Basic Information

This section contains basic information about the dataset, suitable for a minimal metadata entry.

**Title:** Diversity, Richness, and Biomass Hotspots

**Dataset ID:** diversity-richness-biomass-hotspots

**Quality Control:** Check Required

**Summary:**
This geodatabase includes hotspot maps of 1) nearshore habitat richness, 2) diversity (fish and invertebrates), and 3) biomass (using catch per unit effort of fish and invertebrates), as well as two layers showing the spatial extent of the diversity and biomass hotspot analyses.

This layer was reviewed as part of a Canadian Science Advisory Secretariat (CSAS) regional peer review process on Nov 1-2, 2017 (Rubidge et al. 2018).

Habitat Richness Hotspots: Although there are extensive surveys in targeted areas along the coast of BC, there are no systematic surveys of nearshore species that span the entire coastline of NSB. Due to a lack of spatial coverage for species level data, we developed an approach for mapping habitat richness using a measure of habitat complexity as a proxy for species diversity.

Diversity and Biomass Hotspots: To examine the spatial distribution of alpha diversity, we calculated Shannon Diversity of fish and of invertebrates using catch records from the DFO synoptic trawl and PHMA longline surveys. The two surveys have complementary spatial coverage, with the PHMA surveys occurring in more coastal areas (20–260 m) and the synoptic trawl surveys occurring on deeper shelf areas (50–1300 m). We also used fish and invertebrate biomass as proxies for examining spatial patterns of productivity in the NSB.

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**Cite this data as:** Rubidge, E., Nephin, J., Gale, K.S.P., and Curtis, J. 2018. Diversity, Richness, and Biomass Hotspots. Published Jan 23 2019. Marine Spatial Ecology Section, Fisheries and Oceans Canada, Nanaimo, BC.

**Start Date:** 2003-07-01

**End Date:** 2016-08-01

Contact Information

This section contains contact information for the data creator and program manager.

**Data Creator:**
- **Name:** Katie Gale
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**Co-Creators:** Emily Rubidge, Jessica Nephin, Janelle Curtis
General metadata compatible with the Canada Open Data metadata standard.

**Topic Category:** Environment

**Date Completed:** 2017-11-01

**Date Published:** 2019-01-23

**Status:** Completed

**Update Frequency:** Not Planned

**Dataset Level:** Dataset

**Keywords (GoC Thesaurus):** biological diversity

Science

This section contains metadata specific to the Science branch at DFO.

**Science Keywords:** ecologically and biologically significant areas, EBSA

**Theme:** Classification

**Methods:**

Diversity and Biomass Hotspots:

Longline Data Fish diversity was calculated from CPUE (count/hook/hr) from Pacific Halibut Management Association (PHMA) surveys. PHMA surveys are standardized, depth-stratified random longline surveys that are carried out at depths of 20–260 m. All species caught are weighed or counted and identified to the lowest possible taxonomic level. Data was extracted from DFO's GFBio database on 18 April 2017, limiting the query to records quality-tagged as "fully usable”. The PHMA dataset spans August 2006 - August 2016 and includes records taken in the months of August and September. Shannon Diversity (H') was calculated from CPUE of fish species using the diversity function in the R package ‘vegan’.

Trawl Data Fish and invertebrate biomass and diversity was calculated from CPUE (kg/hr) from DFO synoptic groundfish bottom trawl surveys that are carried out at depths of 50–1300 m. DFO synoptic surveys are standardized, depth-stratified random bottom trawl surveys in four regions of BC that cover the continental shelf of BC: West Coast Haida Gwaii, Hecate Strait, Queen Charlotte Sound, and West Coast Vancouver Island. These surveys do not include inlets, enclosed waters, sensitive habitats (e.g., Hecate Strait Glass Sponge reefs, Learmonth Bank Red Tree corals, Rockfish Conservation Areas), areas that are not trawlable or the steep slope off the southwest part of Haida Gwaii (Workman et al. 2008, Olsen et al. 2009). All species caught
are weighed or counted and identified to the lowest possible taxonomic level. Data was extracted from DFO's GFBio database on 28 November 2016, limiting the query to records quality-tagged as "fully usable". The synoptic dataset spans July 2003 - June 2016, and includes samples from the months of May to October, but most are from May to July.

Total biomass was calculated from the sum of CPUE from all fish taxa in each fishing event (trawl tow). Shannon Diversity (H') was calculated from CPUE of fish species using the diversity function in the R package 'vegan'.

Biomass and Shannon diversity values were used to detect hotspots using the Getis-Ord G* tool. The G* statistic represents the local neighbourhood sum compared proportionally to the sum of all features in the study area. When the local sum is significantly different from the expected sum, then that site is identified as a hotspot (Gi_Bin>0), a cold spot (Gi_Bin<0), or neutral (Gi_Bin=0). A 10 km distance value was used as the neighbourhood size. The false discovery rate correction was applied, which accounts for multiple testing and spatial dependence. Absolute Gi_Bin values of 1, 2, and 3 correspond to 90, 95, and 99% confidence, respectively. Using the Minimum Bounding Geometry Tool, convex hull polygons were drawn around groups of hotspot points (confidence ≥90%) containing 10 or more points. The resulting polygons were then buffered by 1 km and manually edited where needed to exclude any large areas of the polygons that did not include hotspot points.

Nearshore Habitat Richness:
Habitat richness was calculated from eight habitat features: eelgrass, surfgrass, canopy-forming kelp, estuaries, areas of high rugosity, and hard, mixed, and soft substrate. Layers for eelgrass, surfgrass, canopy-forming kelp, and estuaries were assembled as part of an assessment of nearshore EBSA features (Rubidge et al. 2020). The kelp and eelgrass layers consist of polygons and ShoreZone biobands available from the British Columbia Marine Conservation Analysis (BCMCA), and the estuary layer is from the Pacific Estuary Conservation Program, most recently updated in 2014, but originally developed in 2007 (Ryder et al. 2007).
We used the BCMCA layer representing areas of high rugosity that was developed using the Benthic Terrain Modeller ArcGIS tool and the NRCAN 75 m bathymetry model (http://bcmca.ca/datafiles/individualfiles/bcmca_eco_physical_highrugosity_metadata.htm). Finally, for substrate type, we used three layers representing hard, mixed, and soft substrate in nearshore waters from a bottom patch model developed by Gregr et al. (2013).

The nearshore area represents shallow coastal areas (any location 2 km from the coastline or shallower than 20 meters depth) and internal waterways and inlets. The eight layers were clipped to the nearshore area and overlaid with each other in ArcMap 10.4. Habitat richness was calculated by summing the number of features within 1 km x 1 km planning units. Habitat richness values were used to detect hotspots of habitat richness within the nearshore area using the Getis-Ord G* tool. The G* statistic represents the local neighbourhood sum compared proportionally to the sum of all features in the study area. When the local sum is significantly different from the expected sum, then that site is identified as a hotspot (high values; Gi_Bin>0), a cold spot (low values; Gi_Bin<0), or neutral (Gi_Bin=0). A 1 km distance value was used as the neighbourhood size. The false discovery rate correction was applied, which accounts for multiple testing and spatial dependence. Absolute Gi_Bin values of 1, 2, and 3 correspond to 90, 95, and 99% confidence, respectively. For the purpose of MPA network planning, only 1 km planning units with Gi_Bin values of 3 (99% confidence) were classified as habitat richness hotspots.

References:


Data Sources:
Source: Kelp: general kelp, bull kelp, and giant kelp polygons and biobands (5 layers) obtained from BCMCA (https://bcmca.ca/?s=kelp).
Source: Eelgrass: eelgrass polygons and biobands (2 layers) obtained from BCMCA (https://bcmca.ca/?s=eelgrass).
Source: Estuaries: obtained from Pacific Estuary Conservation Program (PECP) on 20 March 2017.

Scripts or Software Routines: Available at https://gitlab.com/dfo-msea/ebsa-nsb-hotspots

Spatial Data Quality: TBD
Positional Accuracy: TBD
Attribute Accuracy: TBD
Logical Consistency: TBD
Completeness: TBD

Absence Data: For the diversity and biomass hotspots, the input survey data are included (one each layer for longline and trawl surveys) to show the extent of the analysis. The footprint of the nearshore habitat richness analysis is included in the hotspot layer. Areas within these footprints can be considered to be "not hotspots". No information on relative importance can be interpreted for areas outside the footprints.

Uncertainties:
Habitat richness hotspots: Uncertainty in the input habitat layers would be carried through to the final product. E.g., the kelp and eelgrass inputs may not reflect current conditions as some areas haven’t been surveyed or are out-of-date.

Diversity and biomass hotspots:
  Spatial limitations:
    The hotspots highlight general areas of higher diversity/biomass, relative to the area and species sampled. They’re limited to the footprint of the surveys (i.e., not coast-wide, and not NSB-wide), which avoid certain areas (sponge/coral aggregations, very rocky habitats, Rockfish Conservation Areas) that may be important.

    The boundaries are based on available sampling points, and should be interpreted as gradients rather than static hard lines. - The analysis was done at the scale of the NSB, so it's hard to say how useful the polygons would be on the ground to differentiate or prioritize finer-scale areas.

  Temporal limitations:
    The input DFO survey data is pooled over 10-13 years and was collected in the summer (May-Sept/Oct), so the highlighted areas may not reflect seasonal patterns (e.g., important areas in winter) or changes over time.

Use Restrictions: Any use of this dataset should take into account the scale and footprint of the analysis and the limitations (temporal, spatial, other) of the input data. Areas outside the analysis footprint may have importance that is not reflected here. This dataset was created for the purpose of marine spatial planning at a relatively broad scale and may have limitations at fine scales.

Change History

<table>
<thead>
<tr>
<th>Date of Change</th>
<th>Description of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017-11-01</td>
<td>This data has changed from the version published in Rubidge et al. 2018. Two polygons in the Fish Diversity (Trawl) Hotspot layer were manually edited to exclude large areas that did not include hotspot points.</td>
</tr>
<tr>
<td>2020-01-27</td>
<td>Field names and projections cleaned up/fixed</td>
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Temporal Coverage: The PHMA dataset spans August 2006 - August 2016 and includes records taken in the months of August and September. The synoptic dataset spans July 2003 - June 2016, and includes samples from the months of May to October, but most are from May to July. The BCMCA inputs cover dates as described in their metadata at bcmca.ca

Species Data

<table>
<thead>
<tr>
<th>Code and Name</th>
<th>Age Data</th>
<th>Obs Type</th>
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</table>

References:
**Collaboration:** No collaboration outside of DFO.

**Confidentiality:** Not Protected