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Developing social-ecological indicators for Canada's Pacific Marine regions: steps, methods, results and lessons

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Indicators for Ecosystem- Based Management

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SALISH SEA CONFERENCE 2014

Objectives Today

1. Rationale, Mission, Scope, and Scale
2. Steps and Methods
3. Results
4. What's Hot, What's Not
5. Using the products
6. Conclusions

The Rationale

- ▶ Ecological Integrity and Human Well-Being are goals that span across governments, sectors, organizations and communities. Yet typically each group monitors only those elements of the goals that relate to their mandate or interest. This means there is rarely a comprehensive picture of the system and little understanding of how different monitoring activities relate to each other.
- ▶ Addressing monitoring in an integrated, ecosystem-based manner has taken on increasing significance as ecological, social, and economic changes occur in increasingly uncertain, unpredictable, and interconnected ways. EBM monitoring also has the potential to reduce costs by addressing duplication and inefficiencies associated with an uncoordinated approach.

Mission: EBM Indicators and Implementation Strategy

Example:

“MaPP is drafting a list of candidate indicators to be used to monitor ecological integrity, human well-being and governance upon implementation of the marine plans.”



Indicators can be used for:

- Monitoring and tracking the changes in the status of a resource or system and the pressures thereon;
- Evaluating the effectiveness of management measures;
- Assessing the risk of exceeding a limit reference point; and,
- Simulating and predicting or forecasting the future effects of management measures in modeling explorations of management and policy options.

Project Partners

- ▶ *MaPP*
- ▶ *West Coast Aquatic*
- ▶ *Coastal First Nations*
- ▶ *PNCIMA*



Puget Sound Partnership and Parks Canada provided valuable lessons.



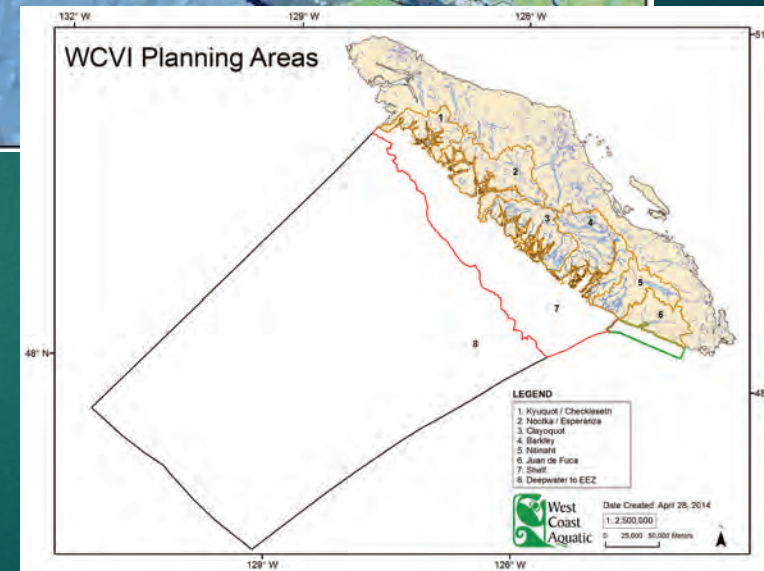
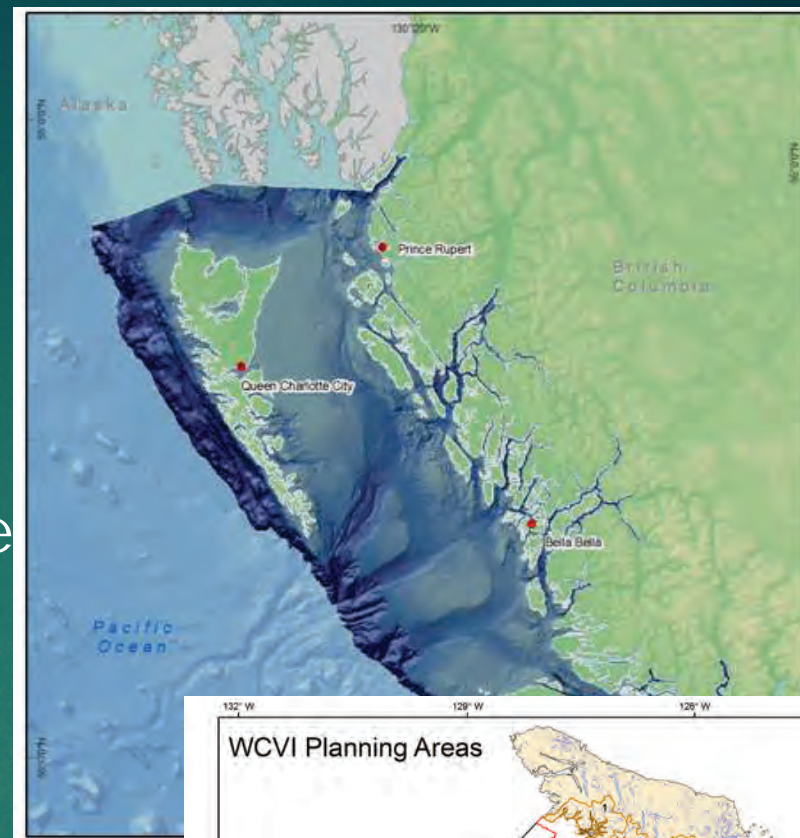
Project Scope

- ▶ Focus is on elements of the ecological and human well-being systems that are directly related to the marine environment (recognizing land and marine are interconnected and HWB affected by both).
- ▶ Look at EBM indicators rather than just indicators falling within specific mandates
- ▶ Not in the scope of this project to set targets or reference points for indicators, nor to develop a monitoring program or data management plan.



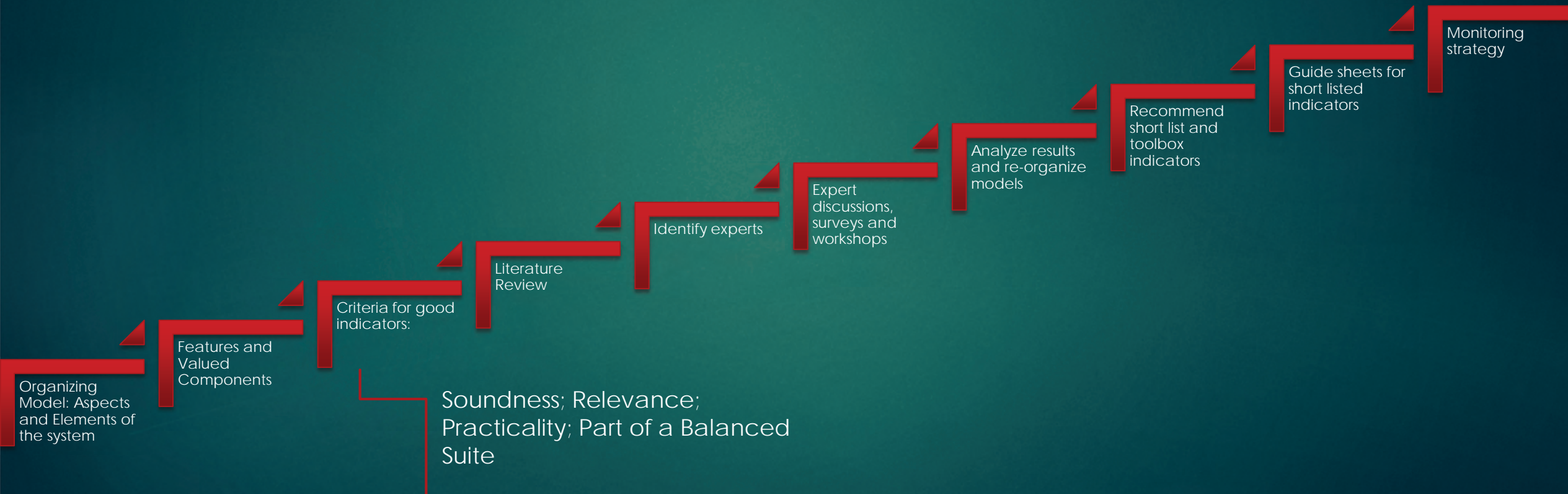
Project Scale

- ▶ Requested to identify a list of indicators that are representative of the health of marine ecoregions.
- ▶ Have also provided a 'toolbox' of EBM indicators, some of which can be used sub-regionally or locally.



Project Steps and Methods

▶ 10 Steps



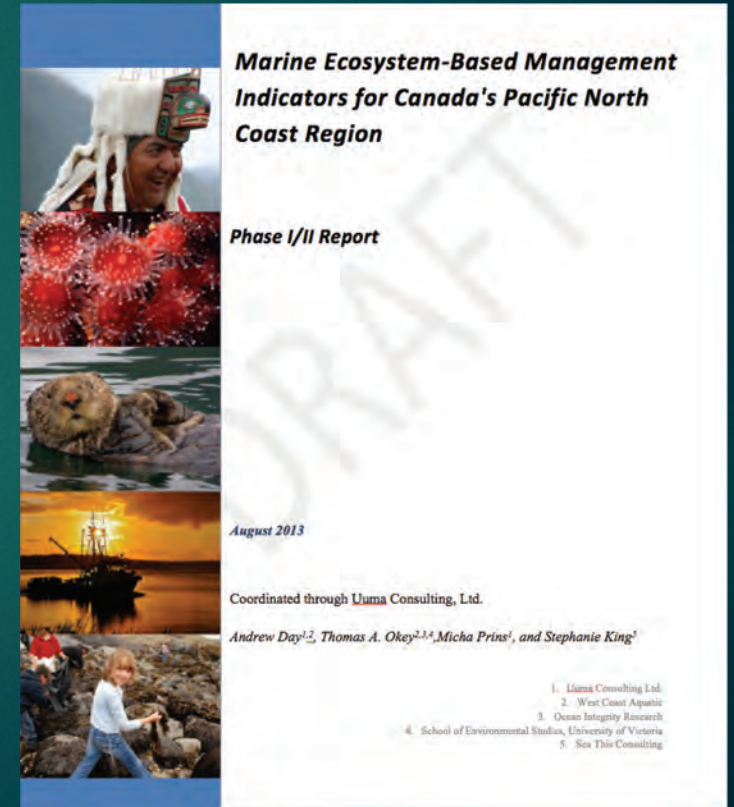
Products

- ▶ Reports including
 - ▶ Purpose
 - ▶ Overview
 - ▶ Types of Indicators
 - ▶ Limitations and Assumptions
 - ▶ Methods
 - ▶ Recommended Indicators
 - ▶ Comparison with draft strategies
 - ▶ Guide sheets to indicators and recommendations re implementation
 - ▶ Monitoring strategy options and considerations

Phase I

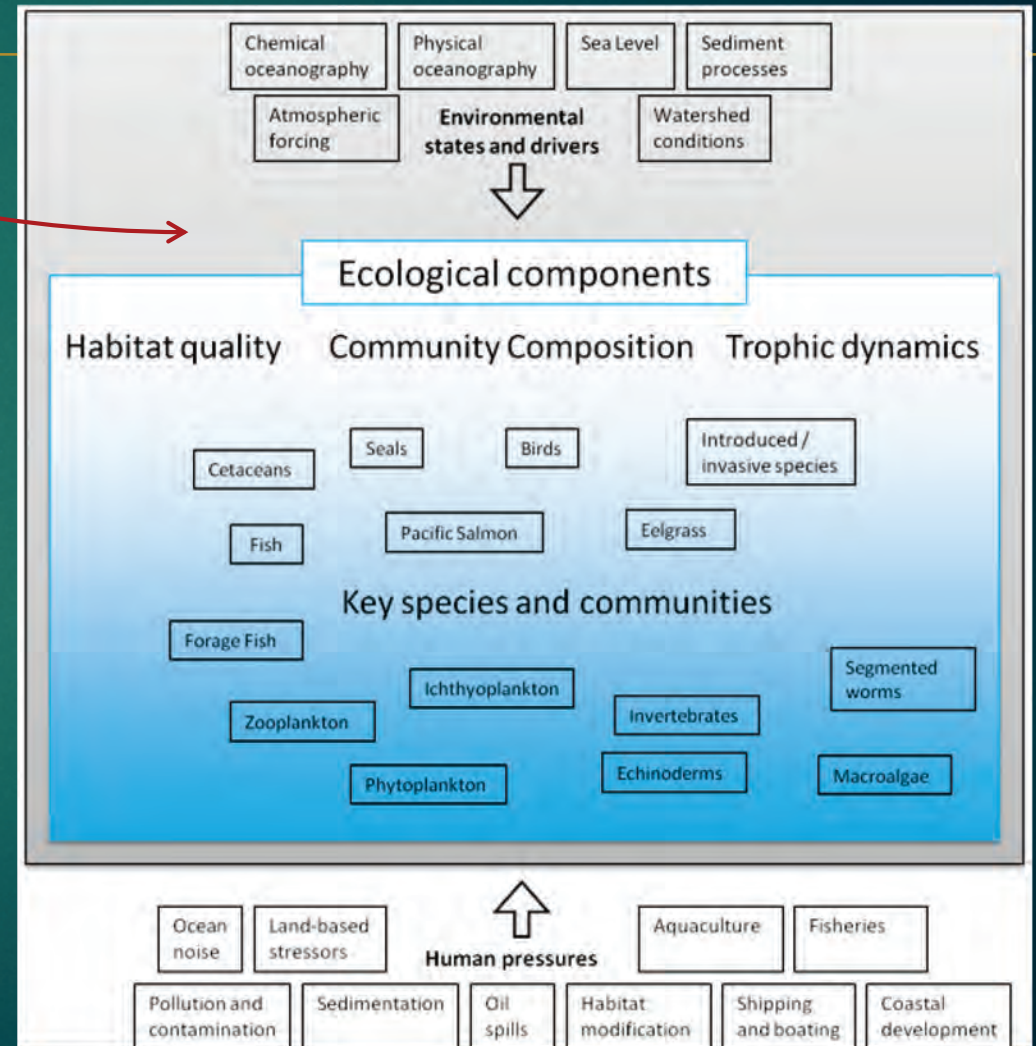
Phase II

Phase III

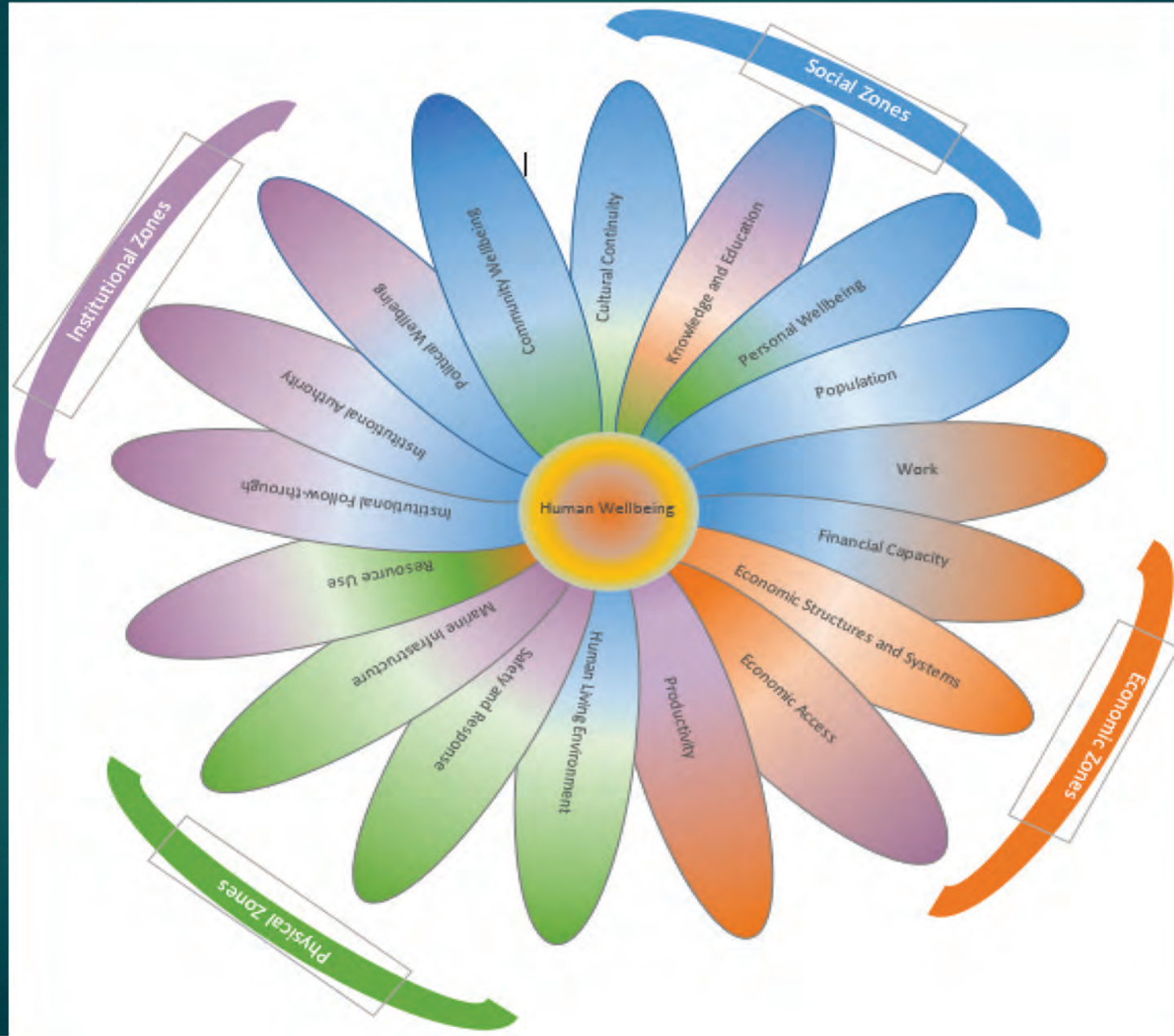


Results: Recommended Ecological Indicators / Groupings

Macro-habitat	Habitats adapted from Halpern et al. 2009 and Hemmera 2013	General description
Estuaries	Estuary Seagrass	Transition zone between freshwater input from land and the ocean. Includes seagrass and other shallow, subtidal vegetated substrate.
Sandy shorelines	Sandy beach	Sandy shoreline including the intertidal zone
Rocky shorelines	Rocky intertidal	Hard and mixed substrate shoreline including the intertidal zone
Kelp forests and rocky reefs	Kelp Rocky reef	Canopy forming kelp forests and rocky reefs
Coral and sponge reefs	Coral and Sponge Communities	Deep and shallow water corals and sponges
Seafloor	Shallow soft-bottom Soft shelf Hard shelf Soft slope Hard slope Canyons Hard deep Sub-arctic and Transitional Pacific general (BCMEC)	Subtidal soft sediments and hard substrates
Water column	Shallow pelagic Deep pelagic	Water column from the surface to the bottom



Results: Recommended HWB Indicators / Groupings



Results: Recommended Ecol. Indicators and Related Objectives / Strategies

Groundfish	
Habitats	Kelp and rocky reefs, coral and sponge reefs, seafloor
Recommended indicators	<p>1. Benthic fish community composition</p> <p>See indicator for community composition. Key species include Pacific halibut, ling cod, rockfish, arrowtooth flounder, greenling, greenstriped rockfish, Pacific herring, petrale sole, dover sole, rex sole, yellowtail rockfish, canary rockfish and Walleye Polluck (Indices 2013). Many species are long lived and slow growing and susceptible to overfishing. Several rockfish species are listed as threatened or of special concern by COSEWIC. Ground fish are a major part of the commercial and recreational fishery in British Columbia.</p>
EBM indicators	2. Age/size structure of longer lived groundfish species
Monitoring options / efforts	The commercial fishery is monitored 100% at-sea and dockside for all species retained and released. DFO has conducted biennial multispecies bottom trawl surveys in Hecate St/Dixon Entrance and Queen Charlotte Sound since 2003.
Related MaPP objectives	<ul style="list-style-type: none"> - There are several strategies for all MaPP sub-regions in Marine Fisheries that are relevant to groundfish - Haida Gwaii has a specific strategy on identifying new rockfish conservation areas (Marine Protection, Issue 3, Objective 3.1, Strategy B.) - Haida Gwaii has a strategy that includes identifying areas that are important for specific life history stages of groundfish species (Marine Fisheries, Issue 1, Obj 1.2, Strategy G)
Broader linkages	<ol style="list-style-type: none"> 1. Linked to other highly rated indicator community composition 2. Linked to HWB indicators in resource use

Results: Recommended HWB Indicators and Related Objectives / Strategies

Wellbeing Zone	E12/ In20: Economic Access: Resource Access and Allocation
Relevant Components	Economic: 4 Access: 4.1 Resource Access; 4.2 Financial Access Institutional: 8 Resource Management: 8.5 Allocation
Importance	Access in an area of highly resource-based economies and cultures is the single most mentioned issue of concern for communities. Increased local access ensures increased local economic benefits and grounds the management of competing interests within an arena of common understanding (see DPRA, 2012). The balance of a variety of resource users' needs (recreational, cultural, commercial) coupled with the urgency of preserving ecological and cultural integrity sit at the crux of decision making for the region. Local access is prioritized on most community and regional economic development plans and is the focus of many MaPP area goals and objectives.
Related MaPP Area Objectives	<p>Promoting Local Access:</p> <ul style="list-style-type: none"> • Encourage local ownership and operation of aquaculture tenures (Central Coast) • Work with partners and other industries to develop a strategic coastal and marine tourism plan for the Central Coast that improves capacity building, product development and marketing initiatives (Central Coast) • Work with Federal agencies to implement strategies for improving local participation and licence ownership in sustainable commercial fisheries (Central Coast) • Encourage local ownership of tenures and a locally-operated aquaculture industry. (Haida Gwaii) • Increase local economic benefits from sustainable commercial fishing activities: through Pacific Integrated Commercial Fisheries Initiative (PICFI), support for local fishermen to develop business plans to access quota and licenses (Haida Gwaii) • Work with federal agencies to encourage local participation in, and local benefits from, albacore tuna troll fisheries. Example – Support fishing license regulations that facilitate access for local fishers to the albacore tuna troll fishery; value added products (e.g., smoked tuna); recreational fishing charters (Haida Gwaii) • Work with federal agencies to enable local access to new and emerging fisheries. Example – Sardine, sea cucumber (Haida Gwaii) <p>First Nations Access:</p> <ul style="list-style-type: none"> • Increase First Nations access to marine resources (North Coast) • Encourage opportunities for First Nations' investment, partnership, participation in aquaculture activities. (North Vancouver Island) • Work with federal agencies to establish new community-based fisheries and increase the number of (local) licenses. Examples – Haida allocation in new and emerging fisheries (eg, sea cucumber); PICFI (Haida Gwaii) • Support First Nations commercial fisheries programs to train fishers and improve aboriginal fishing capacity (North Coast) <p>Allocation Process (Transparent, Fair, Knowledge-based, Integrated):</p> <ul style="list-style-type: none"> • Ensure information from the compatibility matrix and vulnerability matrices inform tenure approval process policies (Central Coast) • Develop guidelines for how the Province facilitates the consistent development of protocols between First Nations and tenure proponents.(Central Coast) • Improve clarity of tenuring and regulatory policies for new aquaculture operations, including First Nations approval, monitoring and management. (North Coast)

Results: Recommended HWB Indicators, Linkages, and 'Balanced Suite' analysis

<p>Links to Other Valued Components</p>	<p>Social Realm: 1 Social Relationships: 1.1 Intergovernmental Relationships, 1.2 Government Stakeholder Relationships, 1.3 Stakeholder Relationships, 1.4 Family Relationships, 1.5 Community Relationships; 2 Culture: 2.1 Values, Norms, 2.3 Engagement, 2.4 Heritage and Traditional Knowledge, 2.5 Identity; 3 Human Capacity: 3.1 Leadership, 3.2 Labour, 3.3 Financial Capacity, 3.4 Personal Wellbeing: Spiritual, Mental, Physical, 3.5 Population, 3.6 Knowledge</p> <p>Economic Realm: 4 Access: 4.3 Market Access, 4.4 Technology/ Knowledge Access, 5 Organization: 5.1 Character or Types of Economic Activity, 5.2 Economic Structures and Systems, 5.3 Economic Culture; 6.2 Economic Productivity, 6.3 Output, 6.4 Growth, 6.5 Economic Resilience, Sustainability</p> <p>Institutional Realm: 8 Resource Management: 8.1 Conservation, 8.2 Legislation, 8.3 Integrated Management, 8.4 EBA, 8.6 Resource Use Monitoring, 8.7 Assessment, 8.8 Maritime Traffic, 8.9 Emergency Response; 9 Economic Development: 9.1 Growth Plans, 9.2 Financial Policies, 9.3 Regulations and Limits; 10 Advisory Processes; 11 Knowledge Sharing Mechanisms: 11.1 Partnerships, 11.4 Data Collection, 11.5 Information Sharing, 12 Community Governance: 12.1 Community Planning</p> <p>Physical Realm: 13 Resources: 13.1 Extracted Resources, 13.2 Cultural and Recreational Areas, 13.3 Conservation; 14 Access and Distribution Channels and Equipment: 14.2 Docks, Marinas, Boat Ramps, 14.3 Beaches and Foreshore, 14.4 Vehicles, Roads, Rail, 14.5 Waterways, 15 Industrial Infrastructure: 15.1 Harvesting and Supporting Activities, 15.2 Processing, 17 Energy: 17.1 Marine and Land Fuel Facilities, 17.2 Energy Supply Operations; 19 Residential Environment: 19.5 Governance Facilities, 19.6 Population; 20 Cultural Facilities: 20.1 Cultural and Recreational Facilities,</p> <p>Ecological Components: phytoplankton</p>			
<p>Balanced Suite</p>	<p>Applicable Themes</p>	<p>Related Human Needs</p>	<p>Related Area Values</p>	<p>Links to Other Models</p>
	<p>Distribution</p>	<p>Power</p>	<p>Diversity</p>	<p>Sheltair, 2006</p>
	<p>Participation</p>	<p>Freedom</p>	<p>Interconnectedness</p>	<p>T'aaq-wiihak Fisheries, 2013</p>
	<p>Group Dynamics</p>	<p>Participation</p>	<p>Connection with the Natural Environment</p>	<p>WCA, 2011</p>
<p>Recommended Dashboard Indicators</p>	<ul style="list-style-type: none"> Local Access (per community or area): Number and ratio of commercial and recreational licenses and tenures held 1) locally and non-locally, 2) by First Nations and Non-First Nations by sector (such as: fisheries, aquaculture, adventure tourism/commercial recreation, mineral exploration, energy production, and other natural resource tenures) Tenure application process: 1) How many new tenure applications have been made in a time period; b) What type of economic activity; b) how long has it taken to process; c) ratio of acceptance to rejection; d) if rejected, why?; e) accepted, was there significant opposition and from whom (specific to First Nations) (info from BC land referral) 			

Results: Guide Sheets for Indicators

Ecological components: Key species and groups

Herring

Overview

Pacific herring (*Clupea pallasii*) are a small pelagic fish found most BC waters. They spawn in shallow sub-tidal or intertidal waters in estuaries and sheltered bays each spring, turning the water milk-white. They are considered an important prey of Pacific salmon, seals, whales and seabirds, and have significant cultural and economic value. Pressures on herring include climate change, fishing intensity, coastal development and quality of spawning habitat. Stocks declined drastically in the 1960s, DFO shut down the fishery for a period, and herring stocks rebuilt quickly.



Herring spawn on a tree branch (MaPP photo)

Recommended indicators

Herring spawn distribution: This indicator is a measure of the location that herring spawn. Monitoring is practical given herring spawn in shallow locations in the same general regions every spring. There is a long time series of data, and the indicator is relevant given its ecological, cultural and economic value.

Habitats

Herring spawn on algae in the shallow subtidal and intertidal zones, and are thus important components of kelp forests, rocky and sandy shorelines and estuaries.

Current monitoring

1. Herring spawn distribution

- 1.1. Existing monitoring programs and monitoring agencies

Fisheries and Oceans Canada (DFO) have an extensive monitoring program for herring on the BC coast. They are managed according to stock areas, which include three major stocks (Haida Gwaii (Area 2E), Prince Rupert District (PRD) and Central Coast (CC)) and two minor stocks (Area 2W and Area 27) in the MaPP region. Stock assessment is based on commercial catch, spawn survey data, test fishery and research catches (DFO 2012).

The Herring Conservation and Research Society (HCRS) runs a fishery monitoring program which consists of hauls and 100% dockside monitoring of roe, spawn on kelp, food and bait and special use fisheries. [This](#)

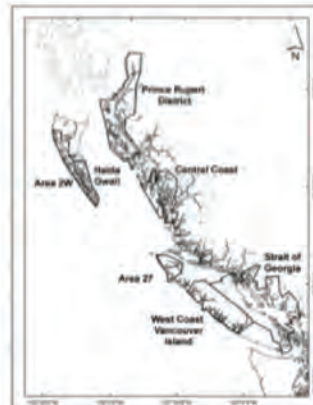


Figure 1. Management areas for herring stocks in BC (figure from DFO 2013).

program is funded by commercial herring license holders.

- 1.2. Data collection and analysis

Herring spawn distribution and intensity of egg deposition is monitored for each of the stock areas. Spawning dates, vegetation substrates, estimated lengths, widths and intensities of egg depositions have been recorded since 1928. Spawn surveys include both surface and SCUBA surveys. SCUBA diver transect surveys are made for all major herring spawn beds while surface surveys are still used in minor areas where divers are not available. Surface surveys are also used for narrow and minor spawns in shallow water, and conducted by either beach walking at low tide or using a skiff to estimate the shoreline length and width of spawn. DFO uses contract divers hired through the test fishing program for the SCUBA herring spawn surveys. Detailed methods for SCUBA and surface surveys are described in the DFO Herring Spawn Survey Manual (Fort et al. 2013).

The DFO herring spawn data are compiled into cumulative spawn tables which list the date, size, and egg layers of spawning records by area. These data are used to generate an annual cumulative Spawn Habitat Index (SHI) for each kilometer of the coastline which is a measure of spawning herring shoreline utilization by taking into account the long-term frequency and magnitude of recorded spawns over time (Hay and McCarter 2012). Composite herring spawn maps are also generated which show spawning locations by year. Mapping is described in McCarter et al. (2005).

- 1.3. Spatial and temporal coverage

Pacific herring spawning surveys have been conducted annually since the 1930s along the BC coast for the major and minor stocks shown in figure 1. Since 1928, approximately 30,000 Pacific herring spawning events at almost 1,400 locations have been recorded (Hay and McCarter 2012). The cumulative spawn analysis is constructed at 1km spatial resolution.

- 1.4. Data storage and access

Herring spawn survey data and the cumulative spawn analyses are available on the DFO website as part of the Herring Geographical Bulletin (see link in resources section below). Maps and ArcView shape files of composite spawn maps are also available for download. The Pacific Biological Station (Nanaimo, BC) holds paper records and an electronic database of herring spawn (McCarter et al. 2005)

Herring spawn data and maps are also collected and stored in British Columbia Coastal Resource Information Management System (<http://ilmbwww.gov.bc.ca/cis/coastal/others/crimindex.htm>).

- 1.5. Limitations

Despite a rich data set, there is limited understanding of why herring spawn where. The SHI represents past spawning sites and not necessarily current or future spawning sites. About 25 – 30% of the spawn surveys (mostly pre-1950) could not be digitized. Many small spawns, which may be important from a habitat perspective, are not included in the herring spawn database.

- 1.6. Review and reporting

Herring spawn surveys combined with catch and test fishery sample data are used for the stock assessment of BC herring in order to estimate the number of fish that returned to spawn and provide an assessment of size and strength of herring stocks. DFO reports this information yearly in the stock assessment for BC herring in order to manage stocks sustainably and protect herring habitat, and ecosystem processes.

Future monitoring strategies

Recommended future monitoring is to continue the existing herring spawn survey program.

Results: Implementation Strategy Options and Considerations

EBM Monitoring
Program

Partnership-Based
Approach
coordinated by
central organization

Embed indicators in
agencies,
communities and
related organizations



What's Hot & What's Not

What's Not

- Lots of time and money to do; and still a challenge to have something that is, as a whole, sound, relevant, practical and balanced.
- Meta Theory of Meta Everything
- Scale and variability are significant issues
- Difficult to understand pathways and prove causality
- Difficult to set reference points and targets
- Difficult to balance need for consistency with need to adapt to new research results
- Ecological and HWB interactions not well understood
- Bias towards quantitative
- The data hammer and the cash press
- Cultural divides

What's Hot & What's Not

What's Hot

- Grounded theory
- Diversity of participants
- HWB petal diagram (very comprehensive HWB approach)
- Ecological habitat / system approach
- Partnerships forming around common interests
- People looking for new ways of doing things

Using the Indicators

Relation to Marine Plans

- ▶ *Are the indicators meant to help monitor the effectiveness of strategies over time?*
 - ▶ Yes. Indicators can be used for spatial strategies (amount of area that is in protected status) and for non-spatial ones (# of applications for new tenures; processing time; etc.).

Using the Indicators

Relation to Marine Plans

- ▶ *Are the indicators meant to help with local level or agency/group specific monitoring?*
 - ▶ Yes. The toolbox contains indicators that may help groups decide what needs to be monitored (either specific stressors or broader 'state of the system'). However, science is continually evolving in this regard so toolbox will need updating. Depending on implementation, the sub-regions, communities, and partners could use the toolbox to communicate about indicators.

Using the Indicators

Relation to Marine Plans

- ▶ *Will the indicators help with local, sub-regional or regional application of products such as risk assessments, cumulative effects assessments, etc.?*
 - ▶ Yes; components and indicators are needed for each of these products and using a common set to draw from saves time and allows comparison between sub-regions while giving flexibility to differences (example: water quality and mussels).

Using the Indicators

Relation to Regional Marine Framework

- ▶ *Are there indicators that are best monitored regionally (in all sub-regions) rather than only in some sub-regions?*
 - ▶ Yes; many indicators may benefit from comparative analysis between regions (and also with other parts of BC and Canada).
 - ▶ Note that some indicators should not be compared.

Using the Indicators

Relation to Regional Marine Framework

- ▶ *Can the indicators help monitor the effectiveness of regional strategies over time?*
 - ▶ Yes. Example: governance framework – talks a lot about activities and process, but doesn't talk a lot about outcomes – what indicators would tell you whether all those meetings and agreements are making a difference?

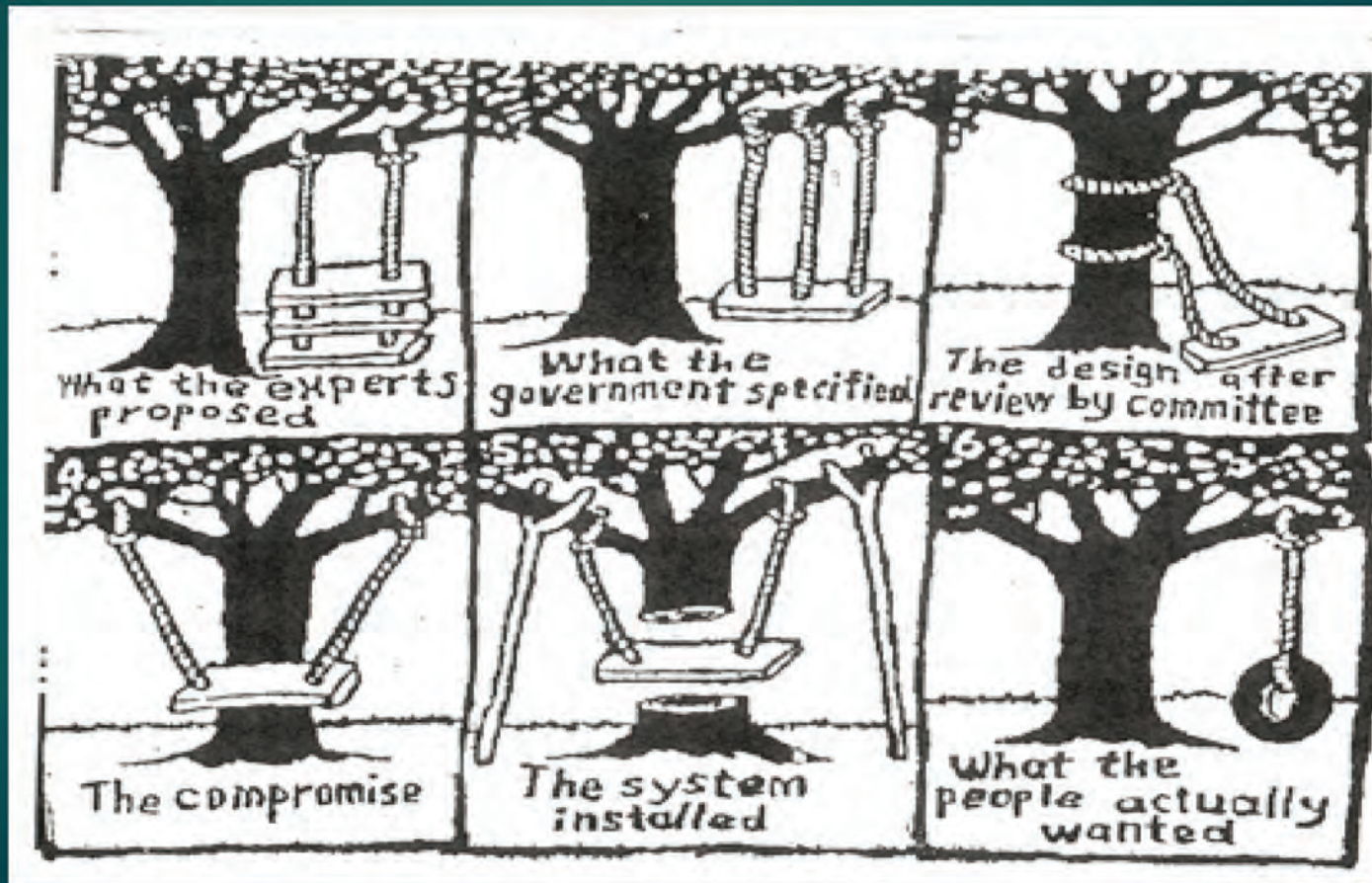
Using the Indicators

Relation to Regional Marine Framework

- ▶ *Can the indicators be informed by and help inform EBM monitoring related to land use plans and agreements?*
 - ▶ Yes; it makes sense to look at merging them, especially for human well-being indicators.

OK, BUT...

WHERE IS ALL THIS LEADING, REALLY?



Using the Indicators

Relation to Implementation

1. Three basic options for monitoring strategies



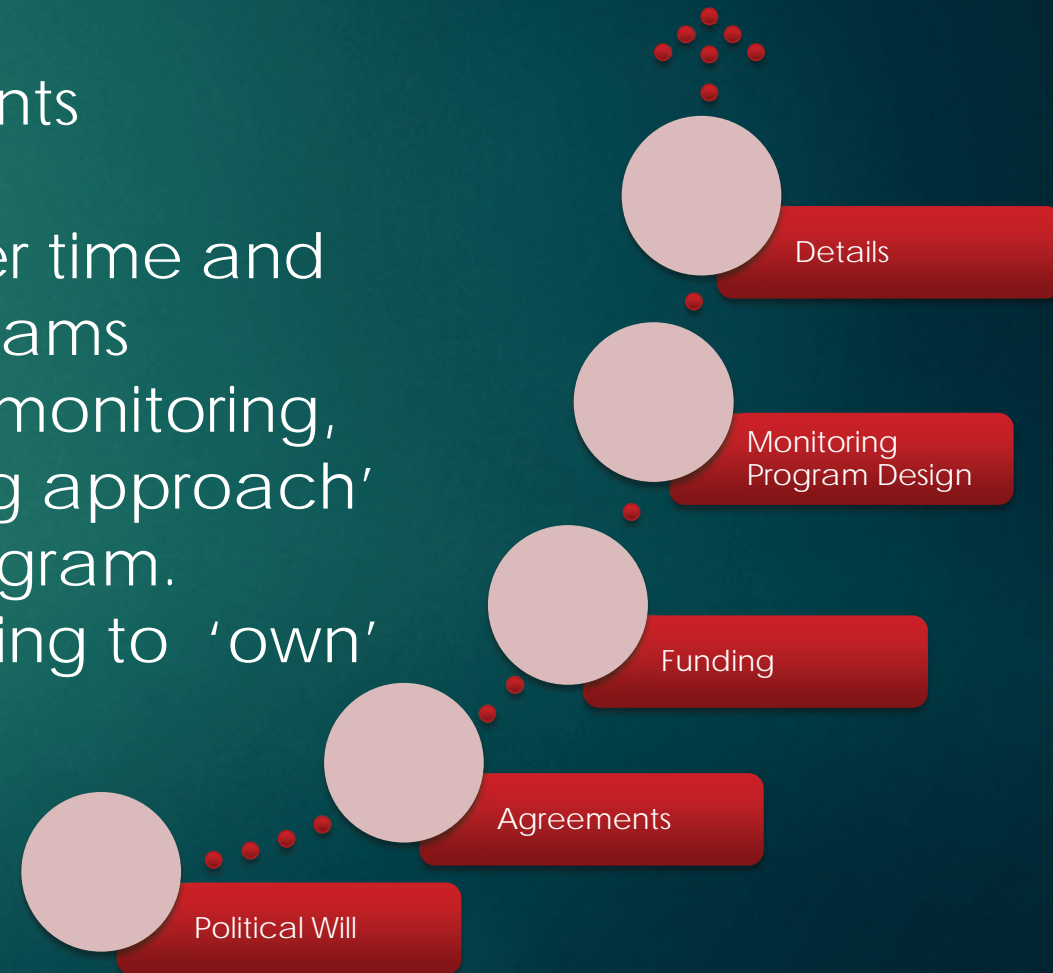
Relation to Implementation

Monitoring Strategy Drivers

1. Governance agreements and commitments

- Clarify if planning bodies stay in place over time and provide a 'house' for the monitoring programs
- Express political commitment to taking a 'monitoring, evaluation, and adaptive decision-making approach' that will use the results of the indicator program.
- Confirm commitments for those participating to 'own' particular indicators.
- Establish Monitoring Leadership Group.

2. Funding drives design and costs



Relation to Implementation Agreements

Monitoring Strategy Considerations

1. Focus on Utility

- Monitoring must measure progress towards Marine Plan objective and definitions of success. What impacts do we predict to result from the Marine Plans? What process results do we expect to achieve?
- Link indicators to specific policy and operational decisions (establish pathways via logic models)
- Develop targets and reference points: how do we define 'success'? What do we value and what are we willing to do to produce or preserve those values?
- Recognize that some data is just good to have in order to find correlations

Relation to Implementation Agreements

Monitoring Strategy Considerations

2. Appreciate the Need for Learning

- Need a systematic approach to testing indicators and adjusting them over time in response to utility.
- Share info about effective methods at all levels (data gathering to presentation). "Community of Practice."
- Greater integration of HWB and Ecological.

Relation to Implementation Agreements

Monitoring Strategy Considerations

3. Collaboration Details

- Focus on partner's core indicators as foundation; then work on partner indicators; then indicators that aren't currently monitored.
- It will take time to talk with different partners and outline how program might work
- Key barriers (policies, admin, technical, institutional)

4. Quantitative and Qualitative Approaches Needed

- Attribution, influence, and meaning are challenges. Use narrative to provide depth and understanding.

5. Explore use of Technology

Conclusions

- ▶ Implementation driven by political will and resources
- ▶ Focus on utility, learning, collaboration, quantitative/qualitative approaches
- ▶ Very large, very complicated, very holy grail
- ▶ Grounded theory, diverse participation, HWB development, ecological habitat approach, partnership strategy, and pragmatic recommendations are unique contributions from this project
- ▶ Can new technology change the game?

Thank You.

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Coastal First Nations
G R E A T B E A R I N I T I A T I V E