Oil spill preparedness planning: filling critical species data gaps using habitat suitability modelling

Candice St. Germain  
*Fisheries and Oceans Canada, Canada, candice.st.germain@dfo-mpo.gc.ca*

Jessica Finney  
*Fisheries and Oceans Canada, Canada, jessica.finney@dfo-mpo.gc.ca*

Cole Fields  
*Fisheries and Oceans Canada, Canada, cole.fields@dfo-mpo.gc.ca*

Edward Gregr  
*Fisheries and Oceans Canada, Canada, edward.gregr@dfo-mpo.gc.ca*

Lucie Hannah  
*Fisheries and Oceans Canada, Canada, lucie.hannah@dfo-mpo.gc.ca*

See next page for additional authors

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Speaker
Candice St. Germain, Jessica Finney, Cole Fields, Edward Gregr, Lucie Hannah, and Sharon Jeffery
Oil spill preparedness planning: Filling critical species data gaps using habitat suitability models

Jessica Finney
Science, Pacific Region

Cole Fields, Ed Gregr, Candice St. Germain, Lucie Hannah, Sharon Jeffery
Emergency Response:
Stranded fuel barge in the Central Coast

Photo: Jordan Wilson

B.C. Spill Response
@SpillsInfoBC

#JakeShearer fuel barge anchored 25 nautical miles SW of #BellaBellaBC near Goose Island. @SpillsInfoBC response officers staged to deploy. Incident details: ow.ly/CP6530gPnKS

Canadian Coast Guard @CCG_GCC
CCGS Gordon Reid is on scene responding with partners to an incident involving a barge Jake Shearer that became separated from its tug south of Goose Island in Queen Charlotte Sound #BC. @SpillsInfoBC @VicJRCC_CCCOS

10:02 PM - 26 Nov 2017
Emergency Response:
Stranded fuel barge in the Central Coast
Emergency Response:
Stranded fuel barge in the Central Coast

HSM
Present
Absent

Present
Absent

Identifying areas with HSM presence and absence.
Emergency Response:
Stranded fuel barge in the Central Coast

Photo: Jordan Wilson
Outline

• Habitat Suitability Models
• Habitat Modelling Workbook
  – Environmental and species data
  – Modelling algorithms
  – Model evaluation
  – Interpretation and application of results
• Summary
Habitat suitability models

• Use algorithms to relate species data to background environmental variables

• Create maps predicting suitable habitat and/or abundance

\[ \text{Chlorophyll} + \text{Temperature} + \text{Salinity} + \text{Depth} = \text{niche} \]
Habitat Modelling Workbook

Intent:

• Fill critical species data gaps

• Support the use of best practices

• Support consistent development and validation
Habitat Modelling Workbook

Data preparation
- Environmental
- Species

Model development
- HSI
- GLM
- BRT

Model validation
- Numerical
- Spatial

Model interpretation
- Uncertainty
- Application
- Limitations

Increasing complexity and data requirements

Calibration

Independent data
Transferability (space/time)
Habitat modelling workbook: Data preparation

• Environmental data
  – Spatial resolution
  – Temporal resolution
  – Relevance to species

• Species data
  – Presence only vs. presence/absence
  – Prevalence
  – Number of records
  – Bias – spatial, temporal, sampling, etc.
Habitat modelling workbook: Environmental data

Bathymetric derivatives
- Bottom type/bottom patches
- Depth
- BPI
- Slope

Ocean circulation derivatives
- Tidal velocity
- Temperature
- Salinity
- Current speed

Remote sensing derivatives
- Chlorophyll $a$ conc.
Habitat modelling workbook: Species data – Oil vulnerability framework

- National framework to identify marine organisms **most vulnerable** to ship-source oil spills (2015)
- Framework applied in Pacific Region (2016-17)
- Adapted frameworks applied in Quebec and Maritimes Regions (2016-17)
Habitat modelling workbook: Species data

• Benthic species

• Species listed in:
  – Species vulnerable to oil
  – Conservation priorities for MPAs
Habitat modelling workbook: Species data

• 12 initial species

• Represent a diversity of:
  – Life history characteristics
  – Habitats
  – Data availability
Habitat modelling workbook:
Species data – Benthic habitat mapping dive surveys

• About 920 transects since 2013

• Record presence/absence of:
  – 102 invertebrate species
  – 61 algae species
Habitat modelling workbook: Model development

• Tiered approach to modelling

• Three models with increasing complexity and data requirements

• You don’t always need a Cadillac, sometimes an old Civic will do
Habitat modelling workbook: Model development – HSI

- Habitat Suitability Index (HSI)
  - Based on hypothesised species-habitat relationships
  - Low complexity
  - Low data requirements
Habitat modelling workbook:
Model development – GLM and BRT

• Generalized Linear Models (GLMs)
  – Regression-based method
  – “Medium” complexity

• Boosted Regression Trees (BRTs)
  – Tree-based machine learning method
  – “High” complexity
Habitat modelling workbook: Model interpretation

• Calibration
  – During model building
  – Based on variance explained

• Validation
  – Testing completed model
  – How well the model meets study objectives

• Key transferability assumptions:
  – Stationarity
  – Representativity
Conducting consistent analyses:
Habitat Modelling Workbook

• Interpretation of results

• Representing uncertainty

• Application of results
Summary

- HSMs help fill in data gaps
- Outputs:
  - Habitat suitability maps for 12 species
  - Habitat suitability modelling workbook
  - Code to facilitate model building
  - Environmental and species data layers
Summary

• Provides consistency in approach Regionally

• Provides a framework to model species distributions for a range of data situations

• Guidance on how to describe uncertainty
Summary

• This process will highlight additional gaps in knowledge

• Applications beyond oil spill response
  – Marine spatial planning, e.g., MPAs, EBSAs
  – Fisheries management
  – Risk assessments
  – Species at risk
Questions