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# Proceedings of the regional peer review for the identification of ecologically significant species, and community properties for the Western Arctic Biogeographic Region

**November 8-9, 2016**
**Winnipeg, Manitoba**

**Chairperson: Eva Enders**
**Editor: Kathleen Martin**

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501 University Crescent
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**Foreword**

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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## SUMMARY

Canada's *Oceans Act* authorizes Fisheries and Oceans Canada (DFO) to take an ecosystem approach to the integrated management of human activities in the sea. A component of this is to provide enhanced protection to species and community properties that are particularly significant to maintaining ecosystem structure and function. Species and community properties can be ecologically "significant" because of the functions that they serve in the ecosystem and/or because of features that they provide for other parts of the ecosystem to use.

Under the National Conservation Plan, DFO Oceans Program has been tasked with leading the development of a Marine Protected Area (MPA) Network in the Western Arctic Biogeographic Region. To inform ecological conservation priorities for this MPA Network, the Oceans Program has requested Science to identify Ecologically Significant Species and Community Properties (ESSCP) for this region.

A regional science peer-review was held November 8-9, 2016 in Winnipeg, Manitoba to provide advice on ESSCP. The meeting included participants from DFO Science and Oceans Program, Fisheries Joint Management Committee, the Canadian Museum of Nature, and the Universities of Manitoba and Waterloo.

This proceedings report summarizes the relevant discussions from the peer-review meeting and presents revisions to be made to the associated research document. The Proceedings, Science Advisory Report, and the supporting Research Document resulting from this advisory meeting are published on the DFO Canadian Science Advisory Secretariat Website.

# INTRODUCTION

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS), regional peer-review meeting was held on November 8-9, 2016 at the Freshwater Institute in Winnipeg, Manitoba. The purpose of the meeting was to provide advice on Ecologically Significant Species, and Community Properties (ESSCP) for the Western Arctic Biogeographic Region.

The Terms of Reference, including the objectives for the science review (Appendix 1) were developed in response to a request for advice from DFO Oceans Program, Central and Arctic Region. Participants included DFO (Science, Oceans Program), Fisheries Joint Management Committee, the Canadian Museum of Nature, and the Universities of Manitoba and Waterloo (Appendix 2).

One working paper was prepared and circulated to participants in advance of the meeting and was the basis for the review. The working paper identified information to support the identification of Ecologically Significant Species, and Community Properties (ESSCP) in the Western Arctic Biogeographic Region. It will be updated and published as a CSAS research document.

The meeting Chair welcomed participants and described the role of CSAS in the provision of DFO peer-reviewed science advice. Participants introduced themselves and described the expertise that they brought to the discussion. The Chair reviewed the Agenda (Appendix 3) and the Terms of Reference for the meeting, highlighted the objectives, and identified the expected products from the review (Science Advisory Report, Proceedings, and Research Document). Participants were reminded that everyone at the meeting was a participant and that they were expected to contribute fully to the discussions. Vanessa Grandmaison (DFO Oceans Program) was identified as rapporteur for the meeting. The conclusions and advice resulting from this review will be published as a Science Advisory Report (SAR) and will be used to inform ecological conservation priorities for the MPA Network in the Western Arctic Biogeographic Region.

# PRESENTATIONS

## ESSCP: PURPOSE AND APPLICATION

Presenter: Don Cobb

ESSCP fill an important gap in the suite of available management tools by considering ecological and biological significance from an ecosystem perspective, including species, functional groups, and processes that drive ecosystem structure and function. They are useful in situations where the species, functional groups or processes are not spatially or temporally explicit, and do not capture the importance of ‘whole’ ecosystem structure and function.

Examples of other management tools that may also be used on their own or in coordination with ESSCP include the following:

- Ecologically and Biologically Significant Areas (EBSA), which are spatially-based and often focussed on features (or spatially delineated processes),
- Integrated Fishery Management Plans (IFMP), which focus on species of commercial, recreational or aboriginal value,

- Listing under the *Species at Risk Act* (SARA) or identification as Sensitive Benthic Areas, which focus on sensitive and/or depleted species and areas.

ESSCP can provide the scientific basis for selection of conservation objectives for various Ocean Management initiatives (e.g., Integrated Oceans Management Plans, Marine Protected Area (MPA) Network planning, identification of new Areas of Interest (AOI) for marine protection, MPA conservation objectives and indicators, Marine Environmental Quality (MEQ) objectives and indicators).

ESSCP are 'information layers' that can be applied to a variety of management applications. They can and should be revised as new knowledge becomes available. To date, DFO has not attempted to assess ESSCP for any Canadian region, however there are examples where DFO has assessed a single species for ecological significance (DFO 2009a) and reviewed the ESSCP criteria for application in the Bay of Quinte (DFO 2014).

## DESCRIPTION OF STUDY AREA: WESTERN ARCTIC BIOGEOGRAPHIC REGION

Presenter: Don Cobb

The Western Arctic Biogeographic (WAB) region is described in DFO (2009b). It includes marine waters within the Yukon, Northwest Territories, and Nunavut. The western boundary, between this region and the Arctic Basin Biogeographic region, is the 200 m depth contour of the Beaufort Sea, thus, the western portion of the WAB region includes the Beaufort Shelf, Banks Island Shelf, and gateway to Amundsen Gulf. In addition, the WAB region includes Amundsen Gulf, Coronation Gulf, Queen Maud Gulf, M'Clintock Channel, Viscount Melville Sound, and M'Clure Strait. The deepest portions of the WAB region (~600 m) are located in Amundsen Gulf and Viscount Melville Sound.

Although this area is considered one region, there are many different environments (depth, water masses, etc.) within which species, species groups, and communities are distributed. There are dramatic seasonal extremes (e.g., full darkness, full daylight) and subsequent pulses of productivity. Sea ice dominates much of the year and there are ice-adapted (sympagic) species and communities. The various ice-related zones (landfast ice, pack ice, multi-year ice, rubble zones, flaw leads, polynyas) provide unique habitat features. Within the region, species residency time varies. There are limitations in data confidence and data availability for the area.

DFO (2015) used a biogeographic classification system to divide the Western Arctic Biogeographic Region into 18 types of habitats or ecosystems referred to as ecological units (eco-units). Dominant ecosystem features, sea-ice data, bathymetric data, sills and water mass information were the primary inputs used to delineate the eco-units.

### Comments and questions

A participant noted the issue of connectivity amongst different regions in the Arctic Ocean and adjacent seas, and the connectivity between the WAB region and Mackenzie River system (and other rivers) has not been addressed. This is a significant feature in the area that modifies biota and other indicators (fundamental processes). Depending on water depth, connectivity can be highly variable, and this should be captured in the research document.

The author agreed to expand the text by adding more information on the rivers and their impact on EESCP in the research document.

## NATIONAL GUIDANCE FOR ESSCP CRITERIA

Presenter: Don Cobb

DFO (2006) identified four criteria to be used for the identification of ESSCP:

1. Species or communities with important trophodynamic roles (forage species, influential predators, nutrient importing/exporting species, and species that carry out other important ecosystem functions),
2. Species that provide three-dimensional structure or support species that provide three-dimensional structure,
3. Aggregate and/or community groups and properties essential for ecosystem structure and function,
4. Species, if introduced by humans and were to become abundant, would compromise ecosystem structure and function (e.g., harmful algal species).

In addition, two types of modifiers were identified (rarity or uniqueness, and sensitivity [resilience]).

### Comments and questions

A participant noted that he is struggling with a clear definition of community properties. The participant also thought that connectivity is a key community property.

Another participant asked if the definition of temporal variability can be included as a community property in the research document.

## METHODS USED IN THE WORKING PAPER

In the working paper, species, species groups, and community properties were identified from the scientific literature and recent DFO presentations. Only species that were considered established in the WAB region were considered for the assessment. For example, Killer Whale (*Orcinus orca*) was not included. Aquatic invasive species and species with recent range expansions were also not included. Ecological importance was evaluated in terms of functional role (e.g., predators, forage species) and trophic or food-web relationship. The DFO (2006) criteria were applied, the results were scored and the level of confidence in the research or data was added.

Following a preliminary review of the report by the steering committee and species experts, the criteria were revised to better reflect the Arctic ecosystem and to focus less on fisheries themes. Species groups were added. Scoring was removed to avoid influencing the discussions. Species or species groups that fill an important trophic role in the food web (e.g., dominant species, keystone species, specialized species), are ecologically significant in the transfer of energy and biomass, or provide three-dimensional structure, which is important for one or more life stage(s) of other ecologically significant species, were identified.

It was not possible to evaluate lower trophic levels in this biogeographic region at a species level (long list, limited data), but they could be classified by habitat association (benthic, epi-benthic, pelagic, sympagic), and/or functional feeding group (filter feeders, detritivores, planktivores, predators). In some cases, it was also possible to identify representative species. The research document author is looking for input from meeting participants on how best to identify ESSCP for the lower trophic levels.

### Comments and questions

A participant asked why Polar Bear (*Ursus maritimus*) was identified as being resilient. This led to a discussion regarding the definition of resistance and resilience. It was suggested that both are relevant to the discussion but are related to how an organism(s) or an emergent property of the ecosystem respond to perturbations and should be used as modifiers.

A participant asked how this process considers species that may become prevalent in the future. The author indicated that such species are not captured in the report as they are not fully established in the region. Another participant suggested that the term 'invasive' species could be changed to 'non-indigenous' species. Further, another participant highlighted the need to differentiate non-indigenous species as being either 'invasive' or 'colonising'. Participants recognized that both types of non-indigenous species can have a large impact on other species in an ecosystem, and that this should be captured in the advice.

The science advisory report will need to identify the scope used to consider species during this assessment and then explain the limitations. This will be captured as an uncertainty and should include the need to re-evaluate ESSCP in the future. The research document should identify species that we are aware are extending their distributions into the region but which are not considered established.

# ASSESSMENT

## CRITERIA FOR ESSCP

In the national guidance (DFO 2006), definitions were not provided, making it difficult to apply the criteria consistently. Some of the definitions had embedded within them meanings that were not mutually exclusive. This led to a discussion of separating criteria into categories (i.e., distribution, ecosystem component contribution, energy transfer, specialization, habitat-creating or -modifying).

There was concern that the outcomes might be biased if 'double counting' was not controlled. However, there may be instances where this is appropriate. For example, Arctic Cod (*Boreogadus saida*) was identified as a keystone species and it is central in the food web under the energy flow criteria.

The assessment is based on an ecosystem view point, thus, consideration of both top-down and bottom-up processes are needed.

During the meeting, participants discussed what was meant by the criteria and came up with definitions (Appendix 4) that were then used to evaluate species and species groups against the criteria. This altered what was considered under some of the criteria identified during the national process. For example, since the criterion for 'habitat-creating or -modifying' was added, 'three-dimensional structure-creating' was removed from the definition of dominance. 'Export and import of energy' was moved under 'horizontal transport' related to energy transfer.

A participant asked how the report would differentiate between knowing versus inferring when a criterion was met. The report author pointed to the certainty categories that would be used in the assessment (Appendix 5).

The definitions from the appendices (criteria and certainty) are captured in the research document and referred to in the science advisory report.

A table (Appendix 6) with the criteria and the list of species or species groups, that participants thought should be considered as ecologically significant, was developed.

The species and species groups were subdivided within the table into categories: marine mammals, marine birds, anadromous fishes, marine fishes, benthic invertebrates, zooplankton, prokaryotes, eukaryotes, and planktonic detritus (including living and non-living components).

To better evaluate the criteria, the table (Appendix 6) with the list of species and species groups that participants felt should be evaluated was filled out by the participants during the meeting. Although the table was initially populated with marine mammals at the start, the intent was not necessarily to keep this order in the final document as the order might be used to imply a priority, which was not supported by the assessment. A participant indicated that the order in the table might bias the results.

A participant pointed out that it is worth noting when we agree that a species meets or does not meet the criteria, as opposed to not knowing enough to evaluate the criteria (i.e., no data/information).

Participants were reminded throughout the meeting that the scope of the assessment was the WAB region, i.e. limited to <200 m depth in the Canadian Beaufort Sea (Beaufort Shelf and Mackenzie Estuary), but also including Amundsen Gulf, Viscount Melville Sound, Coronation Gulf, and McClintock Channel.

## Distribution

A participant pointed out that the criterion regarding distribution within the biogeographic region should remain in the table. Initial discussion began with identifying even versus patchy, and widespread versus localized distributions. As the table was filled out it became clear to participants that the patch or even distribution categories were not being assessed in the same way for all species groups. Initially, participants tried adding descriptors for patchiness relative to available habitat but there still remained problems with evaluating this criterion in a consistent way. Bowhead Whale (*Balaena mysticetus*) and Beluga (*Delphinapterus leucas*) would have widespread, patchy, seasonal distributions, while Arctic Cod, for example, are dispersed evenly most of the time but on occasion aggregate into large schools (i.e., patchy). Ultimately participants agreed to remove the patchy/even criteria.

Seasonal versus year-round residency within the biogeographic region was included under distribution. Seasonal movement also captured energy transfer into and out of the biogeographic region. So as not to double count this criterion, a second horizontal transfer column for energy transfer into and out of the biogeographic region was not included.

## Ecosystem component contribution

### Contribution to ecosystem biomass

Dominance was the term initially used in the discussions related to contribution to ecosystem biomass. The discussion evolved to an evaluation of abundance or biomass and was ultimately changed to ecosystem component contribution. Participants agreed that abundance should not be compared within the groups but should be compared among groups. When Beluga, as a species, is compared to bacteria, bacteria are numerically more dominant. Participants agreed to use the relative biomass information for the species categories (Figure 1). An estimate of the relative percent contribution would be included for each of the species categories.

Participants discussed the use of biomass determined from a model. It was pointed out that care needs to be taken describing the biomass criteria in the text. It should clearly describe the process used to determine the biomass estimates and how they were used in the evaluation criteria. It may help to include a trophic pyramid in the research document to appropriately depict the concept of trophic structure. The biomass estimates were not provided for within-trophic comparisons in the table thus there is no inherent relative importance implied within species groups. A participant suggested that this be added in the text. The model was based on the Beaufort Shelf region so there was concern that there were insufficient data to separate out individual species within groups. A participant asked that the species that contributed most to the biomass of marine mammals be identified with an asterisk in the table. A confidence value of 'low' should be assigned for ESSCP groupings that differ from the biomass groupings in the EcoPath model. Participants agreed with this approach.

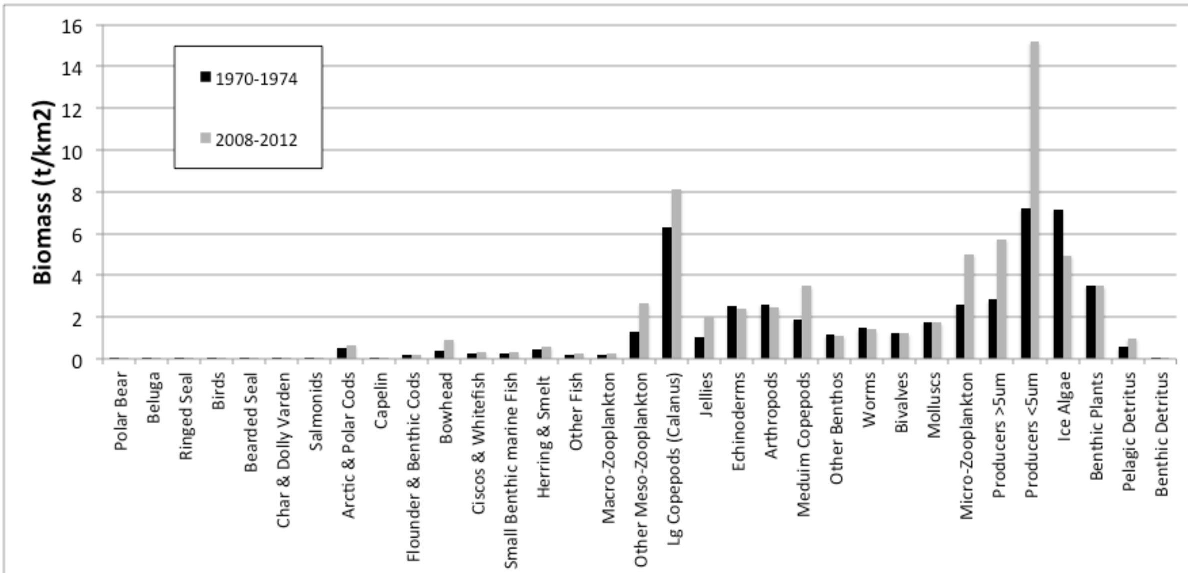


*Figure 1. Relative biomass for species and species groups estimated using an EcoPath model for the Beaufort Shelf (< 200 m, C. Hoover, Fisheries and Oceans Canada, pers. comm.).*

A participant asked how the modelling accounted for import and export of energy. It was noted that the model was a closed system model but took into account the seasonal inhabitants, such as marine mammals. The lower trophic levels are considered resident. The fundamental assumption in the model is that nutrient import and export are equal. This should be noted in the text. The model provides valuable guidance, however, it was developed for the Beaufort Shelf and there was hesitation on applying it to the entire biogeographic region, which should be captured as an uncertainty.

The relative importance of the species groups might be identified in the text. In the text of the research document, it would be particularly important to  to describe  the trophic level and its components.

### Centralized ecosystem component

A participant thought it might be possible to evaluate dominance by identifying what would happen if a species or species group was removed from the ecosystem. For example, what would happen if Polar Bear or if Rainbow Smelt (*Osmerus mordax*) were removed from the ecosystem? In the former, an increase in Ringed Seal (*Pusa hispida*) might be expected, in the latter there might not be a noticeable effect. A participant pointed out that if bacteria were removed the ecosystem would collapse.

Initially this criterion was identified as keystone species, which are defined as pivotal species. A keystone species is one whose effect on its community or ecosystem is large, and/or disproportionately large relative to its abundance (e.g., Arctic Cod, Ringed Seal). This criterion is biased toward species that are data rich. A participant pointed out that they thought Arctic

Cod and Ringed Seal, from their perspective should be considered keystone species. From the modelling, Arctic Cod come out as the highest keystone species (Figure 1). Participants questioned whether *Calanus* spp. might also be considered as a keystone species but there was no agreement.

After further discussion, the criterion was changed to controlling ecosystem processes. In evaluating this criterion, categories with low biomass would not control the system. Participants discussed this category further and evaluated it by asking if the component was central to the ecosystem processes.

A participant described this criterion using the “wasp waist” concept for the ecosystem: Most of the energy tracks through one organism in the food chain. It is like a pipe of set diameter controlling everything above, in the food chain, and everything below. The pipe controls the amount of flow of energy in the form of food through the ecosystem. Arctic Cod, Ringed Seal, and *Calanus* spp. fit this description and were identified in the table (Appendix 6).

Following these discussions, the term keystone species was removed from the table and the central component (control valve) was used to capture the “nodes” originally described under the energy transfer category.

## Energy transfer

A participant suggested that the fundamental property of energy and energy transfer is important in the discussion of significance. It includes both vertical and horizontal transfer.

While scoring the fishes, it became clear that there are uncertainties about where fishes move (within and outside of the region) on a seasonal basis. Fishes may change their position in the water column and move horizontally on a seasonal basis. This type of habitat shift was not captured elsewhere.

### Vertical transfer

Participants were not sure how useful the vertical transfer column would be for some species like marine mammals. Many marine mammals have the ability to dive. Some are more benthic focused feeders (e.g., Bearded Seal [*Erignathus barbatus*]). A participant asked what does this tells us. It might be helpful to distinguish them from Ringed Seal, for example, that have the capacity to feed both from the benthic and pelagic zones. A participant felt it would be useful to distinguish energetic consumption for those species that can feed in different eco-zones. A participant also noted that it would be important to note if the species or species groups were transferring energy or accumulating it. This was included in the research document.

Marine offshore fishes would be involved in vertical energy transfer except those tied to the sediments. Greenland Halibut (*Reinhardtius hippoglossoides*) is associated with the bottom but also clearly moves up into the water column to feed. Certainty for vertical transfer would be High for Arctic Cod and Greenland Halibut. For pelagic marine fishes present in over 50 m water depth, there appears to be no relationship to benthic-pelagic coupling because these fishes generally remain up in the water column. The benthic invertebrates do not actively move vertically in the water column. *Calanus* spp. purposefully move downward in the water column during winter. Gelatinous species likely also move vertically in the water column but this should be verified with an expert.

Passive movement only applies to active organisms when they die.

Participants suggested that in the Research Document, the author should include information on the contribution of each species or species group to benthic-pelagic coupling (i.e., coupling strength rather just the occurrence), since it is a fundamental component of Arctic ecosystems.

The benthic-pelagic coupling is weaker in deep water than over the shelf and there are differences between primary productivity groups.

#### Horizontal transfer

Participants discussed whether the seasonality under distribution was the same as horizontal energy transfer. Participants agreed these criteria differed as the distribution criterion was not just about energy transfer. Horizontal transfer is tied to life history and size of organisms and needs to be described in the research document. Small plankton would not transfer energy horizontally (unless they were entrained in a water mass that was moving) while a large Bowhead Whale would. There are also some species (e.g., Polar Bear) from an energy transfer perspective that can transfer terrestrial energy into the system.

Trophic energy flow through the food web was originally captured under the Energy Transfer criterion. It considered the number of nodes as a measure of the linkages and the complexity in the food web. This concept may work for species, but it is not applicable for communities. It was not initially clear if this was to be captured on a scale (high, medium, low). Participants thought it should capture the strength and number of nodes. The discussion then turned to whether this was the same as the centralized ecosystem component. One participant thought that the centralized ecosystem component has to do with what happens to the system when something is taken out of it. The strength of the nodes/relationships describes the trophic relationship. Participants were unclear what was meant by the strength of nodes or how this would be captured in the table, so this concept was amalgamated with the centralized ecosystem component.

#### Relative importance to the ecosystem

Participants felt that the best approach would be to establish a category for overall relative importance to the ecosystem from an energy transfer perspective. This concept captures in a qualitative way relative importance based on the criteria discussed during the meeting. It considered complexity of trophic interactions (in part how many organisms do they feed on and how many feed on them), diversity of the community, and the importance of all interactions on the ecosystem. With increasing water depth, biological diversity generally declines, and the relative biomass of individual species also decreases relative to more shallow habitats. A logical extension is that the number of nodes or feeding linkages therefore decreases with increasing depth. In addition, body size of invertebrates decreases with water depth. However, the converse is true for marine fishes, which tend to increase in average body size with depth for most species in the WAB.

Participants categorized relative importance to the ecosystem as Low, Moderate or High, and ranked this criterion based it on the expert opinion as a group. The rationale for the rankings should be described in the research document.

In the context of energy transfer, marine mammals were generally considered to have low importance in the ecosystem. Ringed Seal was the only marine mammal species rated as Moderate since it has a strong link to Polar Bear and has therefore more nodes relative to the other marine mammals. Marine birds were considered Low because of their use of the area for staging before leaving the region. Anadromous fishes would be Low as they link more strongly to the freshwater environment. Arctic Cod would be High and Greenland Halibut would be Low. Coastal marine fishes would be Moderate to High because the coastal area has a lot of energy transfer within it. The small nearshore benthic marine fishes would also be Moderate. As the benthic or bentho-pelagic community (50–200 m) generally excludes large abundances of older/larger Arctic Cod, it was rated as Low. Pelagic marine fishes would be considered Moderate because of their importance to marine birds in the ecosystem.

Nearshore benthic invertebrates for hard bottom communities were rated Moderate while the soft bottom communities were rated Moderate to High (important source of food for marine birds and marine mammals). A participant described the hard bottom environments as having fewer species and those species (sponges, echinoderms, and cnidarians) being less important as food for fishes and marine mammals. Participants asked if this was a bias in the sampling or based on our knowledge of these communities. Deep water environments have lower biomass of invertebrates and were therefore rated as Low importance.

Microzooplankton were identified as being Low to Moderate as they are important to the food web but are not a primary prey item for fishes. Mesozooplankton are important as fish food, so they were rated as Moderate to High. Macrozooplankton were considered key prey items for the Arctic Cod and Ringed Seal and were rated as Moderate to High. Knowledge of pteropods is limited but they are not considered an important link in the food web, consequently they were rated Low. Gelatinous species were rated Low to Moderate. They are very abundant and are likely more important to the ecosystem, however, very little is known about them. Question marks were added to the evaluation table for both species groups. *Calanus* spp. was rated High. Small pelagic phytoplankton were rated Moderate. Larger phytoplankton were rated High as they feed the pelagic food web and sink to the bottom so are important for both energetic pathways. Ice-associated algae were identified as Moderate to High importance.

Toxin-producing algae would have High impacts on the ecosystem but were rated as Low for their importance to the food web, based on current abundance. They do, however, exert a disproportionate impact on the ecosystem relative to their abundance.

Microbes were rated Medium to High as they are food for smaller organisms and benthos, and they form aggregates that even the larger species feed on. Planktonic detritus was rated Low to Medium in the Beaufort Sea, the material is being cycled in the pelagic rather than being exported to the benthos. This process is documented in the literature.

#### Feeding type

There are different ways individuals and species groups acquire energy (e.g., passive feeders, active feeding, active predation, active filter feeding). Active predation is selective. Bowhead Whale select areas that are rich in food but they do not specifically select the type of food they consume. They feed on anything in the water column. Participants felt that something about the type of feeding should be considered in the assessment to acknowledge it may be important to determine ecological significance. It was suggested that feeding should be subdivided into selective and non-selective feeding and active versus passive feeding. Bowhead Whale would be an active non-selective feeder. There was some concern that this would cause repetition in the table. Participants suggested capturing this under the energy transfer criteria rather than under the specialization criteria.

Some of the marine fishes were identified as being non-selective active feeders because they feed on anything that fits into their mouths. Arctic Cod, for example, will choose the largest, most lipid-rich zooplankton. Based on diet studies, they actively select food. Greenland Halibut are active selective feeders. Coastal fishes are also active but are generally non-selective.

Benthic invertebrates on hard bottoms are often sessile (attached to the substrate) and are filter and suspension feeders so they would be non-selective and passive compared to other species. However, benthic communities in both soft and hard bottoms include all feeding types. They are mixed although the proportions may differ between different habitats (e.g., substrate, water flow, depth). A participant noted that filtering bivalves may be passive compared to marine mammals but they are active compared to other soft bottom species. Lots of bivalves are also deposit feeders. Therefore, benthic invertebrates were identified as Mixed, as were the Gelatinous species.

Micro and macrozooplankton are selective and active feeders. The participants were not sure about mesozooplankton. They considered that they are selective but were not sure if they actively select their prey. This should be confirmed with an expert. Pteropods are non-selective and passive feeders. Feeding type was identified as being not applicable for phytoplankton.

### Specialized habitat association

A participant noted that, in general, Arctic species should not be considered specialized. There is not a huge food source in the Arctic on which to specialize. Bowhead Whale were used as a second example and the table was completed for them. Their specialized filter-feeding in the pelagic zone was initially considered functionally unique but this led to further discussion of specialization and feeding type. Participants decided that specialization should be changed to specialized habitat association, and that functional-uniqueness was a separate criterion.

Ice was used as an example of a habitat specialization. Bowhead Whale would be considered a habitat specialist as they chose specific areas with upwelling that concentrates food items. More details should be included in the research document to capture the significance.

Bearded Seal rely heavily on multi-year ice. Ice is one type of habitat used, but does not reflect the full range of habitat associations. Bowhead Whale choose areas with high prey aggregations. Polar Bear use first year ice to get off the coast and to hunt Ringed Seal. Marine birds were associated with leads and polynyas in the spring.

Whitefishes such as Broad and Lake Whitefish feed where there are soft bottom sediments, whereas ciscoes feed pelagically.

Participants discussed habitat specializations of Arctic Cod. They are ice associated when ice is present, but a participant wondered if it was their preferred habitat, or whether they were utilizing this habitat to seek refuge from predators. Information from the Beaufort Sea Marine Fishes program has identified the association of Arctic Cod with the 200–450 m depth range in the Beaufort Sea (i.e., within the adjacent Arctic Basin Biogeographic region) during summer months in some years. However, information for the WAB region is limited. Habitat use by Arctic Cod seems to be dependent on the relative abundance and age of individuals.

Greenland Halibut was not assessed as having any specific habitat association, although participants discussed the occurrence of larger individuals in deeper waters offshore and its primarily benthic habitat association with evidence of feeding activity in the lower pelagic zone.

The invertebrate communities can be delineated by habitats. The hard bottom organisms are associated with high currents. The substrate is a surrogate for the strength of the current.

Zooplankton as a whole were not assessed as having any specific habitat association, although communities are generally depth-associated within the pelagic zone, where some species are associated with certain water masses.

Ice-associated algae by definition are associated with ice and phytoplankton is associated with the euphotic zone (surface waters, sunlight).

Macrophytes, like kelp, need hard stable substrates.

### Habitat-creating or -modifying

A participant pointed out that the habitat-forming criteria would apply to more than kelp, it should include organisms that modify their habitat in a way, which creates a whole new colonization for other organisms. The ‘habitat-forming’ criterion was modified to distinguish between ‘habitat-creating’ and ‘habitat-modifying’ species.

These criteria do not apply to marine mammals, birds or fishes. Kelp is habitat-creating, as are many of the epibenthic faunal categories. There are generally more habitat creators (structuring species) on hard bottom environments than on soft bottoms. Many macrofaunal species modify sediments through bioturbation which favors fine-scale heterogeneous habitats for micro- and meiofaunal species. Ice-associated algae are also habitat-creating as they generate long strands that are used as habitat by small fishes. Planktonic detritus is also habitat-creating.

Habitat-modifying taxa include infauna (soft bottom) and epifauna. Ice-associated algae also modifies habitat by creating mucous.

## MODIFIERS

### Functional uniqueness

Uniqueness was not identified as a criterion for ecological significance in the national process (DFO 2006) but was considered a modifier. Participants noted that if uniqueness was just meant to identify uncommon, how would this be translated into ecological significance and how would this be operationalized? It may be that protection could be afforded to rare species, but it may not be because they are ecologically significant. It was agreed that uniqueness should not consider rarity but should focus on “functional” uniqueness.

A participant pointed out the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) uses a scaled uniqueness criteria; unique to Canada, unique to an area within Canada, unique to an eco-zone. A similar approach may be used in the current assessment.

A participant noted that the scale of the assessment is the WAB region, which does not include rivers and lakes themselves. Subsequently, rivers and lakes where Dolly Varden (*Salvelinus malma*) occur were not being considered in the assessment but their seasonal use of the estuarine and coastal habitat was.

Participants suggested leaving uniqueness in the table and once it was scored it might become more apparent as to how it may or may not factor into the assessment of ecological significance. A participant noted that there are very few pelagic fishes in the region (about 7 of 70 species) but that they are functionally unique. In that context, they would be relevant from an ESSCP perspective.

A participant pointed out that functional uniqueness is important from a species perspective. It relates to resilience; if there is no functional redundancy in the ecosystem there is limited resilience. There would not be a replacement for a species if it were lost from the system. Embedded within this is the concept of community properties versus taxonomic properties. Functional uniqueness or its converse provides resilience and resistance to the community.

Bowhead Whale were considered functionally unique for their feeding adaptation. A participant suggested Narwhal (*Mondon monoceras*) were functionally unique recognizing the use of their tusks and that they are more selective feeders than Beluga. Participants were looking at this in terms of whether there was functional redundancy in the ecosystem, or a unique behaviour. Looking at functional uniqueness in terms of the ecosystem at large, Bowhead Whale are the only species that filter-feeds and accumulates the food into a large “package” and would therefore be considered functionally unique. Polar Bear are unique in their ability to feed on other marine mammals. The pelagic marine fishes are functionally unique with respect to other fishes. Ice-associated algae are also considered unique.

A participant suggested that stable isotope analysis (lipid compositions) might be used to support identification of uniqueness within the ecosystem.

One of the participants identified that the bacteria (heterotrophic microbes) should be considered a functionally unique group as they both produce and consume nutrients.

## Resistance

Resistance is the quality that leads species or communities to withstand perturbations. In the context of ecological stability, resistance is the property of communities or populations to remain "essentially unchanged" when subject to disturbance.

Participants populated the table for this modifier, ranking species or species groups as Low, Medium or High. Species groups, with a mix of species are more difficult to evaluate. The characteristics of species in the group may cancel each other out. For example, Dolly Varden would have low resistance, but there are other species in the group, which would mean, the species group as a whole, would be considered to have moderate resistance.

Participants were unsure of the scoring of some species groups in this category.

A participant noted that when discussing the resistance for invertebrates, perturbations are important to consider. Currently, the resistance is High because there are no perturbations, however, they are not physically resistant to these perturbations. For species groups like echinoderms, resistance is higher for nearshore communities because they have adapted to natural perturbations. As you move down the shelf, resistance can be Medium, and the deep area it is Low because the area is so stable and the species or communities do not have this natural resistance.

Another participant pointed out that Arctic Cod exhibit high inter-annual fluctuations, suggesting that their resistance potential is low. However, the population has the capacity to recover relatively quickly, representing a degree of natural resilience.

## Resilience

In ecology, resilience is the capacity of an ecosystem to recover quickly in response to a perturbation or disturbance.

K-strategy species were considered to have lower resilience than R-selected species.

Participants filled out the table for this modifier, ranking species or species groups as Low, Medium or High. Species groups, with a mix of species are more difficult to evaluate. The characteristics of species in the group may cancel each other out. For example, Dolly Varden would have medium resilience comparable to the species group as a whole.

Participants were unsure of the scoring of some species groups in this category. Checking the ages of the bentho-pelagic fishes (50–200 m depth) might clarify whether Medium is appropriate for them.

For invertebrates, a participant suggested that overall, they have low resilience. However, there are some species that are high because they are able to come back especially in the nearshore. It is important to consider the life cycle. There are no slow growing corals in the near shore area because they would not survive.

Participants suggested that the confidence in the data for both resilience and resistance is likely low and is mostly inferred and questioned whether this should be kept in the table. Another participant suggested that there are different strengths for these inferred decisions. For marine mammals, our inferences may be high because a lot is known about their life history. For organisms in which information on their life history or specifics to this area are limited, the certainty decreases. The information, however, is useful.

It is very important to identify in the research document the differences between dealing with a specific species and dealing with species groups or whole communities. For example, phytoplankton as a group has High resilience. Some of the species would be resilient, so the community that bounces back will not necessarily be the same as the one that was first perturbed. Shift in species composition may impact transfers within the system. Species shift may result in changes to size fractions as well.

Participants suggested considering the scale of the fluctuations in nature. Life cycle parameters drive resilience. It is also dependent on where the species are located.

Smaller phytoplankton are more resistant than larger phytoplankton and would have High resilience (as they grow fast). A participant noted, however, that most fluctuations in phytoplankton are explained by grazing.

Ice-associated algae would have Low resistance and High resilience. Macrophytes were considered to have High resistance because their habitat changes a lot and they grow fast so resilience would be High.

### Rarity or uniqueness

Participants discussed whether rare species added value to the assessment. To some extent they may be captured under Functional uniqueness. A participant thought that they might highlight the importance of kelp, which they thought is likely rare. Another participant felt that there were insufficient data to evaluate whether or not these species or communities were rare. In some processes, this criterion uses the COSEWIC status of a species as a proxy for the criterion. Details on why the species was assessed as a particular designation would be needed rather than just using the designation. Participants agreed not to include this as a modifier in the table.

## SPECIES EVALUATION EXAMPLES

Beluga was the first species used to evaluate against the criteria in the table. Beluga were not considered highly specialized feeders and they are not specialized in terms of their habitat.

Arctic Cod were the next species addressed in the table. Arctic Cod have widespread, patchy, year-round distributions. They are critical for vertical transfer. They probably are responsible for some horizontal transfer within the biogeographic region. They may not provide the same horizontal transfer of energy between regions, like marine mammals do. They are not specialized feeders. In the Beaufort Sea, the adults are focused on the slope, while immature individuals are more widely dispersed. They have an important influence on the food web with multiple linkages above and below them on the food web. They do not modify their habitat. They likely have a medium level of resistance, and a high level of resilience. They are not rare.

Benthic invertebrates were divided into epibenthic and infaunal species group or communities. All are widespread, and patchy in terms of species composition. None are currently known as keystone species. Trophic nodes are linked to both epifauna and infauna. They are responsible for passive vertical transfer (i.e., movement of energy through trophic levels). Some also actively move into the water column (e.g., suprabenthic species). As this is a species group, various feeding types are represented. There are key habitat associations (hard bottom) for epibenthos. Resistance is low for both types of benthos but epibenthic resistance and resilience is low compared to infauna. A participant indicated that the resilience should be evaluated in comparison to fishes and other species groups rather than to other benthic invertebrates.

A participant noted that the text in the research document should provide more details about the rationale for the information (scoring) included in the table.

## SPECIES AND SPECIES GROUPS

Before attempting to score more species in the table against the criteria, participants discussed the species and groupings that should be included. Marine mammals should include Polar Bear, Narwhal, Beluga, Bowhead Whale, Bearded Seal, and Ringed Seal. Atlantic Walrus (*Odobenus rosmarus*) would not be included.

Sea ducks (eiders), loons, and gulls were grouped together. The group includes marine birds that move into the region for staging. Canadian Wildlife Service information suggests that these are the birds that are key in the region. Murre and Guillemot were not included as they do not occur in large numbers in the region. Their breeding sites were captured during the EBSA process.

Anadromous fishes were divided into two groups, the nearshore pelagic feeders that are geographically mobile and the benthic feeders that are not geographically mobile. The nearshore pelagic feeders include Arctic Char (*Salvelinus alpinus*), Dolly Varden, Arctic Cisco (*Coregonus autumnalis*), and Rainbow Smelt and are found in both 0–5 m and 5+ m depths and move farther into the marine environment. The benthic feeders include Lake Whitefish (*Coregonus nasus*), Least Cisco (*Coregonus sardinella*), and Broad Whitefish (*Coregonus clupeaformis*) that are restricted to the nearshore estuarine zone in 0–5 m water depths. It was noted during the discussions that Least Cisco tend to be pelagic nearshore feeders while other species may be better described as benthic feeders. A participant indicated that there is a difference in the habitats and the environments at about 10–20 m water depths. Inshore of the 20 m isobaths, it is freshened and very dynamic in terms of wave action, variable temperature and salinity (temporally). Consequently, the fishes that are found here tend to be a different community that is tolerant to variable conditions in comparison to the fishes that occur beyond the 20 m isobaths. Therefore, it makes sense to differentiate this zone from the shelf, and then further split fish into pelagic and benthic habitats. Adding these categories improves the potential to assess impacts and stressors on ESSCP.

Participants discussed whether the two fish groups were broadly distributed across the region or if they were more restricted to the Beaufort Sea and whether the groupings should reflect where the research was focused. Anadromous chars occur across the region although most of the Whitefish species are found in the Beaufort Sea area rather than being distributed throughout the region. Furthermore, Dolly Varden and Arctic Cisco are transboundary species (Canada/U.S.).

Within the Beaufort Sea, the fish communities had been grouped into the nearshore shelf (20–75 m depth), offshore shelf (75–200 m depth), upper slope (200–500 m), and lower slope (500–1000 m). Participants agreed that Arctic Cod and Greenland Halibut could be separated from whatever other marine fishes were included within these groups. Arctic Cod was separated because of its pivotal role in so many food chains and Greenland Halibut because it is a large carnivorous predator. The groups of marine fishes would be separate from these two species to avoid overlap. All participants recognized that by grouping species certain criteria could not be scored but felt that there was a benefit to including them in this assessment. There was discussion about basing the groups on location (e.g., upper slope, shelf) or feeding behaviour.

The final groupings of marine fishes that follow were identified through a combination of approaches:

- Arctic Cod,
- Greenland Halibut,
- Coastal marine fishes, 0–10 m depth, variable environment (e.g., Fourhorn Sculpin [*Myoxocephalus quadricornis*], Arctic Flounder [*Liopsetta glacialis*]),
- Small nearshore benthic marine fishes, 10–50 m depth (e.g., Capelin [*Mallotus villosus*], some sculpins); these fishes are eurythermal and euryhaline, i.e., able to tolerate a wide range of temperatures and salinities,
- Benthic or bentho-pelagic marine fishes, 50–200 m depth (e.g., eelpouts, snailfishes, some sculpins),
- Benthic large bodied marine fishes, > 200 m depth (e.g., Arctic Skate [*Amblyraja hyperboreus*]; excluding Greenland Halibut, which were treated separately),
- Pelagic marine fishes, > 50 m depth (e.g., Pacific Herring [*Clupea pallasii*]).

It was highlighted that for some of these groupings, specifically Arctic Cod, Greenland Halibut, and benthic large-bodied marine fishes occurring at >200 m, information used in the assessment was based on recent data collected from the offshore Beaufort Sea, within the adjacent Arctic Basin Biogeographic region.

Next, participants began to discuss the groups to use for invertebrate and other lower trophic level species and species groups. Participants felt that dividing into groups was important to capture different patterns of energy flow through the groups. Size fractions and feeding types (e.g., filter feeders versus predators) might be important to capture for some of these taxa. Participants felt it was important to identify ESSCP groupings with functional differences within the grouping. For example, fishes were grouped by a combination of depth zone and feeding type (benthic vs pelagic), and likely have limited functional diversity within the groupings. However, some of the invertebrates were grouped by depth zone, bottom type, taxonomy, or some combination of these factors, and would therefore have significant functional diversity within the groupings themselves (e.g., predators, scavengers, detritivores, deposit- and filter-feeders).

The initial categorization of benthic invertebrates was into epifauna, which included mostly megafauna and infauna, which included micro-, meio-, and macrofauna. Epifauna are characterized by species whose typical habitats are on the outer surface of their environment (e.g., animals living on top of the sediments) while infauna include aquatic organisms that live within the dominant medium of their environment, but especially within aquatic sediments. An approach similar to that taken for fishes was applied to the invertebrates. Participants indicated that this was not just relevant to the Beaufort Shelf but applied across the region.

The separation of invertebrates, by epifauna and infauna, bottom type and depth, parallels the approach taken for fishes. These categories link to the rest of the Arctic marine food web and to the upper trophic levels and ecosystem functions such as nutrient cycling, etc. The categories can be applied across the Canadian Arctic but scores may differ.

Epifauna were divided into the following species groupings:

- Nearshore hard bottom, 0–50 m depth (e.g., Sponges, Echinoderms, and Cnidarians),
- Nearshore soft bottom 0–50 m depth (e.g., Echinoderms, Arthropods, and Bivalves),

- Shelf hard bottom 50–200 m depth (e.g., Sponges, Echinoderms, and Cnidarians),
- Shelf soft bottom 50–200 m depth (e.g., Echinoderms, Arthropods, and Bivalves),
- Deep hard bottom > 200 m depth (e.g., Sponges, Echinoderms, and Cnidarians),
- Deep soft bottom > 200 m depth (e.g, Echinoderms, Arthropods, and Bivalves).

Infauna were divided into the following species groupings:

- Nearshore soft bottom 0–50 m depth (e.g., Polychaetes, Bivalves, and Arthropods),
- Shelf soft bottom 50–200 m depth (e.g., Polychaetes, Bivalves, and Arthropods),
- Deep soft bottom > 200 m depth (e.g., Polychaetes, Bivalves, and Arthropods).

Zooplankton were grouped by size class (micro-, meso-, and macrozooplankton) and key species within these groups were highlighted as examples. It was suggested that *Calanus* spp., gelatinous species, and pteropods should be assessed separately from other zooplankton groups, to be consistent with the approach used for other trophic groupings. The harder shell of the pteropods was the rationale suggested for assessing them as a separate candidate ESSCP.

The following are the zooplankton groups identified:

- Microzooplankton,
- Mesozooplankton (e.g., *Pseudocalanus* spp.),
- Macrozooplankton (e.g., *Themisto* spp., *Thysanoessa* spp.),
- Pteropods,
- Gelatinous species,
- *Calanus* spp.

Groupings for the remaining marine eukaryotes and prokaryotes were as follows:

- Pelagic phytoplankton, < 5 µm (pico plankton) (e.g., *Micromonas* spp.),
- Pelagic phytoplankton, > 5 µm (nano and micro plankton) (e.g., *Chaetoceros* spp.),
- Ice-associated algae (e.g., *Nitzchia frigida*),
- Toxin-producing algae (e.g., *Pseudonitzschia* spp.),
- Macrophytes and Kelp,
- Heterotrophic microbes (including bacteria),
- Planktonic detritus (living and non-living).

These groupings take into account pelagic-benthic coupling. For phytoplankton, specific species within the groups could be more fully described in the research document. Toxin-producing algae were separated from the other groups as they are beginning to be found in the Alaska portion of the Beaufort Sea in greater abundance (blooms) in recent years.

Participants discussed the macrophyte and kelp group. There have been no studies in the biogeographic region on these species and their importance in the ecosystem. There are eelgrass beds on the Alaskan coast of the Beaufort Sea but it is not known if they occur in the WAB region.

A participant noted that planktonic detritus includes living aggregates (including microbes) and it is extremely important for vertical fluxes of material (i.e. energy and nutrients). Participants agreed to keep planktonic detritus in the table.

## COMMUNITY PROPERTIES

The report author was asked to provide some background information on Community Properties. There was confusion about what was meant by this term. Some assumed they were criteria, others thought they were communities. The report author indicated that pelagic-benthic coupling is a specific community property of Arctic ecosystems.

Another participant indicated that Community Properties were emergent properties resulting from the formation of communities (e.g., pelagic-benthic coupling driven by ice-associated algae, seasonal nitrification of benthos). Consequently, there could be passive (pelagic-benthic) and active (benthic-pelagic) coupling.

It was pointed out that ice is considered habitat within the EBSA and eco-unit processes. A participant suggested that there is a difference between ice as a habitat and its association with biota and biotic processes. They used the example of the Stamukhi zone along the edge of the landfast ice, where there is a large vertical penetration of the ice into the water column. This results in a vertical ramp under the ice, which blocks the extension of freshwater inputs that flow under the ice and become trapped by the Stamukhi ridges. This forms a freshwater environment where anadromous and freshwater fishes can be found beyond their typical distribution. The participant felt that this was a community property that is substantive and different than elsewhere. It drives biodiversity temporarily and spatially. Embayments in the Arctic are also important, possibly containing different biota and processes than elsewhere in the Beaufort Sea. Another participant pointed out that these were considered ecosystems and were identified within the eco-unit process (DFO 2015). Participants were still not clear what was meant in the original guidance and felt that concepts of habitats, communities, and species assemblages were mixed up.

The report author provided examples of community properties from the national guidance. In most cases these were metrics that might be used to monitor changes in the ecosystems. Community properties, as described by the national process were not identified for the WAB region. Instead, participants focused on identifying ecologically significant ecosystem components (species, species groups, functional groups) and one ecosystem property (planktonic detritus) within the WAB region.

## ECOLOGICAL SIGNIFICANCE

Once the table was complete, participants discussed how best to evaluate the significance. A quantitative approach, i.e., counting the number of categories identified for each species or species group did not seem to be appropriate. Grouping species better reflected the functional groups that are the core components of the ecosystem.

Marine mammals are the only cases where the species were treated separated. In other taxa, individual species were typically used as an example that was representative of the group.

By including the functional groups in the table, we identified that these are significant.

There was some discussion about removing the centralized ecosystem component column as there may be a tendency for anyone using the advice to just focus on Arctic Cod, Ringed Seal, and *Calanus* spp.

Another approach was to identify all the components that were identified as Moderate to High importance for the ecosystem and use them to build an energy transfer diagram. It was also suggested to use a red light-green light approach to rows and columns. Participants felt this was redundant and did not add any clarification.

Energy transfer and relative importance to the ecosystem were particularly important areas of the discussions. These categories were seen as combining most of the information contained within the table.

Participants agreed that the whole table should be the advice.

## NEXT STEPS

The three reports would be completed based on the comments provided and discussions from the meeting. The documents would be sent to all participants for review before they were finalized.

Participants were thanked for their input into the discussion and the meeting was adjourned.

## REFERENCES CITED

DFO. 2006. Identification of Ecologically Significant Species and Community Properties. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/041.

DFO. 2009a. Does eelgrass (Zostera marina) meet the criteria as an ecologically significant species? DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/018.

DFO. 2009b. Development of a Framework and Principles for the Biogeographic Classification of Canadian Marine Areas. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/056.

DFO. 2014. Assessment of freshwater Ecologically and Biologically Significant Areas (EBSA) and Ecologically Significant Species (ESS) criteria. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/025.

DFO. 2015. Eco-units and potential Priority Conservation Areas in the Western Arctic Bioregion. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/021.

# APPENDIX 1. TERMS OF REFERENCE

## IDENTIFICATION OF ECOLOGICALLY SIGNIFICANT SPECIES, AND COMMUNITY PROPERTIES FOR THE WESTERN ARCTIC BIOGEOGRAPHIC REGION

**Regional Peer Review – Central and Arctic Region**

**November 8-9, 2016**
**Winnipeg, MB**

Chairperson: Eva Enders

### Context

Under the National Conservation Plan, Fisheries and Oceans Canada (DFO) Oceans Program has been tasked with leading the development of a Marine Protected Area (MPA) Network in the Western Arctic. DFO Science has identified an overarching MPA Network Conservation Objective, and has provided advice on Eco-units and Priority Conservation Areas for the region. The next step in the MPA Network planning process is to identify the Conservation Priorities.

Canada's *Oceans Act* authorizes DFO to take an Ecosystem Approach to the integrated management of human activities in the sea. A component of this is to provide enhanced protection to species and community properties that are particularly significant to maintaining ecosystem structure and function. Species and community properties can be ecologically "significant" because of the functions that they serve in the ecosystem and/or because of features that they provide for other parts of the ecosystem to use. DFO (2006) has provided initial guidance for the identification of Ecologically Significant Species, and Community Properties (ESSCPs)[1].

To inform ecological conservation priorities for the MPA Network in the Western Arctic Biogeographic Region, Oceans Program has requested identification of ESSCPs for this area.

### Objectives

All species have some function in the ecosystems in which they are found. The objectives of this meeting are to;

- identify potentially significant species, and community properties in the Western Arctic Biogeographic Region,
- identify and assess their functional roles within the ecosystem,
- assess their significance to the overall ecosystem structure and function, and
- establish whether or not specific species or aggregate properties of a community are particularly important for each function, and thus should be considered ecologically significant.

### Expected Publications

- Science Advisory Report

[1] Communities may be highly organized with species linked to one another and to the physical environment so that characteristic patterns occur and properties arise that may not be predicted from knowledge of the component species. These communities may exhibit properties which are more than the sum of the individual parts, including complexity, trophodynamics, biological diversity, stability, productivity and energy flow (e.g., benthic-pelagic coupling).

- Proceedings
- Research Document(s)

**Expected Participation**

- Fisheries and Oceans Canada (DFO) (Ecosystems and Oceans Science, and Ecosystems and Fisheries Management sectors)
- Environment Canada
- Fisheries Joint Management Committee
- Nunavut Wildlife Management Board
- Academia
- Other invited experts

**References**

DFO. 2006. Identification of Ecologically Significant Species and Community Properties. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/041.

## APPENDIX 2. LIST OF PARTICIPANTS

| Name | Organization/Affiliation |
|---|---|
| Ayles, Burton | Fisheries Joint Management Committee |
| Cobb, Don | DFO Science |
| Enders, Eva (Chair) | DFO Science |
| Gallagher, Colin | DFO Science |
| Grandmaison, Vanessa (Rapporteur) | DFO Oceans Program |
| Hoover, Carie | DFO Science |
| Loseto, Lisa | DFO Science |
| MacPhee, Shannon | DFO Science |
| Martin, Kathleen | DFO Science |
| Michel, Christine | DFO Science |
| Niemi, Andrea | DFO Science |
| Paulic, Joclyn | DFO Science |
| Pomerleau, Corrine | University of Manitoba |
| Reist, Jim | DFO Science |
| Roy, Virginie | Canadian Museum of Nature |
| Schroeder, Bethany | DFO Oceans Program |
| Stasko, Ashley | University of Waterloo |

# APPENDIX 3. MEETING AGENDA

**Identification of Ecologically Significant Species, and Community Properties for the Western Arctic Biogeographic Region**

November 8-9, 2016
Large Seminar Room, Freshwater Institute, Winnipeg, MB

Chair: Eva Enders

**Day 1 – Tuesday, 8 November**

| | |
|---|---|
| 9:00 a.m. | Welcome (Chair)<br>- Overview of CSAS peer review process<br>- Terms of Reference and Meeting Objectives<br>- Participant Introductions – Please be prepared with a few sentences about the expertise you bring to the table<br>- Review Agenda |
| | Elaboration of meeting objectives (E. Enders) |
| 9:15 a.m. | Study Area Description (D. Cobb) |
| 10:30 a.m. | BREAK |
| 10:45 a.m. | National Guidance for ESSCP Criteria and Methods Used (D. Cobb) |
| 12:00 p.m. | LUNCH |
| 1:00 p.m. | Final Criteria |
| 2:00 p.m. | BREAK |
| 2:15 p.m. | Species and Community Properties List |
| 2:45 p.m. | Evaluation |
| 4:00 p.m. | What does it take to be considered significant? |
| 4:30 p.m. | Day 1 Wrap-up |

**Day 2 – Wednesday, 9 November**

| | |
|---|---|
| 9:00 a.m. | Review Day 1, Agenda for Day 2 (Chair) |
| 9:15 a.m. | Create final list of ESSCPs |
| 10:30 a.m. | BREAK |
| 10:45 a.m. | SAR Summary Bullets |
| 11:30 a.m. | Sources of Uncertainty |
| 12:00 p.m. | LUNCH |
| 1:00 p.m. | SAR Review |
| 2:00 p.m. | BREAK |
| 4:00 p.m. | Wrap-up and Next Steps |
| 4:30 p.m. | Meeting Adjourned |

# APPENDIX 4. CRITERIA TO EVALUATE ECOLOGICAL SIGNIFICANCE

**Distribution**

Widespread (Ubiquitous) vs Localized distribution across the biogeographic region.

Seasonal vs Year-round distribution [Migratory vs resident or Non-migratory].

**Ecosystem component contribution**

Originally called Dominance, this was changed to Ecosystem Component Contribution as it was considered to better reflect an ecosystem focus.

High biomass (or High abundance).

Centralized ecosystem component - Controlling (rates and directions) of trophic ecosystem processes (productivity, respiration, waste production). This captures the idea of keystone species whose effect on a community or ecosystem is large, and disproportionately large relative to its abundance (e.g., Arctic Cod, Ringed Seal).

This also captures the idea of Trophic Energy Flow (through the food web).

Influence on the food web (number of nodes as a measure of linkages in the food web) [works for species but not for species groups].

**Energy Transfer**

Vertical transfer of energy and material.

Active movement of organisms (seasonal, diurnal) - physical-vertical coupling.

Passive Vertical Transfer (e.g., detrital fall).

Horizontal Transfer (import and export) includes biomass and nutrients (with physical drivers).

Energy transfer leads to connectivity within the biogeographic region (e.g., Bowhead Whale feeding downstream of upwellings).

Energy transfer into and out of the biogeographic region was captured under Distribution - season movements.

Feeding Type identified as selective or non-selective and active or passive feeding.

**Specialized**

Key habitat association, e.g., ice-associated fauna, hot vents associated with specialized species. This can include dynamic phenomena.

**Habitat creating or modifying**

Habitat creators are structural species that create habitat that may be used preferentially by other species and in the marine environment, add to existing physical habitat complexity or create complex habitat in what would otherwise be a homogeneous environment. Some structural species provide physical habitat above the substrate.

Habitat modifiers have a role in altering marine sediments, such as through bioturbation.

## APPENDIX 5: CERTAINTY CATEGORIES AND DESCRIPTIONS

*Table A5.1. Certainty categories and descriptions used in the assessment of Ecologically Significant Species and Community Properties.*

| Category | Description |
|---|---|
| **Very High Certainty (VH)** | Extensive peer-reviewed scientific information or data specific to the area including long-term relevant datasets. |
| **High Certainty (H)** | Substantial scientific information or recent data specific to the area. This includes both peer-reviewed and non-peer-reviewed sources. |
| **Moderate Certainty (M)** | Moderate amount of scientific information mainly from non-peer reviewed sources and first hand, unsystematic or opportunistic observations. This includes both scientific information and expert opinion. This may include older data from the area and may also include information not specific to the area. |
| **Low Certainty (L)** | Little scientific information but expert opinion relevant to the topic and area. |
| **Very Low Certainty (VL)** | Little or no scientific information. Expert opinion based on general knowledge. |
| **Unknown (U)** | No information. |