invertebrate communities. Foundation species were identified as one group that would be important to include and target. To best represent the diversity of all other invertebrate species, the group decided to try to identify a range of habitat types that would each support a unique invertebrate community.

Foundation species were described as those that either form or alter structural habitat that can be used by other marine species or that form distinct marine communities that would not be present otherwise. Some examples of foundation species may be sponges, corals, segmented worm communities, tube dwelling ampelised amphipods and burrowing ghost shrimp.

Identifying habitat types that support different invertebrate communities was difficult. The group recognised that while invertebrates live almost everywhere, there are marine invertebrate hotspots, or areas of high invertebrate diversity. Specific oceanographic and physical substrate combinations are likely to create favourable conditions for diverse suites of invertebrate species and some of these areas of high diversity are well known to marine ecologists. However, it was stressed that there may be additional marine invertebrate hotspots that have not been discovered yet, and therefore areas that share similar biophysical characteristics should be adequately represented and targeted in the analysis as well.

3.2 Sources of Foundation Species and Invertebrate Community Data

Invertebrate data sources available in BC are summarized 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), and quality (precision and accuracy). For example, due to the number of invertebrate species found in BC waters (~10,000) those that have commercial value typically receive the most systematic survey effort and this is often limited to where commercial harvesters work, rather than random or systematic survey design. Other datasets consisted of species' distribution and abundance via

ships of opportunity and random opportunistic survey design. Habitat surrogates were seen as the best way to characterize the diversity of invertebrate communities, overall. Therefore, many of the data sources for this group will likely be developed through a subsequent workshop or process that identifies features related to physical/chemical oceanography and submarine geology/geomorphology.

3.3 Features and Targets

Due to the limited amount of survey effort that is given to non-commercial invertebrate species, much attention was paid to creating habitat surrogates for invertebrate species / community types. Combinations of substrate types, wave exposure, depth intervals and localized oceanographic conditions should be used to capture the diversity of these groups of species. It was recommended that these combinations be targeted by region and that targets be set higher for combinations that are less common. For invertebrate hotspots, specific spatial locations were identified as renown for their high diversity of invertebrates and will be listed as well. Features identified at the workshop are listed in Table 2.

Additional modelling exercises focused on identifying and mapping appropriate habitat features will require further follow-up with the expert participants after the datasets are assembled.

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 foundation invertebrate species, invertebrate hotspots, and habitat surrogates 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 for most non-commercially viable and subtidal species.

3.5 Recommendations

For British Columbia, the experts recommended that six features to represent foundation species be prepared and used in the analysis, and that at least 12 more features be created (modeled) to represent different types of invertebrate habitat. Specific targets were not set for any of these features. Maps for these features will be created by assembling available data and undertaking modeling when necessary. The maps will then be distributed to the invertebrate working group for review, and to solicit recommendations on targets.

Note to experts: Please review the list of features in Table 2 for completeness. (Remember that features are the actual layers of information that get targeted for conservation in the Marxan analysis.) Then, please add to the list of data sets in Table 1 if you can think of data that might inform any of the identified features.

Table 1: Invertebrate Foundation Species & Invertebrate Communities: Data Sources

Dataset/Layer	Category	Description	Geometry	Data Custodian	Extent	Key Fields	Comments	Pre-Processing
Invertebrate harvest atlas	Commercial Species (10)	catch and effort data	4 km grid	Erick Merner, DFO, PBS (250) 756-3363	Harvestable Areas		Only for commercial species	May analyse for diversity hotspots , or include a feature for each harvested species
Substrate type	Habitat surrogates; e.g. caves, loose rock, seamounts	Multibeam sonar surveys	polygon	NRCan	limited spatial extent		Refer to Physical Representivity Report for data sources and substrate classes	
Deep water ecology surveys	Habitat surrogates; surveys may inform or validate	Species and location caught	Point, start and end point of haul	DFO, PBS, Boutillier	survey design? Random?		1999-2006; 2000+ m deep, limited spatial extents	
Shrimp trawl surveys	Habitat surrogates; surveys may inform or validate	Species and location caught	Point, start and end point of haul	DFO:J. Boutillier, G. Gillespie	survey design? Random?		Date back to 1963, 161228 records; limited spatial extents	
ShoreZone data	Habitat surrogates	One of 36 classes assigned to each along-shore line segment	Line segments	Prov. of BC	Province-wide		Only intertidal, difficult to infer information to subtidal habitats	
RMS tidal speed, temperature/salinity climatologies	Habitat surrogates	Mike Foreman (IOS) model output	grids	Available from Ed Gregr (SciTech) or M. Foreman (DFO)				
Kelp presence	Habitat surrogates						Kelp beds provide habitat for many invertebrate spp.	
Eelgrass beds	Habitat surrogates						Eelgrass beds provide habitat for many invertebrate spp.	

During expert review of the workshop report, an expert added these sources of information as useful to provide information on invertebrate communities:

- Nat. Parks Reports,
- Bamfield Marine Sta. rpt. #2,
- reports by Dan Quayle, Ed Ricketts, and other field biologists

Table 2: Invertebrate Foundation Species and Invertebrate Communities: Data Preparation and Targets

Marine Feature	Rationale	Measure	Target	Comments/ Justification for targets	Ecological Considerations	Comment
Foundation Species:						
1. Sponges *Aphrocallistes vastus* *Heterochone calyx*	Provide structural habitat for other species both alive and dead	Known locations – stratify north & south		Different species occur along latitudinal gradients		
2. Corals *Lophelia pertusa* *Stylaster campylecus* *Primnoa willeyi*	Provide structural habitat for species	Known locations – soft & hard corals				***Lophelia pertusa*** 3 D habitat. Only 2 localities known in BC ***Primnoa willeyi*** [Giant Pink-Orange Gorgonian coral] When dead is potential habitat
3. Molluscs *Vermetus compactus* *Crassadoma gigantean* *Mytilus* complex *Penitella penita*	Important benthic and intertidal species	Intertidal / subtidal; classes of habitat, according to sediment type				***Vermetus compactus*** [Little Tube-worm Snail] 3D habitat in tidal current areas ***Crassadoma gigantea*** [Purple-hinged Rock Scallop] shell covered by variety of inverts. ***Mytilus californianus*** [California Mussel] attachment fibers form protected living space in wave exposed habitats ***Penitella penita*** [Flat-tip Piddock] bore channels in shale which become protected habitat.
4. Segmented Worms *Eudistylia vancouveri* *Phyllochaetopterus prolifica* *Dodecaceria fewkesi* *Serpula columbiana*	Most abundant in term of biomass – produce structural habitat	Know locations? Or surrogate identified by subtidal soft sediments – Muds, sands, clays				***Eudistylia vancouveri*** [Banded Giant Feather-duster Worms] intertidal +floats and pilings ***Phyllochaetopterus prolifica*** [Colonial Parchment Tube Worm] intertidal & subtidal mud ***Dodecaceria fewkesi*** *[*Large

						Black U Worm] Condos in semi-exposed low & sub littoral
5. Crustaceans *Balanus glandula* *Balanus nubilus* *Ampelisca* sp *Neotrypaea californiensis*	Benthic disturbers and important intertidal community species, provide habitat for other species	Know locations? Or surrogate identified by intertidal / subtidal habitat classes – all sediment types				***Balanus glandula*** [Common Pacific Acorn Barnacle] {H} intertidal habitat ***Balanus nubilus*** [Giant Acorn Barnacle] subidal habitat ***Ampelisca* sp**. [4 eyed amphipods;] build condos which change habitat ***Neotrypaea californiensis*** [Bay Ghost Shrimp] burrow provides habitat for other spp.
6. Echinoderms *Strongylocentrotus purpuratus* *Amphiodia periercta*	Important predators in both intertidal and benthic communities – some keystone species	Know locations? Or surrogate identified by subtidal habitat classes – all sediment types				***Strongylocentrotus purpuratus*** [Purple Sea Urchin] rasp holes in sandstone which habitat for some spp. ***Amphiodia periercta*** [Giant Mud Burrowing Brittle Star] burrows are habitat for certain spp.
7. Algae **Rhodoliths**	Living reefs	Known locations				Ask Heather Holmes, and/or Andy Lamb
Habitat surrogates for invertebrate communities:						
Intertidal: Rock platform submerged at high tides	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Arbutus Pt, Portland Island, Tumbo Island
Intertidal: Rock substrate with high tidal current velocities	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Burnaby Narrows - Haida Gwaii
Intertidal: Protected surge channels	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Islets south of Anthony Island
Intertidal: Exposed surge channels	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Barkley Sound
Intertidal: Surge channels in caves	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Execution Rock, Areas specific to Barkley Sound

Intertidal: Sand exposed at high tides	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Isabella Islats, Saltspring Island
Intertidal: Low tidal mud flats adjacent to estuaries	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Cowichan Bay, Tofino
Subtidal: Rock Walls with high current velocities	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Active Pass, Gabriola Pass, Race Narrows, Clayquot Sound
Subtidal: Rock tops of seamounts	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Bowie, Explorer
Subtidal: Cobble, High tidal velocities in channels	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Sansum Narrows, sills in mainland fjords??
Subtidal: Sand with high tidal currents in constricted areas	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Race Rocks
Subtidal: Along shore currents	Area of distinct invertebrate community	Known or modelled locations?				**Examples:** Cherry Pt, WA
Pelagic habitat surrogates (zooplankton communities):						
Gyres	Aggregate zooplankton – important upper trophic level linkages					
Eddies	Aggregate zooplankton – important upper trophic level linkages					
Upwelling zones	Aggregate zooplankton – important upper trophic level linkages					
SST fronts	Aggregate zooplankton – important upper trophic level linkages					
SSH gradients	Aggregate zooplankton – important upper trophic level linkages					

4.0 Rare and Endangered Invertebrates Species and Unique Habitats

4.1 Introduction

This discussion considered federally and provincially listed threatened and endangered invertebrate species and unique habitat types that may be surrogates for distinct invertebrate assemblages. This warranted a separate section because of the increased research effort and data that exists for species that are required by law to be recovered and protected. Habitats that were either globally or nationally significant (rare) were also considered in this discussion.

4.2 Sources of Rare and Endangered Invertebrate Species and Unique Habitat Data

Data for rare and endangered species are generally held with the responsible agencies that are tasked with the recovery of listed species. Catalogues have been created, however limited data exist on the overall distribution and abundance of these species on a coast wide scale. Data that identify significant or rare habitat types are generally limited to benthic habitat mapping techniques and are in proportion to the distribution of those specific habitat types that exist within Canada's Pacific.

Observational data for some of the species is limited to opportunistic dive surveys, benthic sampling, fisheries by-catch and habitat modeling for specific species recovery efforts (i.e. abalone). Current data is not available for some species. Data sources identified at the workshop are listed in Table 3. Please fill any gaps, where you have knowledge, especially with respect to custodians of these potential data sources.

4.3 Features and Targets

Experts identified 8 features to be targeted in our analysis (Table 4). However, once a complete list of endangered species is compiled this may increase. Currently, seven of the features to be included in the analysis represent unique habitats and are meant to be surrogates for unique invertebrate communities. Some of these unique habitats may be difficult to map depending on available data. There was much discussion around setting targets and at least part of the difficulty was due to uncertainty as to what the available data might look like. Targets were therefore not set for most of the features in this exercise. However, it was recommended that rare invertebrate sitings be processed by buffering each occurrence, combining all species in one feature layer and then targeting that layer 100%.

4.4 Assumptions/Limitations

Recommendations for the features and targets were constrained by data availability and limited knowledge of where some of these species are distributed, their life histories and the fact that it is difficult to assign genuine rarity to a species or habitat types with limited survey effort.

4.5 Recommendations

The general recommendation of the group was to conserve all areas where endangered species are to known to occur, and ensure that we document the many known unknowns for rare marine invertebrate species.

Note to experts: Please review the list of features in Table 4 for completeness. (Remember that features are the actual layers of information that get targeted for conservation in the Marxan analysis.) Then, please add to the list of data sets in Table 3 if you can think of additional data that might inform any of the identified features.

Table 3: Rare and Endangered Invertebrates Species and Unique Habitats: Data Sources

Category (feature)	Dataset	Description	Geometry	Data Custodian	Extent	Key Fields	Comments	Pre-Processing
Rare and Endangered Invertebrate species locations	CDC list (see note below table)	Inventory list and locations of occurrence	Unknown	Conservation Data Centre (CDC)	BC	species status, date of siting/collection	Issues with lack of survey effort	Map all sitings, buffer, combine all species to one layer and target all
	Cosewic assessments, SARA Public registry	Inventory list and population status	Unknown	COSEWIC (Sandra Milan) and SARA Public registry	BC	Possible location and population information	Issues with lack of survey effort	
	Additional rare sitings and collections	Inventory lists and locations of occurrence	Unknown	Possible sources: Bill Austin List; Royal BC Museum collections (Phil Lambert); Bamfield Marine Sciences Centre	BC	Point locations, habitat features	Issues with lack of survey effort	
Unique habitats	NRCan, Multibeam, BC MEC, BMSC habitat types	In general, data held by NRCan, Multibeam survey data, data used to create the BC MEC, and data held at the Bamfiled Marine Science Center may help to identify these unique habitats		NRCan, Province of BC Ecounits, BMSC			Data source may be determined at subsequent workshop	
Unique habitats: Intertidal / subtidal caves	nautical charts	Cave locations?		Canadian Hydrographic Service (CHS)	BC		Data source may be determined at subsequent workshop	
Unique habitats: Deep sea vents	Deep Sea Vents			Possible sources: Canadian Hydrographic Service (CHS), Natural Resources Canada, University of Victoria	BC		Data source may be determined at subsequent workshop	
Unique habitats: Historical wreck / artificial reefs	sunken ships and artificial reefs	List of sites	Point locations?	Province of BC	BC			
Unique habitats: Abyssal plain	Deepwater ecology surveys			DFO	BC			

	Shrimp Trawl Surveys			DFO				
Unique habitats: Sea mounts	Sea mounts	location and areal extent of sea mounts	Bathymetric relief	CHS and NRCan	BC			
Unique habitats: Fjord walls	Fjord walls	Identify fjord walls from bathymetry data?		unknown	BC		All fjord habitats are not equal	
Unique habitats: Anoxic environments	Anoxic environments	Data gap?					Data source may be determined at subsequent workshop	

Important Note: the CDC list of 50 rare/endangered species compiled by Bill Austin for CDC represented examples only. A list could have been compiled of e.g., 100 species. Also, under the terms of the CDC criteria, rare might mean only rare in BC while common in e.g., Washington.

Table 4: Rare and Endangered Invertebrates Species and Unique Habitats: Data Preparation and Targets						
Marine Feature	**Rationale**	**Measure**	**Target**	**Comments/ Justification for targets**	**Ecological Consideration**	**Comments**
1. Rare and Endangered Species Locations, Populations	Obligations to recover; unknown degree of extirpation of marine invertebrates in BC	Population recovery targets or number of known occurrences	100%	Rare and/or endangered		Survey effort lacking
Unique habitats: 2. Intertidal / subtidal caves	Host distinct species assemblages	Known occurrences			Latitudinal replication	Survey effort lacking
3. Deep sea vents	Host distinct species assemblages	Known occurrences			Latitudinal replication	Survey effort lacking
4. Historical wreck / artificial reefs	Localized habitat	Known occurrences			Latitudinal replication	Survey effort lacking
5. Abyssal plain	Host distinct species assemblages	Known occurrences			Latitudinal replication	Survey effort lacking
6. Sea mounts	Localized habitat	Known occurrences			Latitudinal replication	Survey effort lacking
7. Fjord walls	Host distinct species assemblages	Known occurrences, linear extent?			Latitudinal replication	Survey effort lacking
8. Anoxic environments	Host distinct species assemblages	Known or modelled occurrences			Latitudinal replication	Survey effort lacking
9. Very high currents		Known occurrences				Nakwakto Narrows, Skookumchuk Narrows
10. High silicates throughout water column including surface		Known occurrences				Seymour Narrows
11. Very high wave exposure		Known occurrences				West coast of South Moresby I
12. Strong tidal currents in high (oceanic) salinity water		Known occurrences				Houston-Stewart Channel
13. Very warm surface water		Known occurrences				Pendrell Sound, Ladysmith

14. Very cold surface/ subsurface water		Known occurrences				Race Rocks
15. Moderately strong tidal currents in high salinity water in intertidal		Known occurrences				Bunsby Narrows
16. Sponge reefs		Known occurrences				

Note: Unique habitats #9 – 16 were suggested additions by experts during the workshop report review.

5.0 Conclusions

Overall, at least 26 features (more pending data acquisition) were identified for marine invertebrates. Pre-processing will be necessary to combine datasets from different sources for many of these features, and while targets were not set for any particular feature, it was widely accepted that equal habitat representation across the province is the most efficient way to capture the diversity of marine invertebrates in Canadian Pacific waters. Habitat combinations were discussed here but their associated datasets will likely be identified in the process to include physical marine representation in the BCMCA project. 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.

6.0 References

Ball, I. R. 2000. Mathematical applications for conservation ecology: the dynamics of tree hollows and the design of nature reserves. PhD Thesis. The University of Adelaide.

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

Day, J. C. 2002. Zoning--lessons from the Great Barrier Reef Marine Park. Ocean & Coastal Management 45:139-156.

Austin, W.C. 2000. Rare and Endangered Marine Invertebrates in British Columbia. *Proceedings on the Biology and Management of Species and Habitats at Risk*. BC Ministry of Environment, Lands and Parks. Kamloops, B.C.

Appendix 1: Detailed expert feedback

Inserted below are the workshop report review comments received from experts who participated in the workshop. Comments that were added directly to the document by experts have been incorporated into the text of the report and are not included below. Out of the 10 experts that attended the workshop, seven responded to requests for review of the Workshop Report. Out of the seven that responded, four had no comments and felt the Workshop Report adequately represented the proceedings of the workshop. Comments from the remaining three experts are presented in order of report section.

Question related to Project Background:

> One of the listed goals was to draw on knowledge and expertise from a variety of sources to develop sound, defensible methods and products. Once group that I didn't see as contributing, were first Nations and Traditional knowledge. Is there any way to incorporate some this valuable information?
> *Answer: This is a common question, if fact we address this issue in the FAQ section of our website. The project team supports the recommendations of its First Nations participants who have advised that First Nations' knowledge and spatial marine use is more appropriately mapped and analysed in a separate process that is designed and lead by First Nations, and that such a process will likely occur at a more regional or local scale capable of capturing individual First Nations' use and interests in greater detail than that permitted by the BCMCA's coastwide focus.*

Comments related to Features and Targets:

- I think the weighting of layers will be the most contentious part of the MARXAN analysis. Perhaps an example of possible weighting scheme may be helpful.

- I would think that [the BCMCA should be] also concerned with introduced species to the extent they can impact on native populations.

General Comments:

- Three experts expressed general concerns regarding the use of log book data in the spatial analysis.

Response: We will ask experts to review the prepared feature layers prior to the analyses.