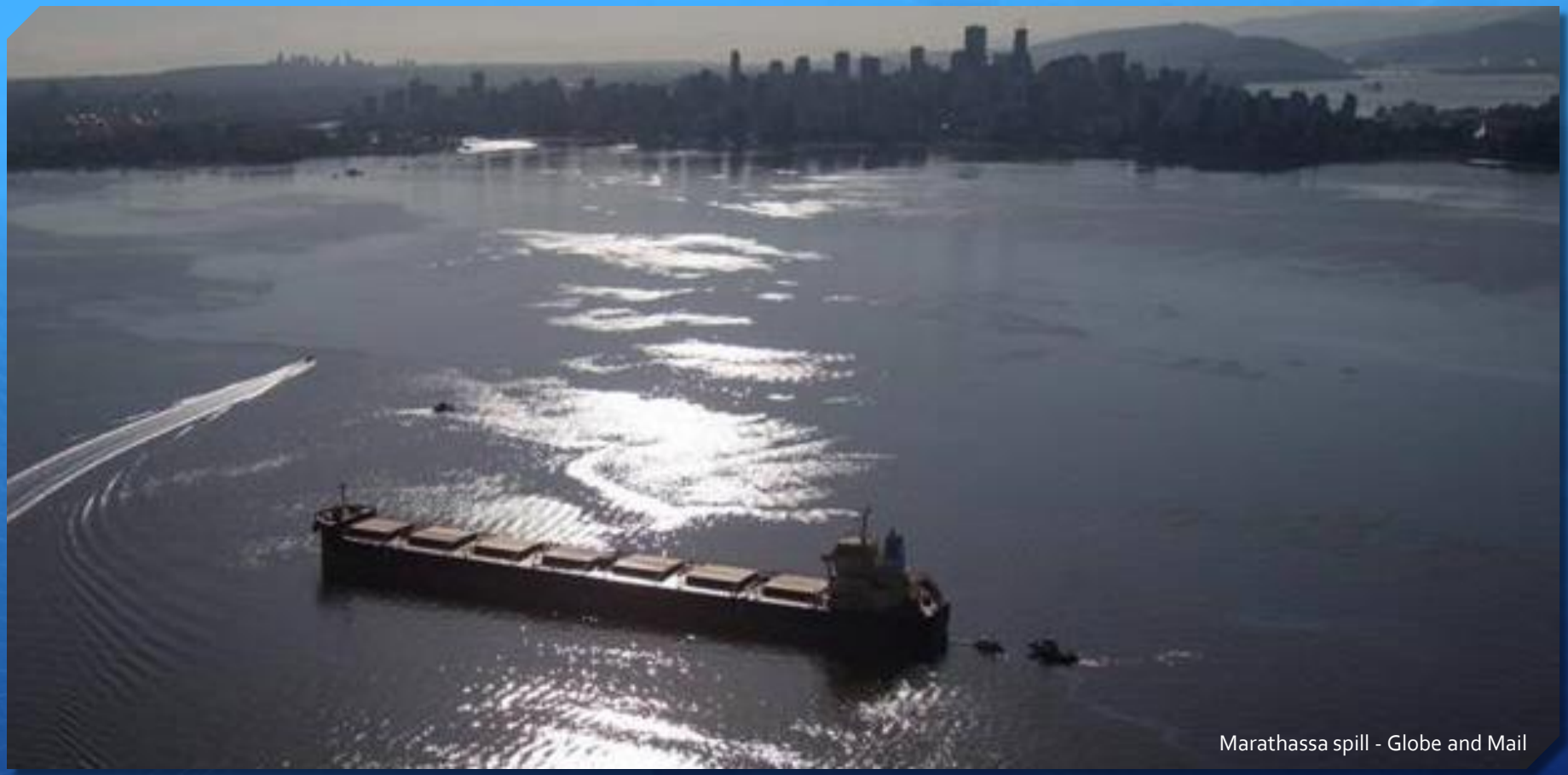

Marathassa spill - Globe and Mail

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

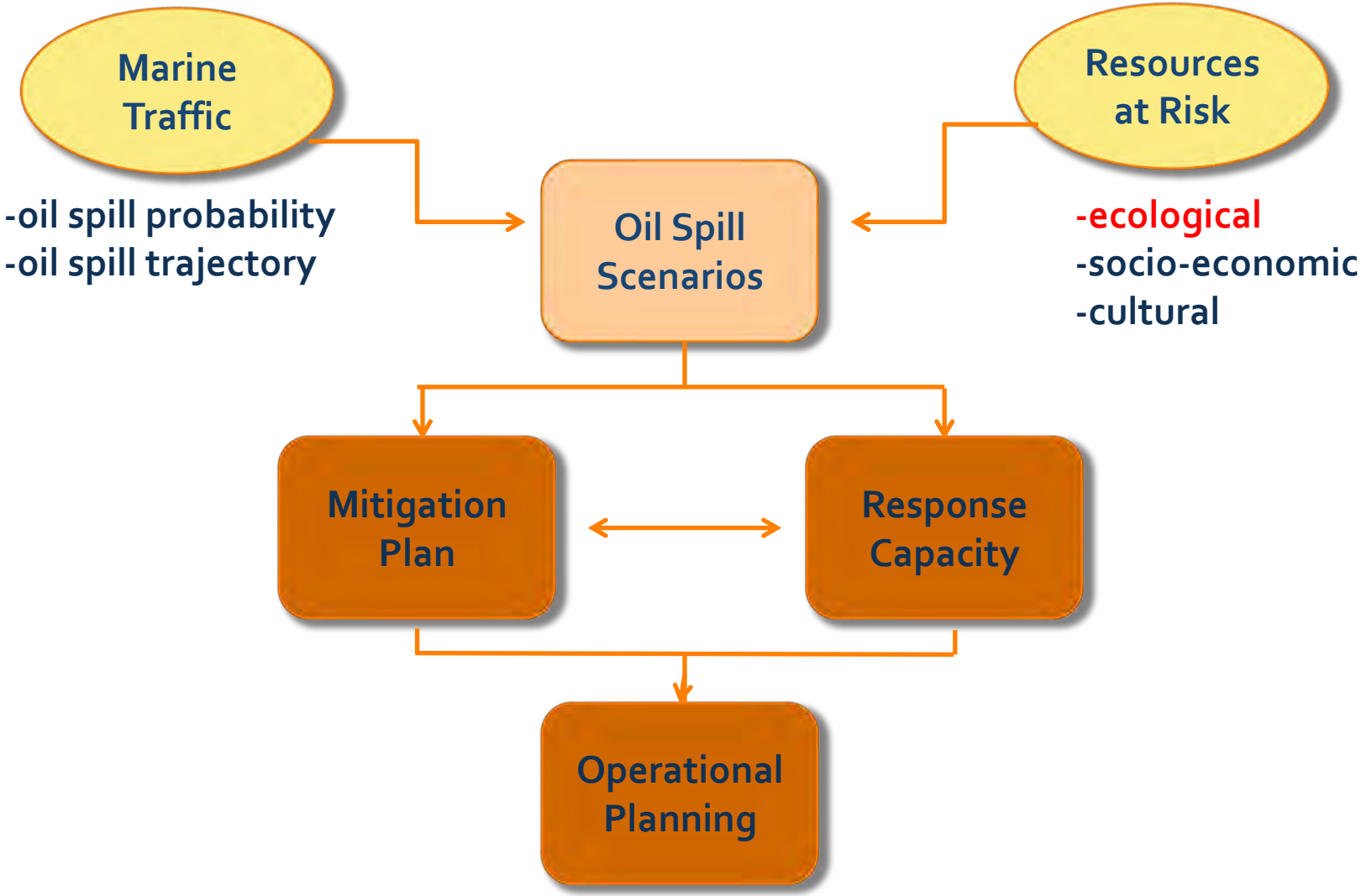
Kate Thornborough, Lucie Hannah, Candice St. Germain and **Miriam O**, Institute of Ocean Sciences, Fisheries and Oceans Canada

# Context

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

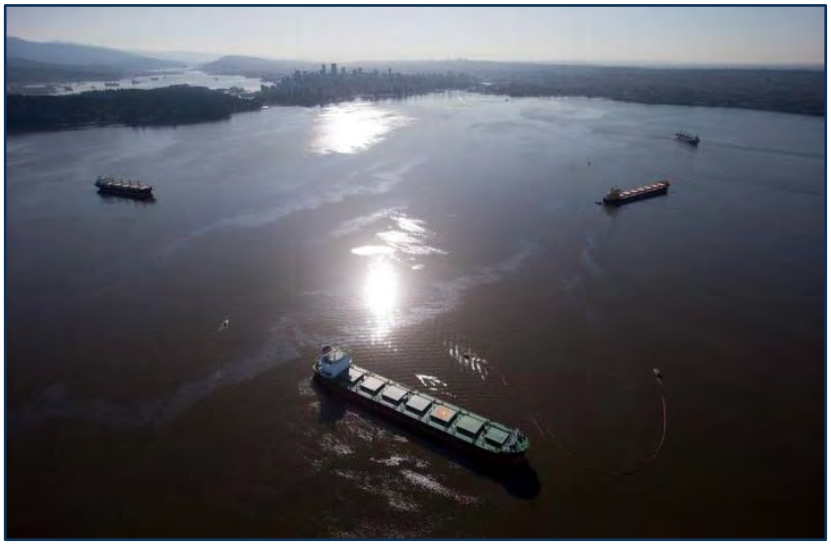
- Area Response Plans (ARPs)
- Response-relevant data for mapping marine resources
- Focus on identifying biological components most vulnerable to ship-sourced oil spills
- Framework to evaluate vulnerability based on criteria to assess exposure, sensitivity and recovery.

# 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



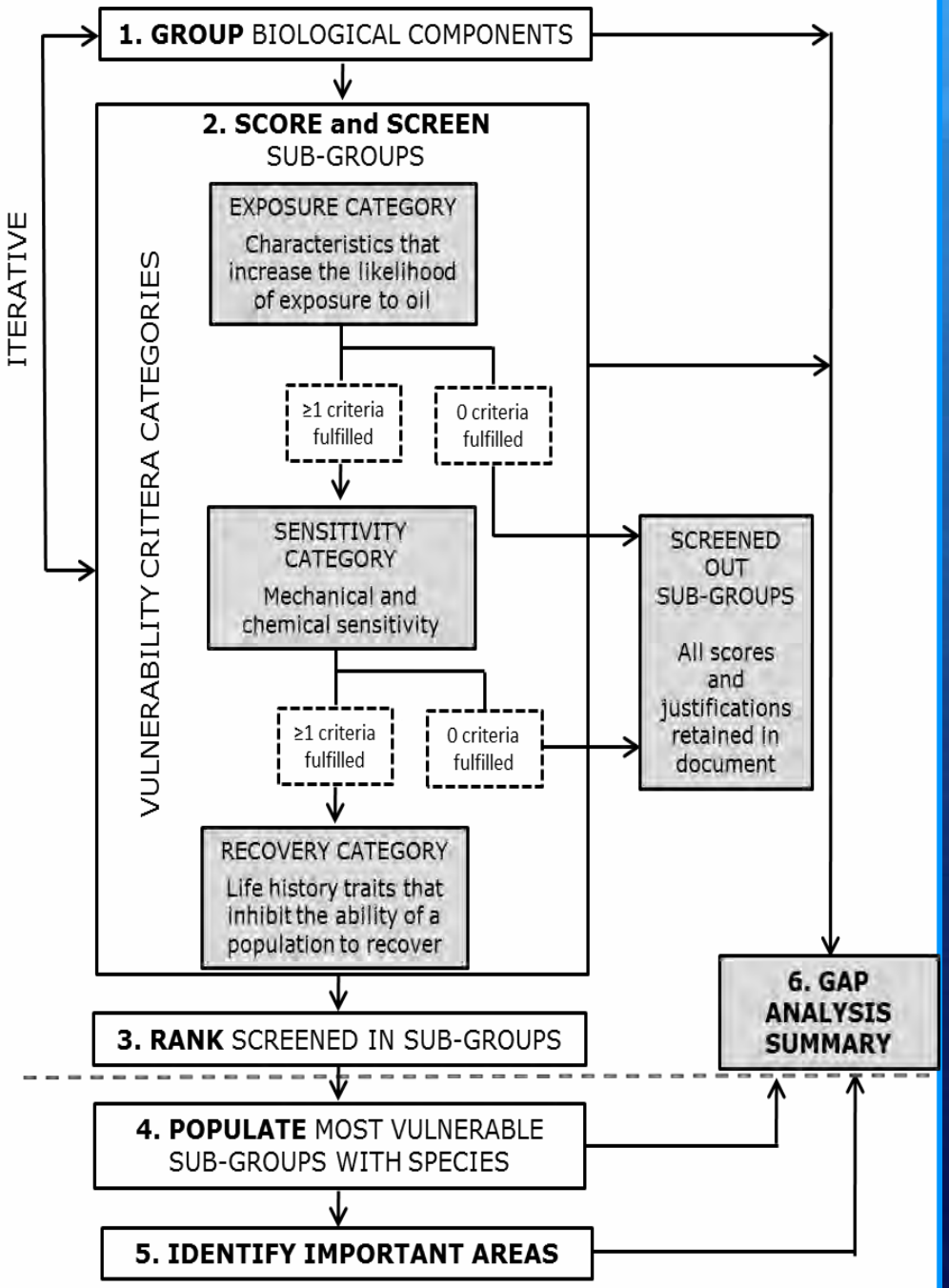
http://www.theglobeandmail.com/news/british-columbia/marathassa-timeline/article23989939

# 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

1. **Grouping** of the biological components into sub-groups
2. **Scoring and screening** of sub-groups against vulnerability criteria
3. **Ranking** screened in sub-groups
4. **Populating** most vulnerable sub-groups with species
5. 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

*Russ Markel*

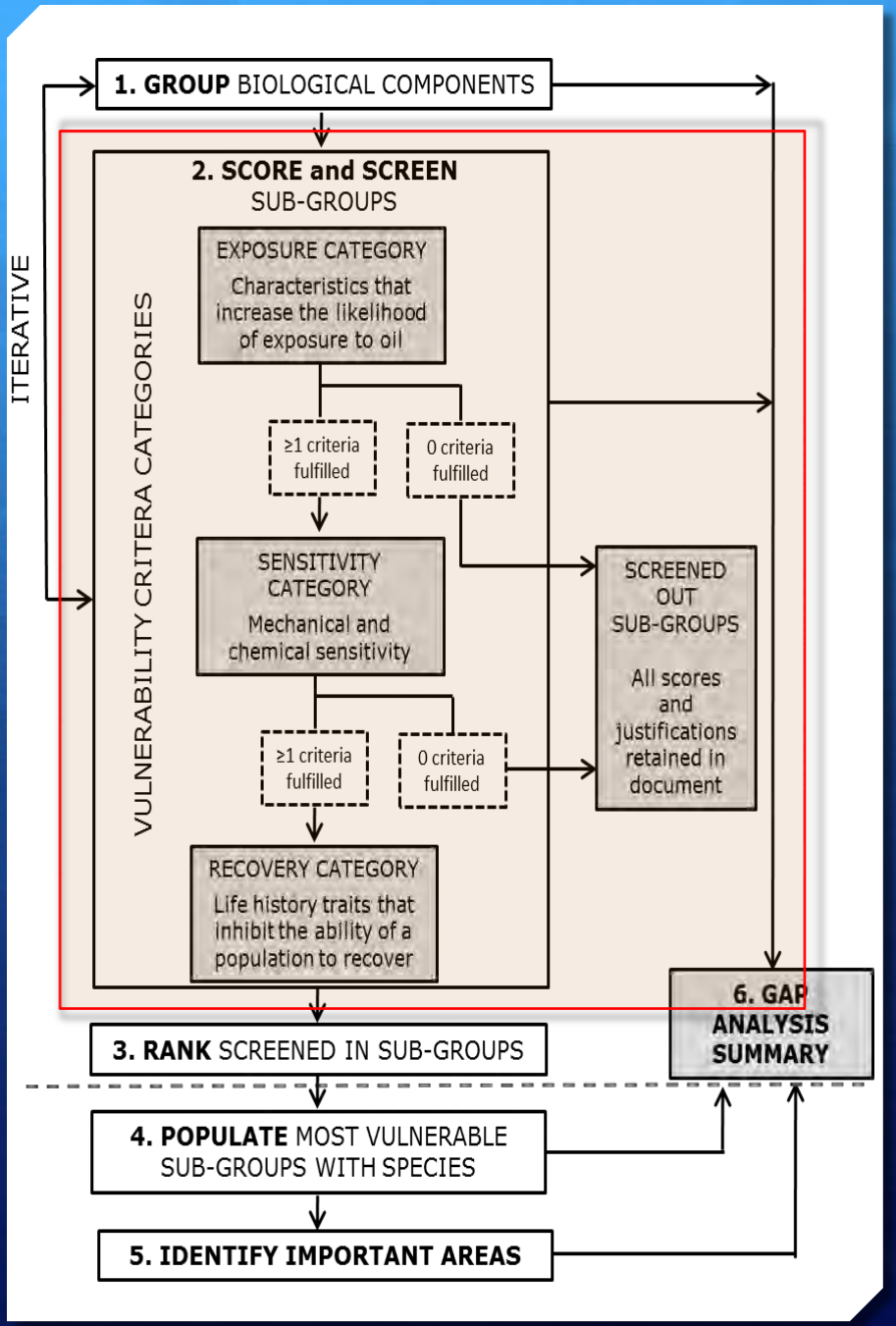
- Members of a sub-group should share similar characteristics with respect to factors important for vulnerability to oil, and divisions are based on biological and ecological traits

# Sub-grouping example

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

*Russ Markel*

# Recovery Criteria

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

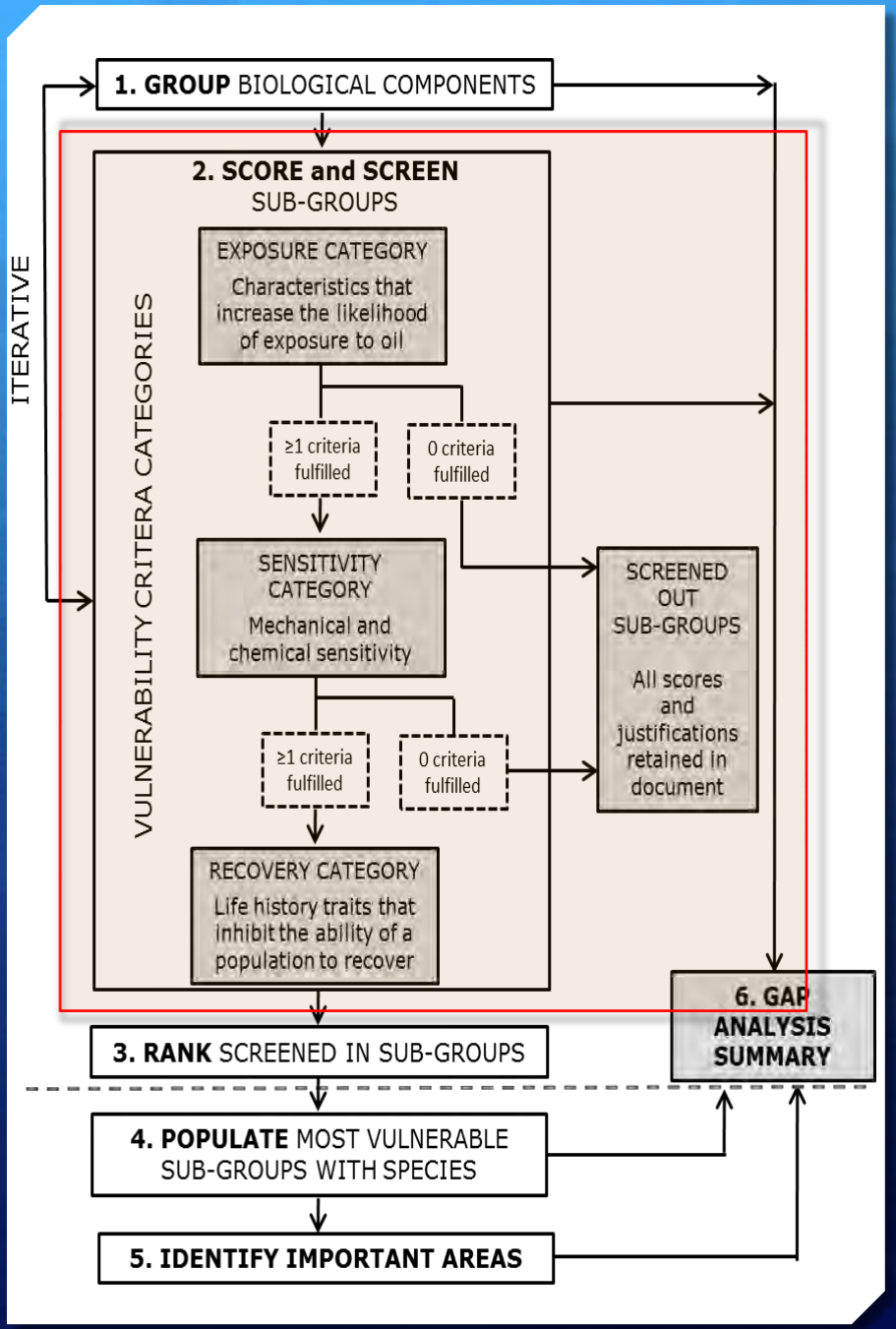
NRCan

www.pncima.org

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

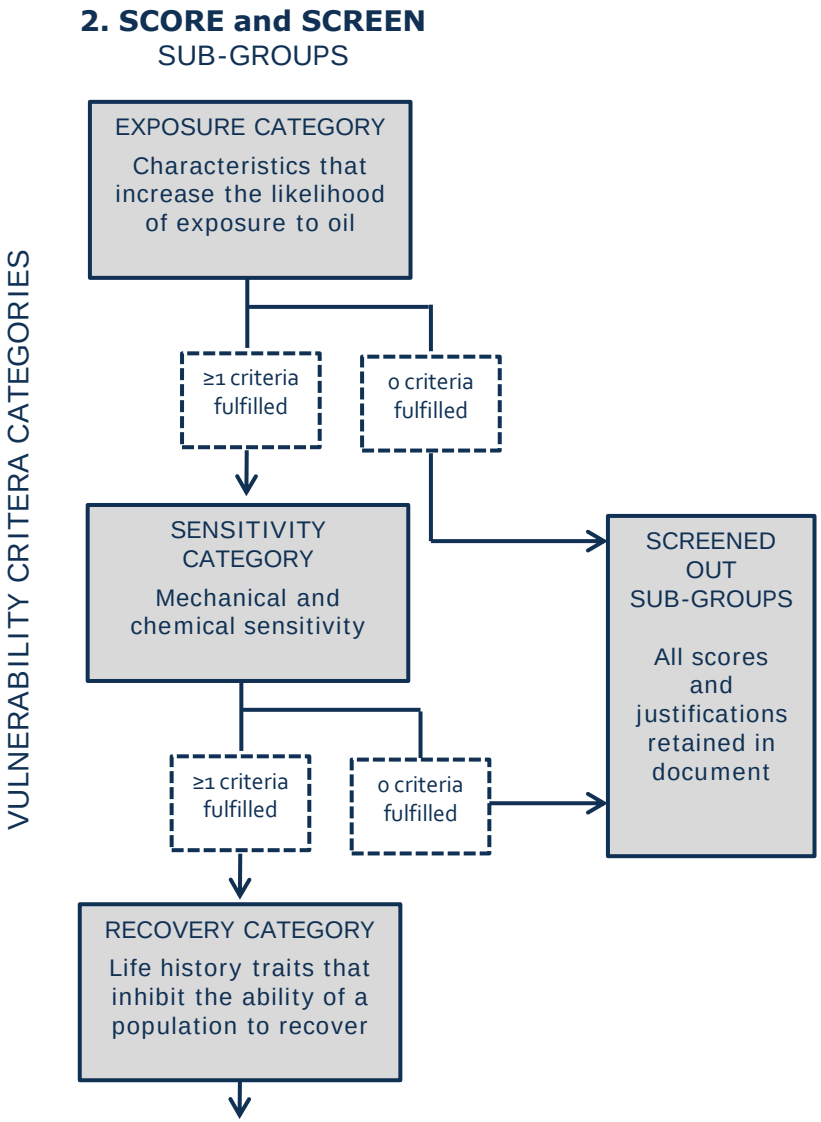
- Scored at the finest level of sub-groups (e.g. dispersed, toothed, cetaceans)
- Based on direct contact with oil
- Scoring was binary (i.e. criteria fulfilled/not fulfilled)
- Scores were reviewed by subject matter experts

# Phase 2: Scoring and **Screening**



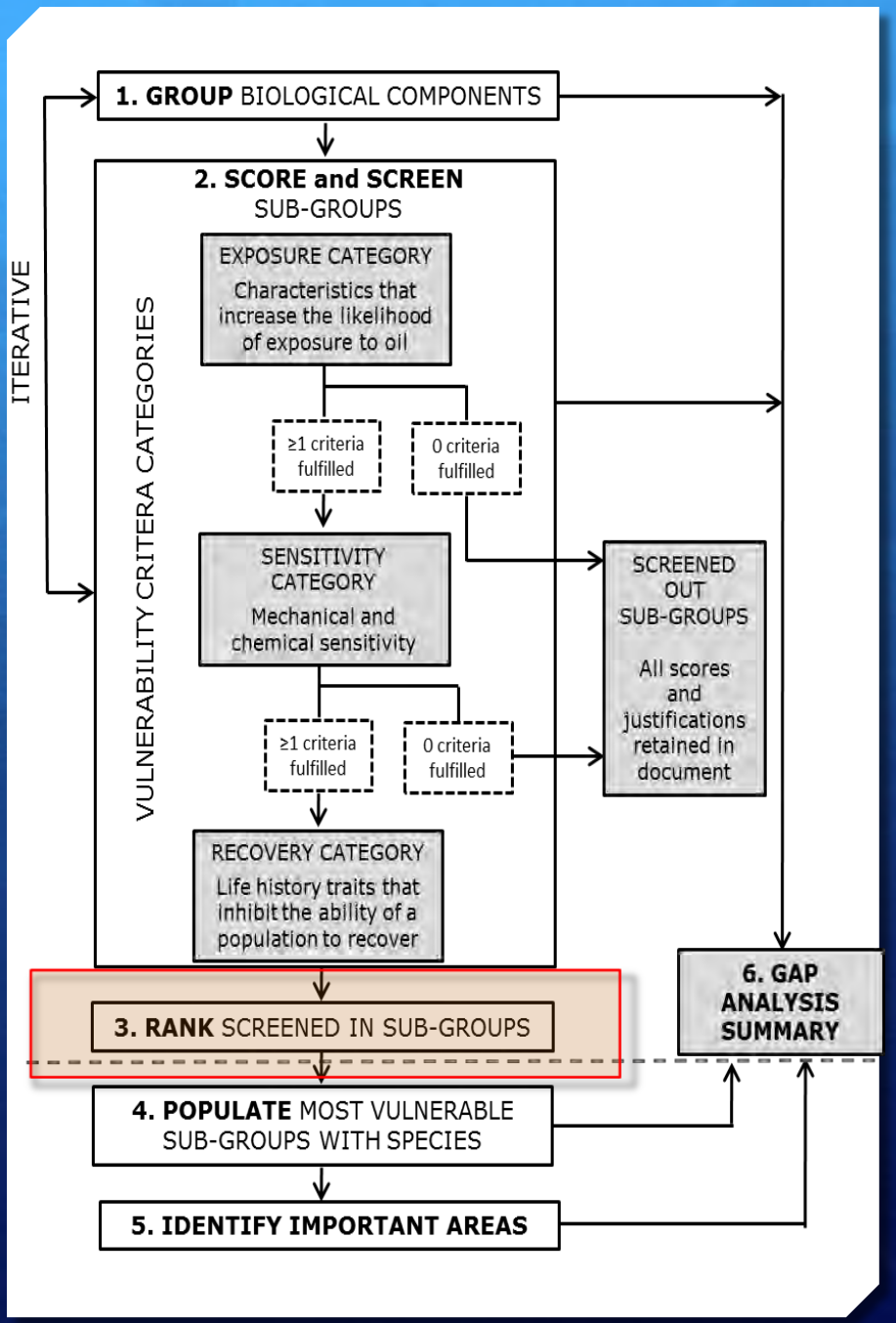
# Phase 2: Scoring and **Screening**

1. 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



# Phase 3: Rank screened in sub-groups

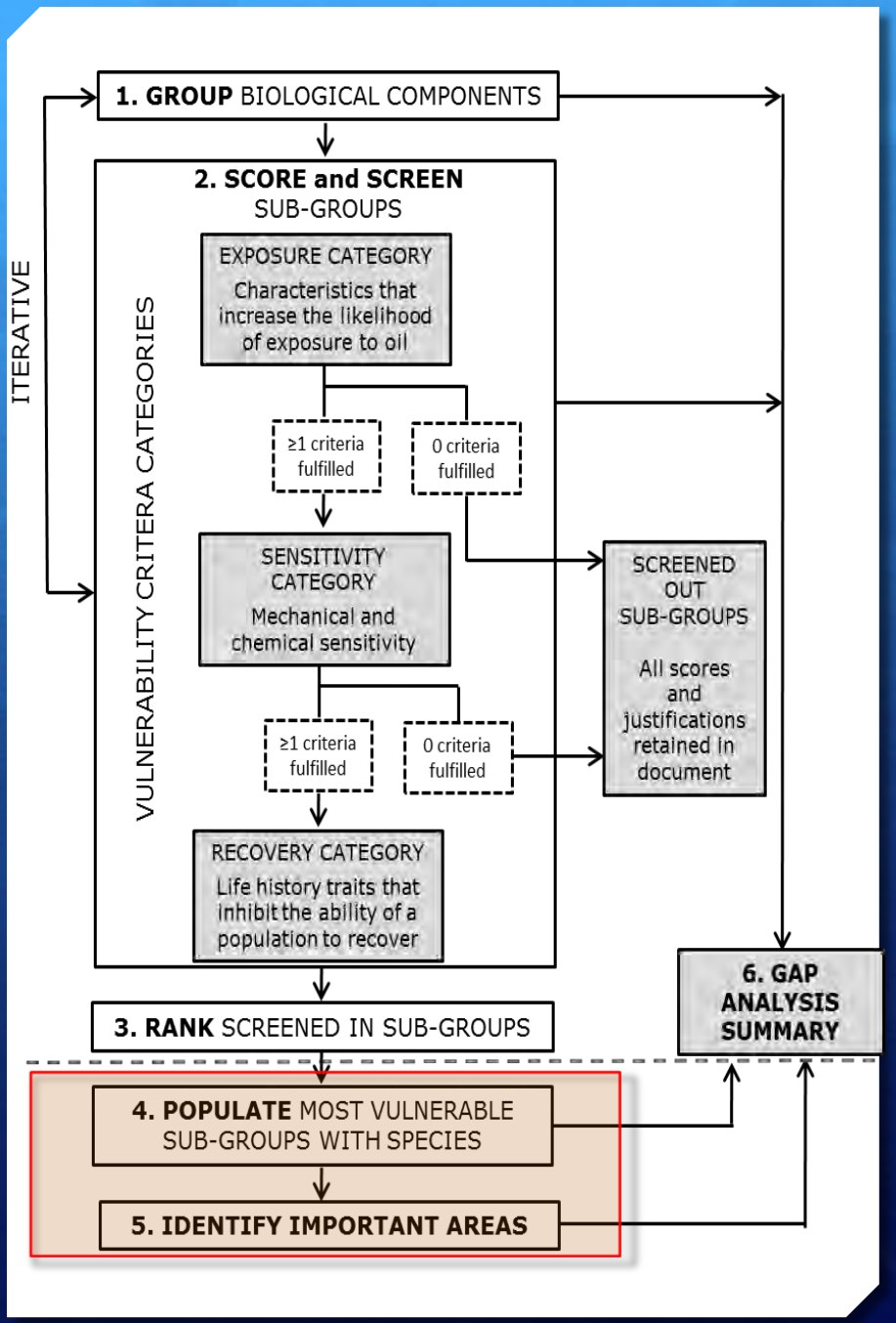
Final list of sub-groups ranked using the total scores for all criteria



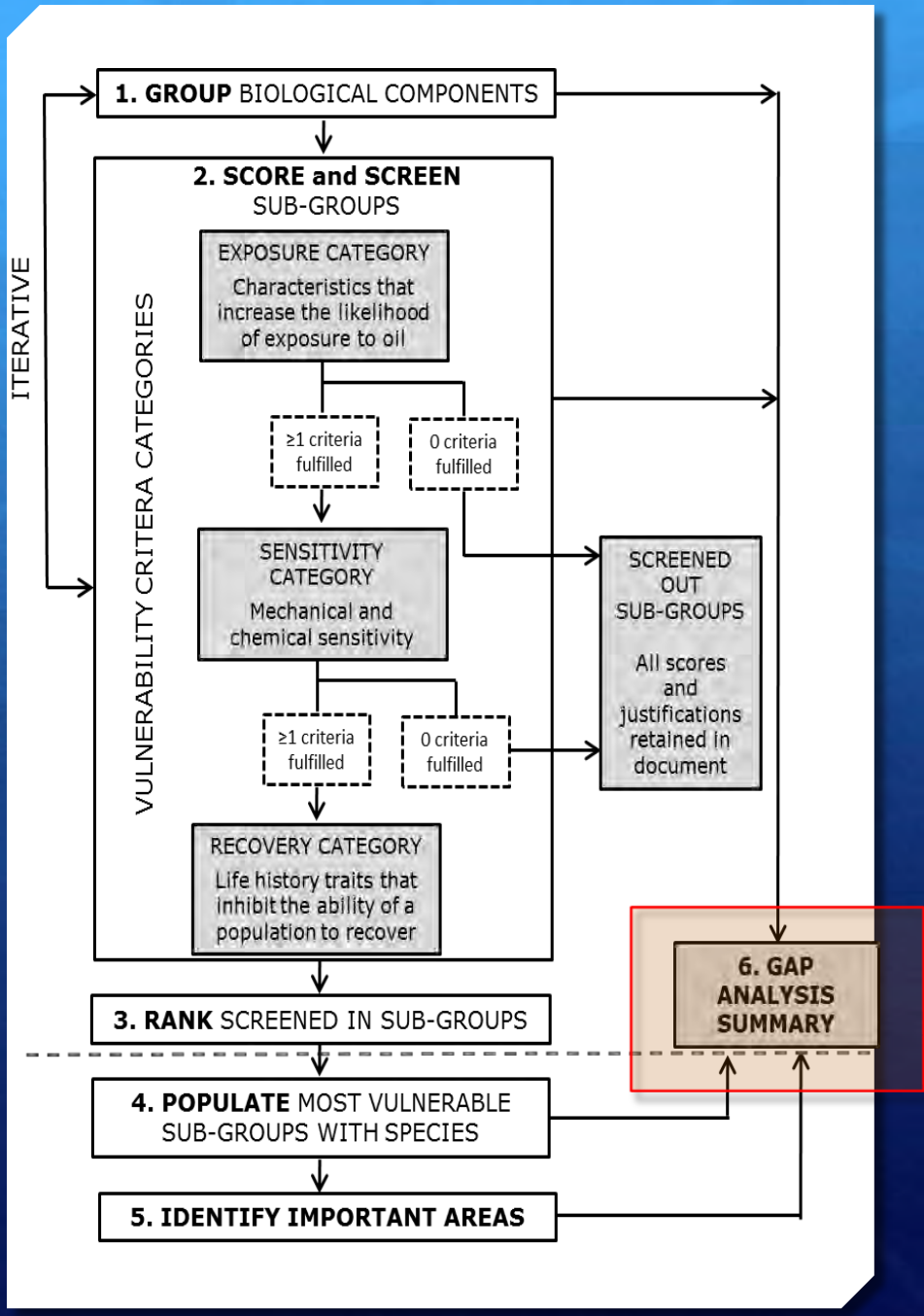
# Phase 4 and 5:

**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


## 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)

| Biological group | Sub-group level 1 | Sub-group level 2 | Sub-group level 3 | Sub-group level 4 | Pacific examples | Vulnerability score (0-10) |
|---|---|---|---|---|---|---|
| MARINE PLANTS & ALGAE | Intertidal | Vascular Plants | Low energy unconsolidated shore | Seagrasses | e.g. *Zostera marina, Z. japonica, Ruppia maritima* | 9 |
| | | | | Salt marsh grasses | e.g. *Carex lyngbyei, Leymus mollis* | |
| | | | | Salt marsh succulents | e.g. *Sarcocornia pacifica, S. pacifica, Glaux maritima* | |
| | Intertidal | Vascular Plants | High energy, rocky shore | Seagrasses | e.g. *Phyllospadix scouleri, P. torreyi, P. serrulatus* | 8 |
| | Subtidal | Canopy Algae | Low – moderate energy rocky habitat | N/A | e.g. *Macrocystis integrifolia* | |
| | Intertidal | Understory / Turf Algae | High energy, rocky shore | N/A | e.g. *Pelvetiopsis limitata, Cymathere triplicata, Postelsia palmaeformis,* | 7 |
| MARINE MAMMALS | Mustelids | N/A | N/A | N/A | e.g. Sea otter | 9 |
| | Cetaceans | Baleen | Discrete | N/A | e.g. Humpback & Grey whales | |
| | Cetaceans | Toothed | Discrete | N/A | e.g. Killer whales (residents (N & S) and offshore populations); Pacific white sided dolphin | 7 |
| MARINE FISHES | Estuarine | Transient | N/A | Salmon (Salmonidae) | e.g. juvenile and adult salmon & steelhead | 8 |
| | Intertidal | Benthic | Associated with unconsolidated substrates (Silt/Sand/Gravel) (inc. eelgrass environments) | Salmonidae (juvenile) | e.g. Salmon (Pink, Chum, Coho, Chinook) | |
| | Estuarine | Transient | N/A | Sturgeon (Acipenseridae) | e.g. Green sturgeon, White sturgeon | 7 |
| | Intertidal | Benthic | Associated with unconsolidated substrates (Silt/Sand/Gravel) (inc. eelgrass environments) | Herring (Clupeidae) | e.g. Pacific herring | |
| MARINE INVERTEBRATES | Intertidal | Sediment epifauna | Low mobility | Mollusca | e.g. Snails [Cl. Gastropoda] | 8 |
| | | | | Cnidaria | e.g. Sea pens | |
| | | | | Echinodermata | e.g. Sea stars | |
| | Intertidal | Rock and rubble dwellers | Sessile (attached to hard substrate) | Mollusca | e.g. Oysters [Bivalvia] | 7 |
| | | | Low mobility | Echinodermata | e.g. Sea urchins , Sea cucumbers, Sea stars | |
| | | Sediment infauna | Low mobility | Mollusca | e.g. Clams [Bivalvia]; Snails [Gastropoda] | |
| | | | | Worms | e.g. Burrowers | |
| | | | | Arthropoda | e.g. Sand crabs [Emerita] | |
| | | | | Lophophorates | e.g. Horseshoe worms, lampshells | |
| | Subtidal benthic | Rock and rubble dwellers | Sessile (attached to hard substrate) | Porifera | e.g. Glass sponges (Hexactinellida) | |
| | | | Low mobility | Echinodermata | e.g. Sea urchins, Sea stars | |
| | | Sediment infauna | Low mobility | Mollusca | e.g. Clams | |
| | | Sediment epifauna | Low mobility | Cnidaria | e.g. Sea pens | |
| | | | | Echinodermata | e.g. Sea stars | |

# Questions?

*Photo by Berger*

*Photo by Linda Tanner*