

A framework to assess vulnerability of biological components to ship-source oil spills in the marine environment

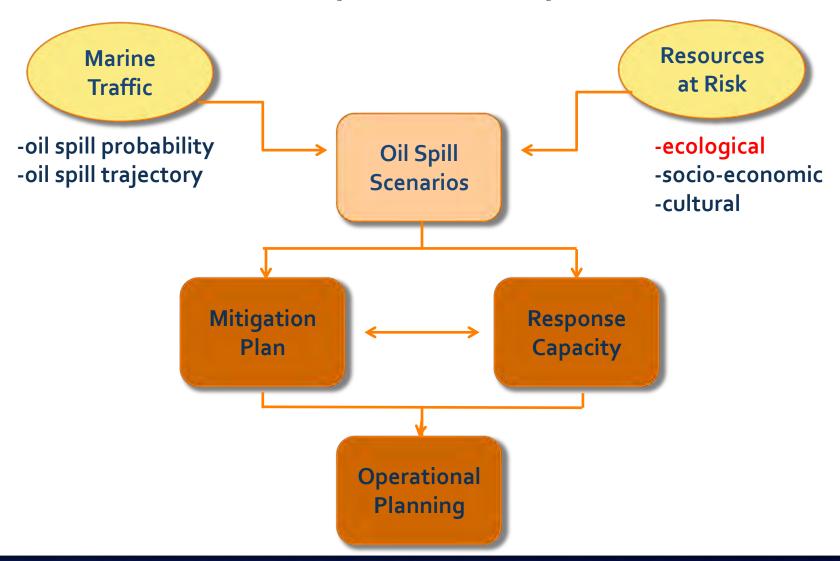
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Context

The World Class Tanker Safety Systems (WCTSS) launched by the Government of Canada in 2013 to improve oil spill preparedness and response capacity

- Area Response Plans (ARPs)
- Response-relevant data for mapping marine resources
- Focus on identifying biological components <u>most</u> vulnerable to ship-sourced oil spills
- Framework to evaluate vulnerability based on criteria to assess exposure, sensitivity and recovery.

Steps to develop an Area Response Plan for ship-source oil spills



National Framework

- + National framework reviewed and accepted through the Canadian Science Advice Secretariat (March 2016)
 - + Rapid assessment of vulnerability to ship source oil spills for biological components under our departmental mandate
 - + Nationally consistent
 - + Regionally flexible
 - + Scientifically sound
 - + Simple to implement



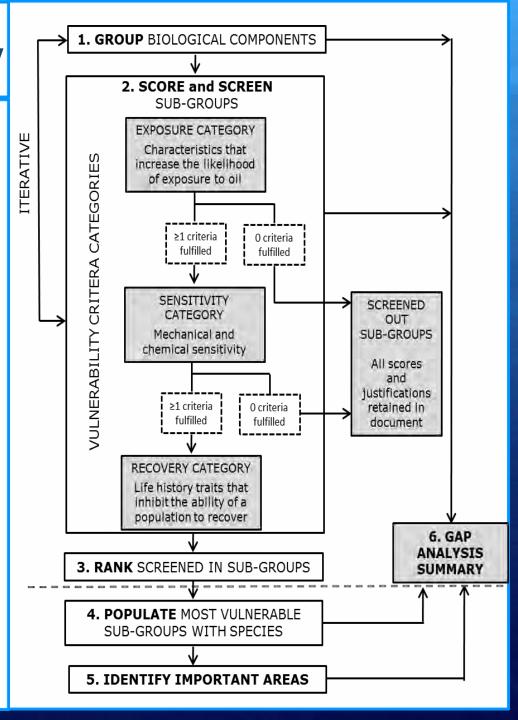
http://www.theglobeandmail.com/news/british-columbia/marathassa-timeline/article23989939

Context: Scope

- + Focus on biological components under our departmental mandate
- + Ecological only, does not consider socio-economic or cultural values
- + Focus on impacts from direct contact with oil (not indirect/secondary)
- + Habitats in this work are defined as areas associated with vulnerable biological components, and biogenic habitats are assessed as species
- + Not limited to any specific oil type.

Framework Overview

- Grouping of the biological components into sub-groups
- Scoring and screening of subgroups against vulnerability criteria
- 3. Ranking screened in subgroups
- 4. **Populating** most vulnerable sub-groups with species
- Identifying important areas for vulnerable species
- 6. Gap analysis



Phase 1:

Grouping of Biological Components

- + Sub-groups developed within:
 - + Marine Algae/Plants
 - + Marine Invertebrates
 - + Marine Fish
 - + Marine Reptiles
 - + Marine Mammals



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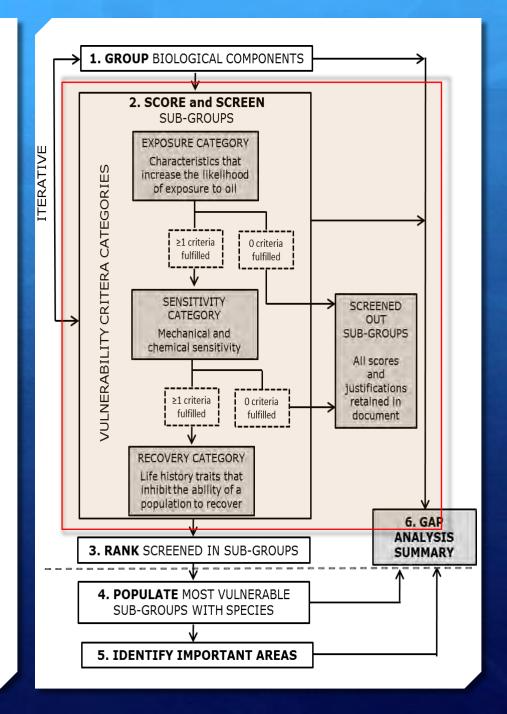
 Members of a sub-group should share similar characteristics with respect to factors important for vulnerability to oil, and divisions are based on biological and ecological traits

Sub-grouping example

Sub-group level 1	Sub-group level 2	Sub-group level 3	Examples of Pacific species within the sub-group	
		Discrete	Resident and Offshore Killer Whales (NE Pacific Northern & Southern Residents & NE Pacific Offshore); Pacific white sided dolphin	
Cetaceans	Toothed	Dispersed	Sperm whales, Killer Whales (W.Coast Transients); False Killer whale; Baird's Beaked whale; Hubbs' Beaked Whale; Stejneger's Beaked Whale; Harbour porpoise	
		Discrete	Humpback whales; whales; Grey whales	
	Baleen	Dispersed	Sei whale; Blue whale; Fin whale; North Pacific Right whale; Common Minke whale	
Pinnipeds	Thermoregulate with fur		Northern Fur Seal	
	Otherninnings	Discrete	Steller Sea Lion, Harbour seal	
	Other pinnipeds	Dispersed	Northern Elephant Seal; California sea lion	
Mustelids			Sea otter	

Phase 2: Scoring and Screening

Vulnerability Criteria



Exposure criteria

- + Concentration (aggregation)
- Mobility and/or site fidelity
- + Sea surface interacting
- Seafloor and/or vegetation interacting



Geoff Shester

Sensitivity Criteria

MECHANICAL SENSITIVITY

+ Reduction of feeding/photosynthesis/insulation

CHEMICAL SENSITIVITY

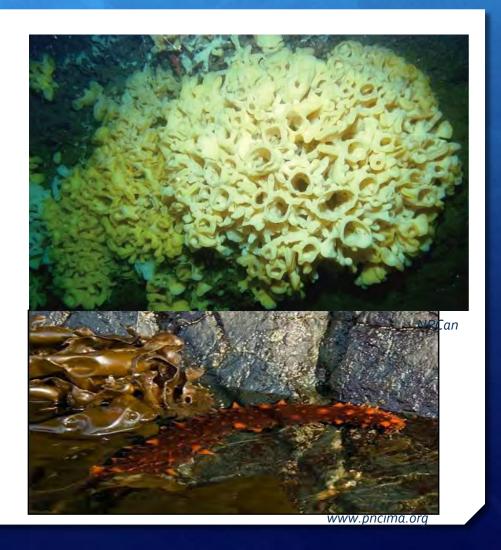
+ Impairment due to toxicity



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Recovery Criteria

- + Population status
- + Reproductive capacity
- + Endemism or isolation
- + Close association with unconsolidated substrates

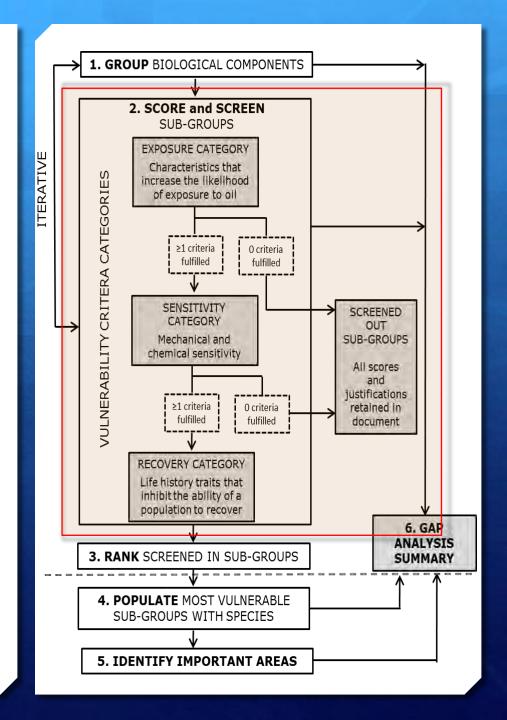


Phase 2: Scoring and Screening **Sub-group Scoring**

- + Scored at the finest level of sub-groups (e.g. dispersed, toothed, cetaceans)
- + Based on direct contact with oil
- + Scoring was binary (i.e. criteria fulfilled/not fulfilled)
- + Scores were reviewed by subject matter experts



Phase 2: Scoring and **Screening**



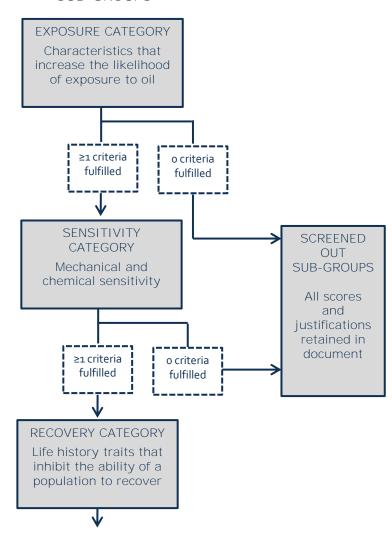
Phase 2: Scoring and **Screening**

- Exposure Criteria (4)
 - + Screen out sub-groups which do not fulfil any criteria
- 2. Sensitivity Criteria (2)
 - + Screen out sub-groups which do not fulfil any criteria
- 3. Recovery Criteria (4)
 - Remaining sub-groups are scored for 4 recovery criteria

2. SCORE and SCREEN

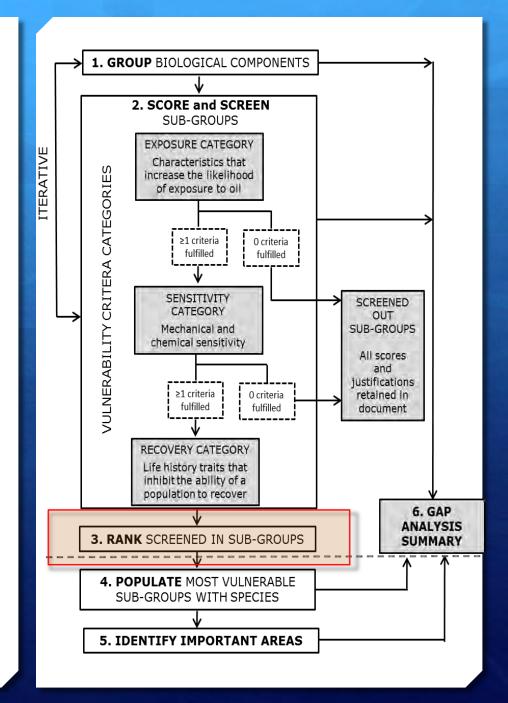
SUB-GROUPS

VULNERABILITY CRITERA CATEGORIES



Phase 3: Rank screened in sub-groups

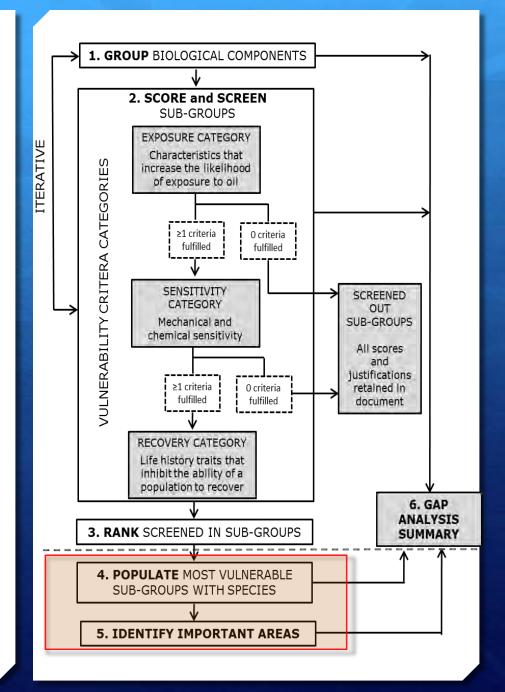
Final list of sub-groups ranked using the total scores for all criteria



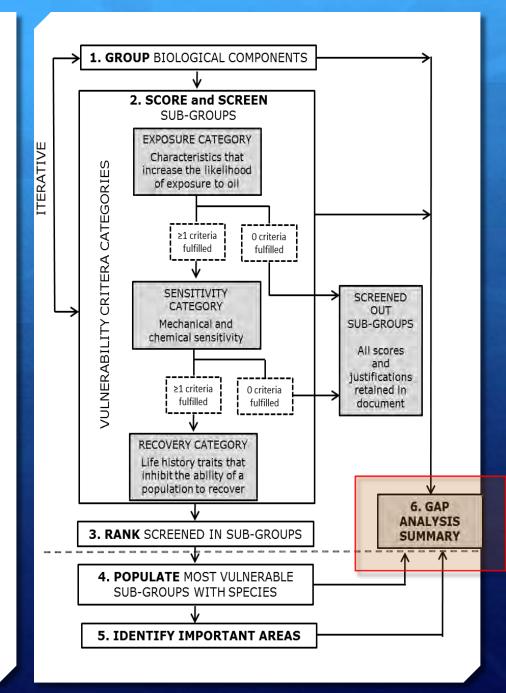
Phase 4 and 5:

Populate most vulnerable sub-groups with species

Identify **important areas** for vulnerable species



Gap Analysis



Gap Analysis

- + Determine knowledge and data gaps
- + Knowledge gaps:
 - + A lack of information or conflicting information causing uncertainty in grouping or scoring
- + Data gaps:
 - + A lack of data on important areas
 - + A lack of current data
 - + Improper data format
 - + Unavailable data
- + Gap analysis used to prioritize future research or identify data needs

Current and Future Work

+ Trial applications underway by DFO in 3 Canadian regions:

- + Pacific
- + Quebec
- + Maritimes





Pacific Application

Pacific Ocean Juan de Fuca Strait The Salish Sea

Preliminary Results

- + 118 biological sub-groups within 5 major groups were assessed
- The 26 sub-groups identified as most vulnerable by criteria (scoring 7-9)
- Next steps: populating species and searching for available data
- + Poster in BIO-P2-10 (Lucie Hannah)

Sub-group level 1 Level 2 Sub-group level 3 Seagrasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera marrina, Z. japonica, Ruppia martina Salt marsh grasses e.g. Zostera martina e.g. Sea otter e.g. Phyllospadic soutleri, P. torreyi, P. e.g. parritica martina e.g. Sea otter e.g. Partina partina e.g. Sea otter e.g. Partina partina e.g. Sea otter e.g. Partina partina e.g. Salt marsh grasses e.g. Zostera martina e.g. Sea pens e.g. Grass partina partina e.g. Sea pens e.g. Grass partina partina e.g. Sea pens e.g. Grass partina partina e.g. Sea urchins, Sea urchins, Sea urchins, Sea urchins, Sea urchins, Sea urchins, Sea stars e.g. Glass sponges (Hexactinelida) e.g. Glass sponges (Hexactinelida) e.g. Glass sponges (Hexactinelida) e.g. Glass sponges (Hexactinelida) e.g. Glass s		AND THE RESERVE OF THE PERSON						
Intertidal Vascular Plants Low energy unconsolidated shore Salt marsh grasses e.g. Carex lyngbyei, Leymus mollis e.g. Sarcecomia pacifica, S. pacifica, Glaux markina e.g. Phyliospadix scouleri, P. torreyi, P. serrulatus e.g. Sarcecomia pacifica, S. pacifica, Glaux markina e.g. Phyliospadix scouleri, P. torreyi, P. serrulatus e.g. Pelvetopsis limitata, Cymathere thieritidal Intertidal Understory / Turf Algae High energy, rocky shore N/A e.g. Pelvetopsis limitata, Cymathere thieritidal e.g. p. Humpback & Grey whales e.g. Killer whales e.g. Salmon (Prink, Chum, Coho, Chinook) e.g. Javenale and adult salmon & steelhead e.g. Salmon (Prink, Chum, Coho, Chinook) e.g. Salmon (Prink, Chum, Coho, Chinoo	_				Sub-group level 3	Sub-group level 4	Pacific examples	Vulnerability score (0-10)
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Cetaceans Baleen Discrete N/A e.g. Humpback & Grey whales e.g. Killer whales (residents (N & S) and offshore populations), Pacific white sided dolphin Estuarine Transient N/A Salmon (Salmonidae) e.g. juvenile and adult salmon & steelhead Associated with unconsolidated substrates (Sitt/Sand/Grave) (inc. eelgrass environments) Estuarine Transient N/A (Acipenseridae) Estuarine Transient N/A (Acipenseridae) Intertidal Benthic Salmonidae (iuvenile) e.g. Salmon (Pink, Chum, Coho, Chinook) Estuarine Transient N/A (Acipenseridae) Intertidal Benthic Sediment epifauna Low mobility Associated with unconsolidated substrates (Sitt/Sand/Grave) (inc. eelgrass environments) Herring (Clupeidae) E.g. Pacific herring e.g. Pacific herring e.g. Pacific herring Associated with unconsolidated substrates (Sitt/Sand/Grave) (inc. eelgrass environments) Mollusca e.g. Snails (Cl. Gastropoda) Chidaria e.g. Sea pens Echinodermata e.g. Sea stars Associated with unconsolidated substrates (Sitt/Sand/Grave) (inc. eelgrass environments) Benthic Sediment epifauna Low mobility Echinodermata e.g. Sea urchins, Sea cucumbers, Sea stars Mollusca e.g. Clams (Bivalvia); Snails (Gastropoda) Worms e.g. Burrowers Arthropoda e.g. Sand crabs (Emerita) Low pobility Echinodermata e.g. Sea sence (a.g. Glass sponges (Hexactinellida) Lophophorates e.g. Glass sponges (Hexactinellida) Lophophorates e.g. Sea urchins, Sea stars Sediment infauna Low mobility Echinodermata e.g. Sea urchins, Sea stars Subtidal benthic Substrate) Mollusca e.g. Clams (Bivalvia); Snails (Gastropoda) Worms e.g. Burrowers Arthropoda e.g. Sand crabs (Emerita) Lophophorates e.g. Glass sponges (Hexactinellida) Lophophorates e.g. Sea urchins, Sea stars Sediment infauna Low mobility Echinodermata e.g. Sea urchins, Sea stars Echinodermata e.g. Sea pens		Intertidal		High energy, rocky shore	N/A		7	
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Estuarine Transient N/A Salmon (Salmonidae) e.g. juvenile and adult salmon & steelhead Intertidal Benthic Associated with unconsolidated substrates (Sitt/Sand/Gravet) (inc. eelgrass environments) Salmonidae (juvenile) e.g. Salmon (Pink, Chum, Coho, Chinook) 8	필물		Cetaceans	Baleen	Discrete	N/A	e.g. Humpback & Grey whales	•
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Rock and rubble dwellers Sessile (attached to hard substrate) Low mobility Echinodermata e.g. Sea stars	_		Intertidal	Sediment epifauna	Low mobility			8
Rock and rubble dwellers Sessile (attached to hard substrate) Low mobility Echinodermata e.g. Oysters [Bivalvia]								
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Subtidal benthic Subtidal benthic Sediment infauna Low mobility Echinodermata e.g. Sea urchins, Sea stars Sediment infauna Low mobility Mollusca e.g. Clams Cnidaria e.g. Sea pens		Subtidal benthic			Porifera	e.g. Glass sponges (Hexactinellida)		
Sediment infauna Low mobility Mollusca e.g. Clams Cnidaria e.g. Sea pens				Low mobility	Echinodermata	e.g. Sea urchins, Sea stars		
			Sediment infauna	Low mobility	Mollusca	e.g. Clams		
			Sediment epifauna	Low mobility				
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Questions?



Photo by Berger



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