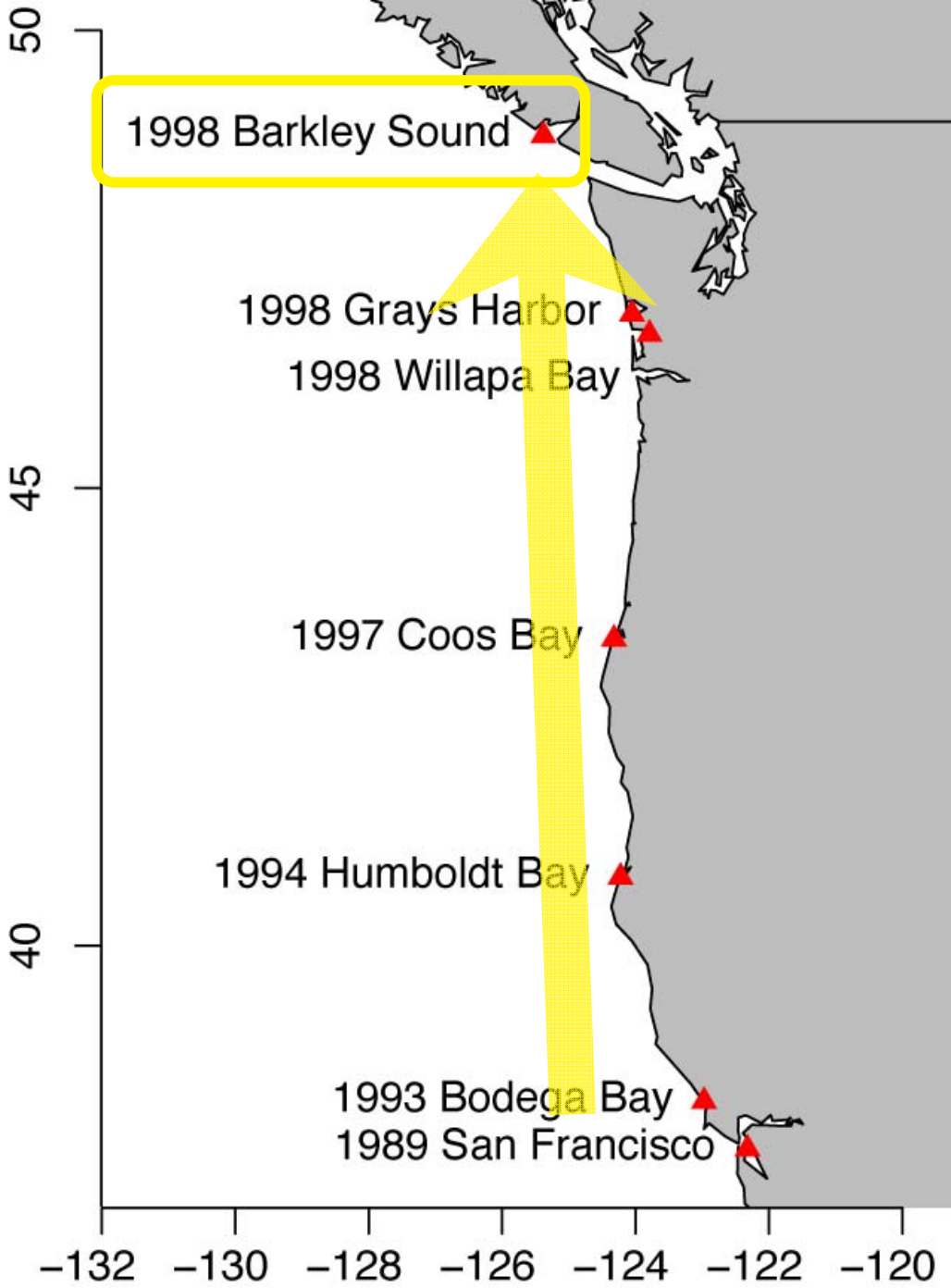
European Green Crab

Carcinus maenas (Linnaeus, 1758)

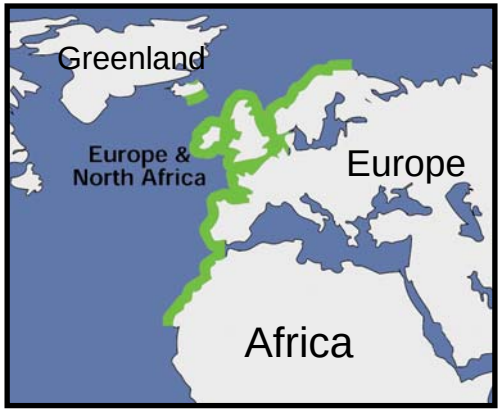
ODF&W

Northward Advance on West Coast of the USA & Canada



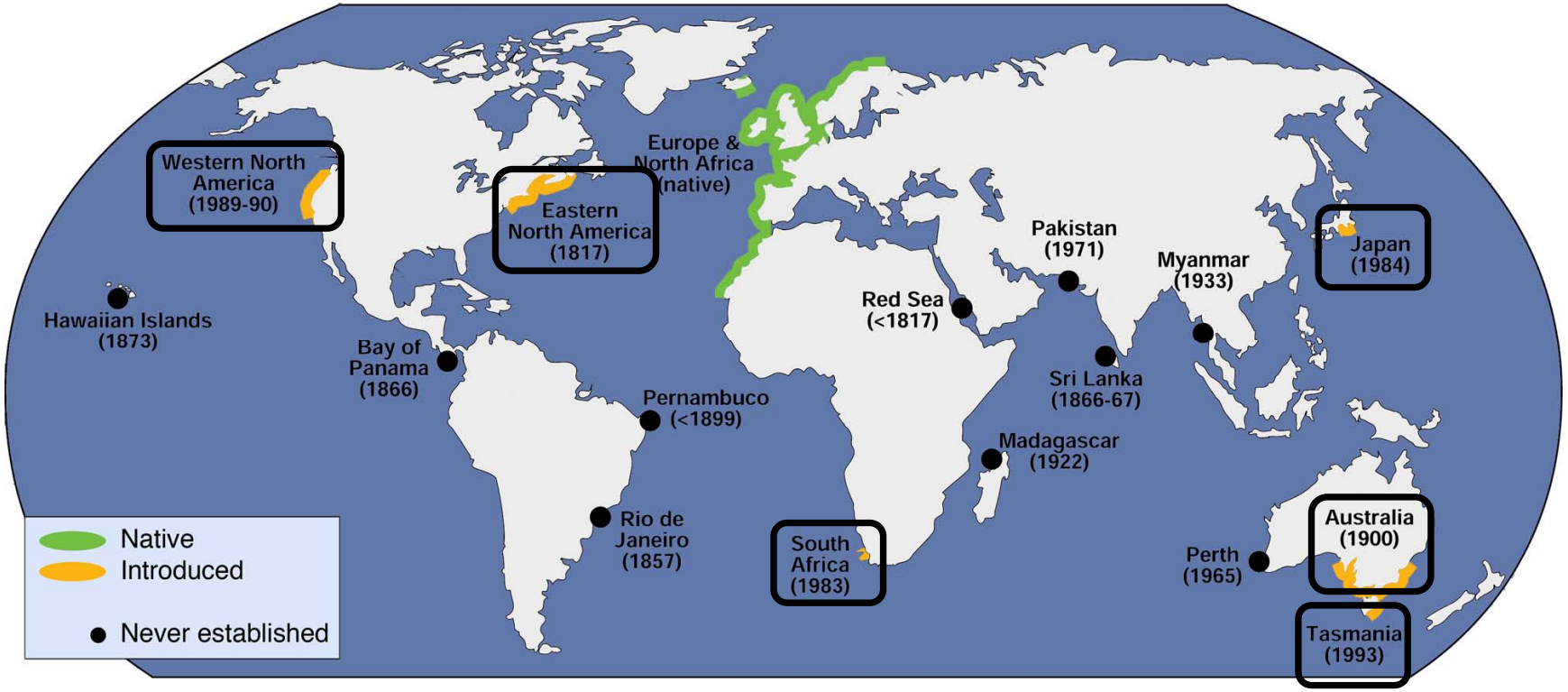
See 2007, M.S. Thesis

European Green Crab Native Range



Carlton & Cohen 2003

European Green Crab Invasion



Carlton & Cohen 2003

Who Cares?

- Coastal Northwest Atlantic
  - Implicated in decline of the soft-shell clam (*Mya arenaria*) industry in Maine, USA (Glude 1955)
  - Reported to negatively impact scallops, quahogs and other bivalves on the east coast of the USA (Grosholz and Ruiz 2002)
  - May outcompete native rock crab *Cancer irroratus* (Miron et al. 2005)

Who Cares?

- Coastal Northeast Pacific
  - Could have severe impacts on native bivalves and native crabs
  - Associated with enormous declines in abundance of native clams (*Nutricola tantilla* and *N. confusa*), as well as native shore crab (*Hemigrapsus oregonensis*), in Bodega Bay, California (Grosholz et al. 2000)
  - Preference for Olympia oyster (*Ostrea conchaphila*) compared with other bivalve species (Palacios and Ferraro 2003)

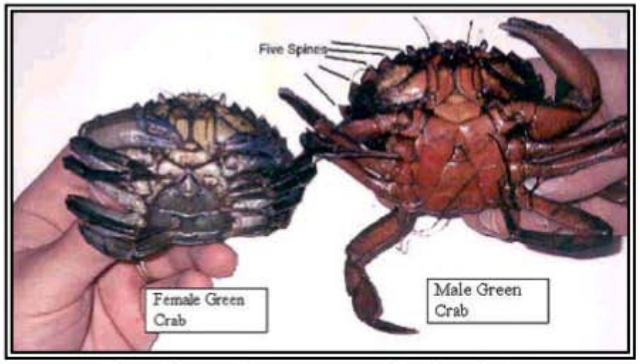
NON-INDIGENOUS AQUATIC SPECIES OF CONCERN FOR ALASKA

Fact Sheet 1 — Green Crab

Carcinus maenas

BIOLOGY & PHYSIOLOGY

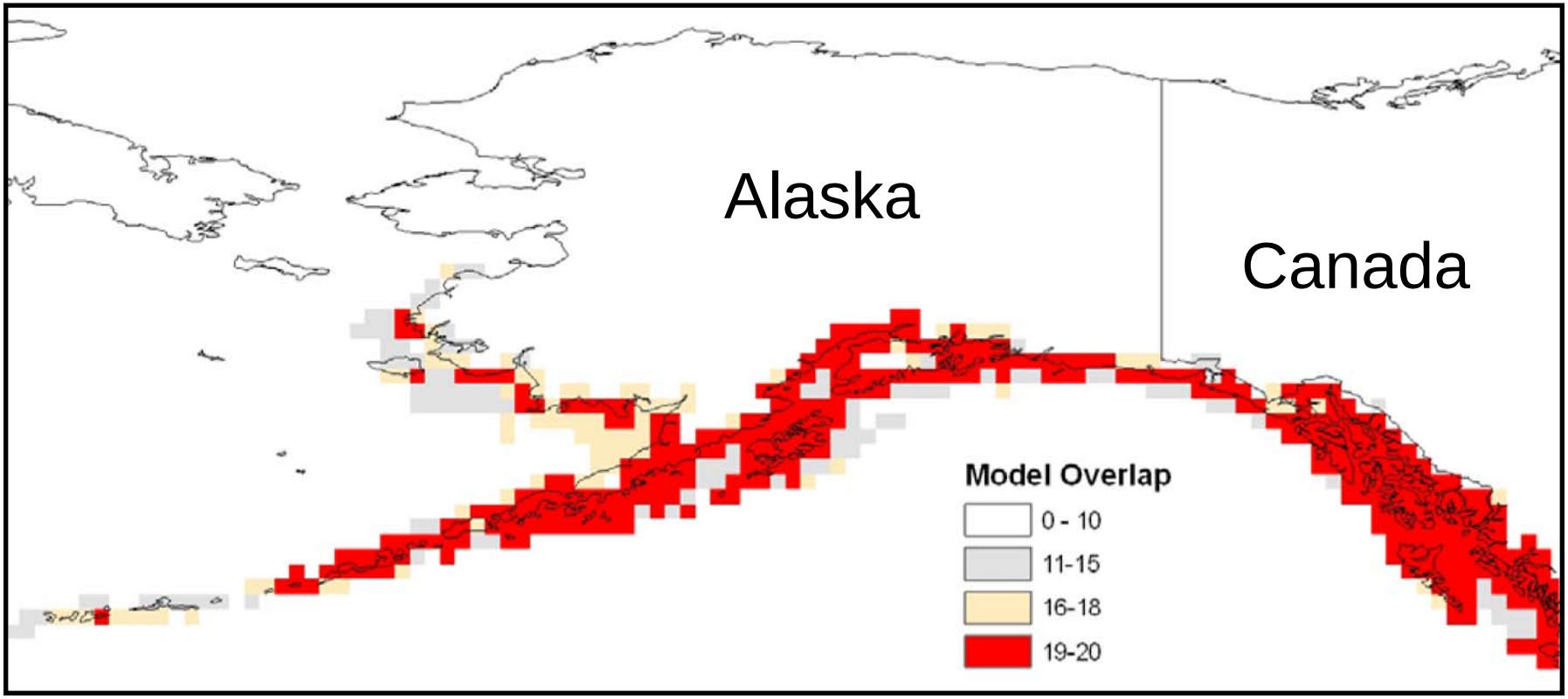
Physical Description: The Green Crab is a small shore crab. Adults measure about 3 inches across. The color of the dorsal (top side) of the shell is a mottled, dark brown to dark green with small yellow patches. Its ventral surface (underside) can display colors of green, yellow, red, and orange. Some studies have indicated that the color of the shell may be due to the amount of time the crab spends between molting stages. A distinguishing feature that can set green crabs apart from native crabs is the array of five evenly spaced triangular spines on either side of the eyes, on the front end of the shell. The three rounded lobes between its eyes may also be used to help identify the Green Crab.



Photos by: Washington Dept. of Fish and Game

Nutrition Requirements: The Green Crab is an omnivore, meaning that it can consume many different species of plants and animals. Its prey includes mussels, clams, snails, polychaetes, crabs, isopods, barnacles and algae. In both field observations and laboratory experiments, the Green Crab has been observed to eat an enormous variety of prey items from at least 104 families and 158 genera in 5 plant and protist and 14 animal phyla.

Ecological Niche Modeling Forecasts using GARP



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Ecological Niche Modeling

"can provide a powerful tool to assess the likelihood of nonindigenous species establishing in an area, **once it has been transported** to a region via anthropogenic or natural dispersal (Peterson & Vieglais 2001, Peterson 2003)"

de Rivera et al. 2007

Predicting the northward range expansion of non-indigenous European green crab (*Carcinus maenas*) along the west coast of North America

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National Marine Fisheries Service
NW Fisheries Science Center, Seattle, WA, USA
[2]University of Washington, Department of Biology, Seattle, WA, USA
[3]University of Washington, School of Aquatic and Fishery Sciences, Seattle, WA, USA

Objectives

- Explore the dynamics of larval dispersal in coastal waters of the northeastern Pacific Ocean
- Predict future range expansion

Questions

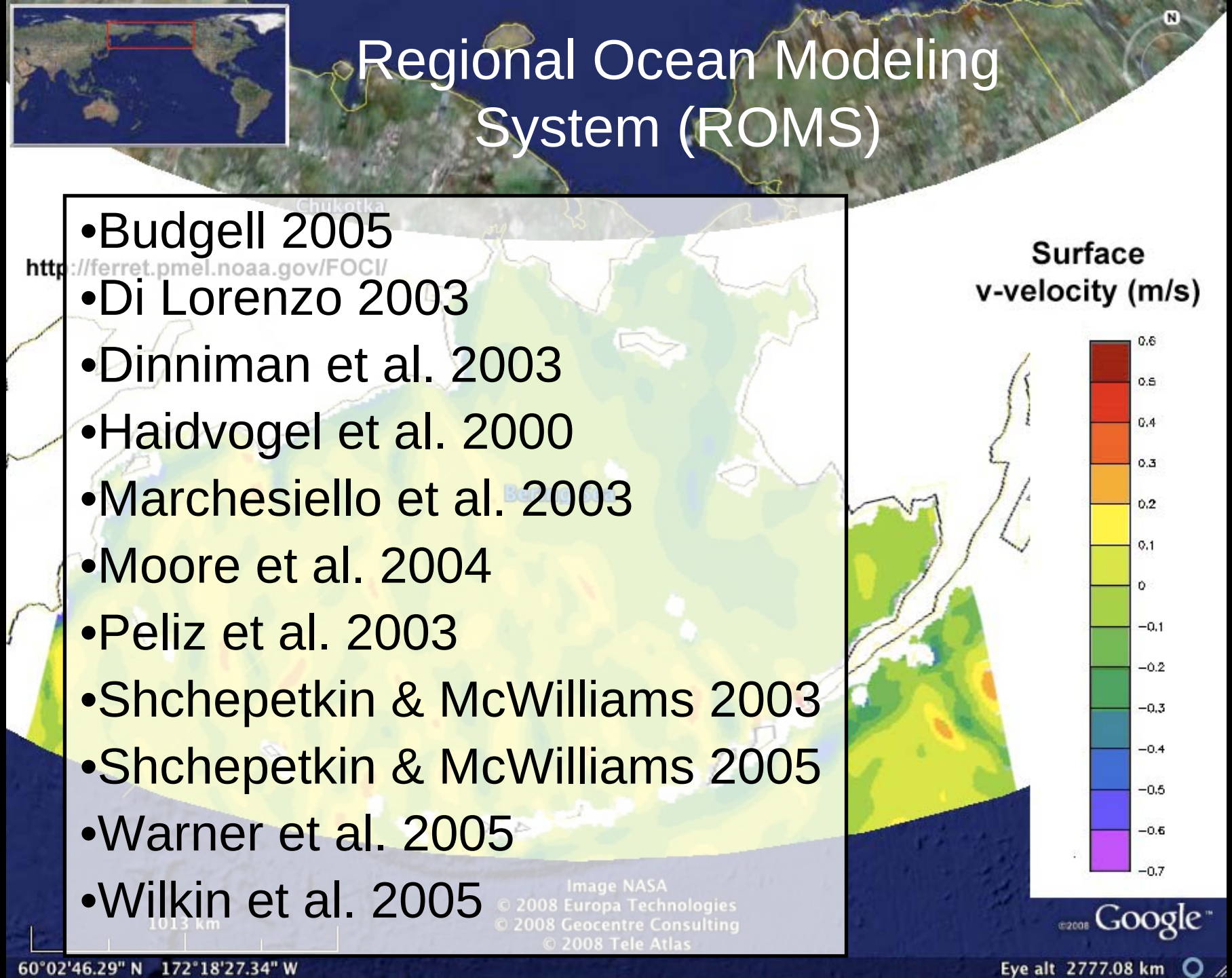
- What was the source population for newly established green crab on Vancouver Island, British Columbia?
- Is larval transport augmented during oceanographic anomalies (e.g., El Niño)?
- Can larvae be transported to estuaries and embayments north of Vancouver Island?

Approach

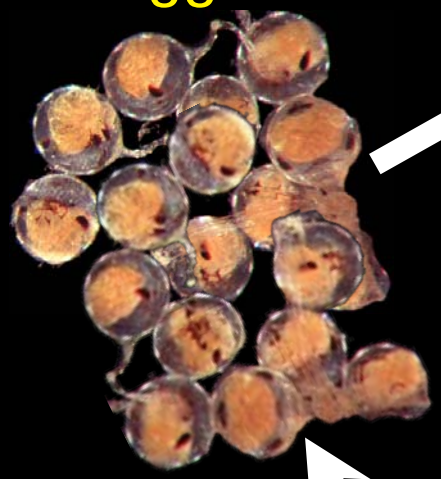
- Develop an individual based model (IBM) of larval green crab dispersal
- Employ existing ocean circulation models to predict larval dispersal and incorporate the effects of temperature on larval development

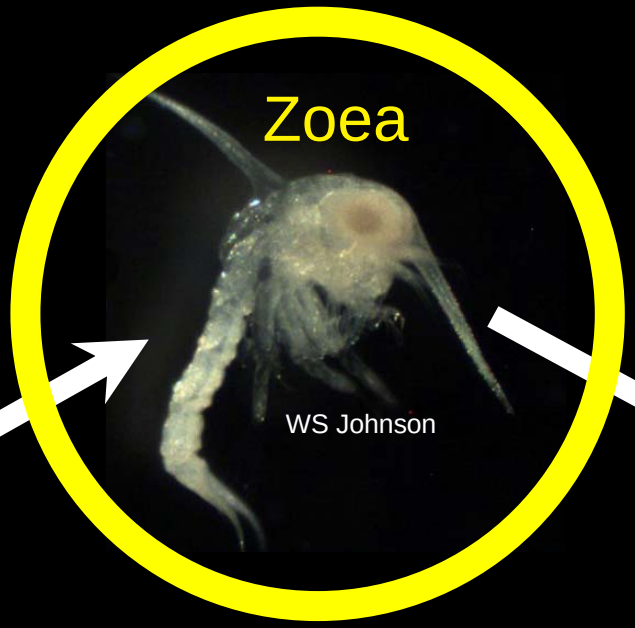
Regional Ocean Modeling System (ROMS)

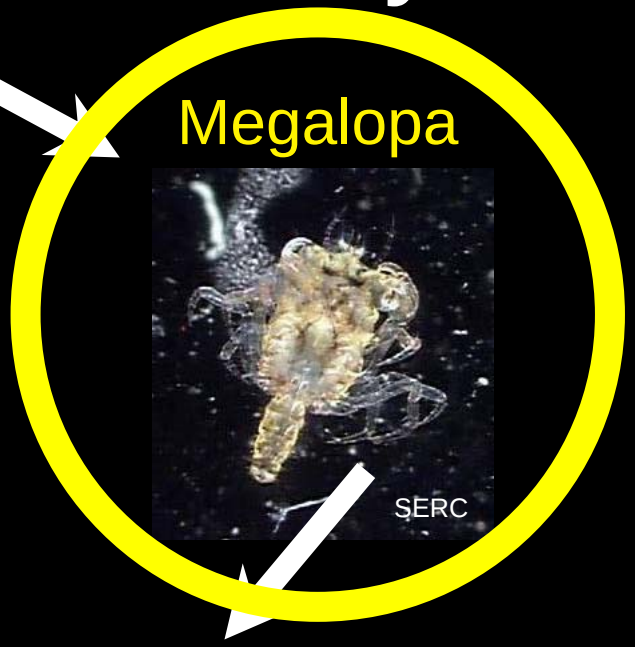
- Budgell 2005
- Di Lorenzo 2003
- Dinniman et al. 2003
- Haidvogel et al. 2000
- Marchesiello et al. 2003
- Moore et al. 2004
- Peliz et al. 2003
- Shchepetkin & McWilliams 2003
- Shchepetkin & McWilliams 2005
- Warner et al. 2005
- Wilkin et al. 2005



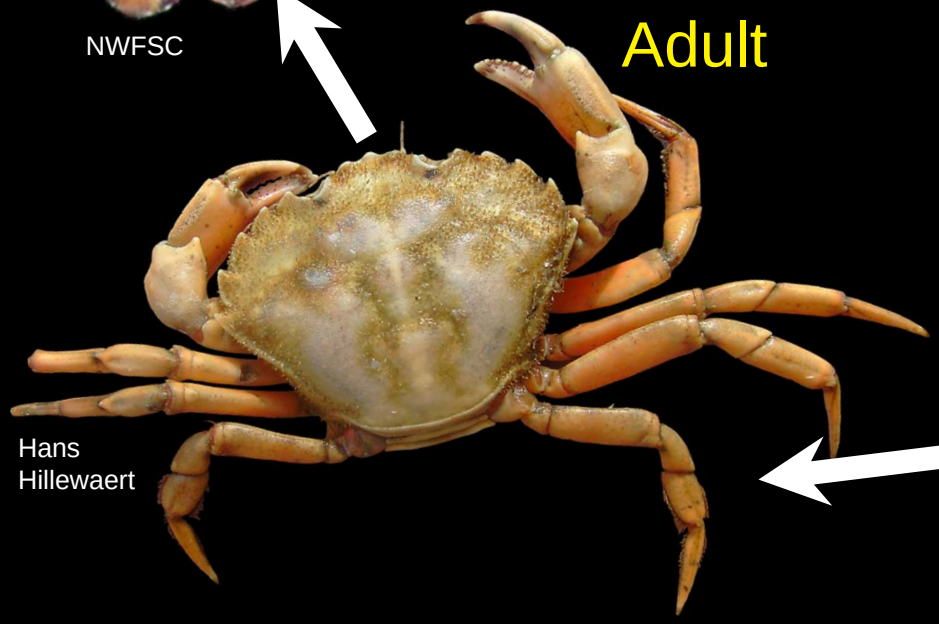
Life Cycle


Eggs
NWFSC


Zoea
WS Johnson


Megalopa
SERC

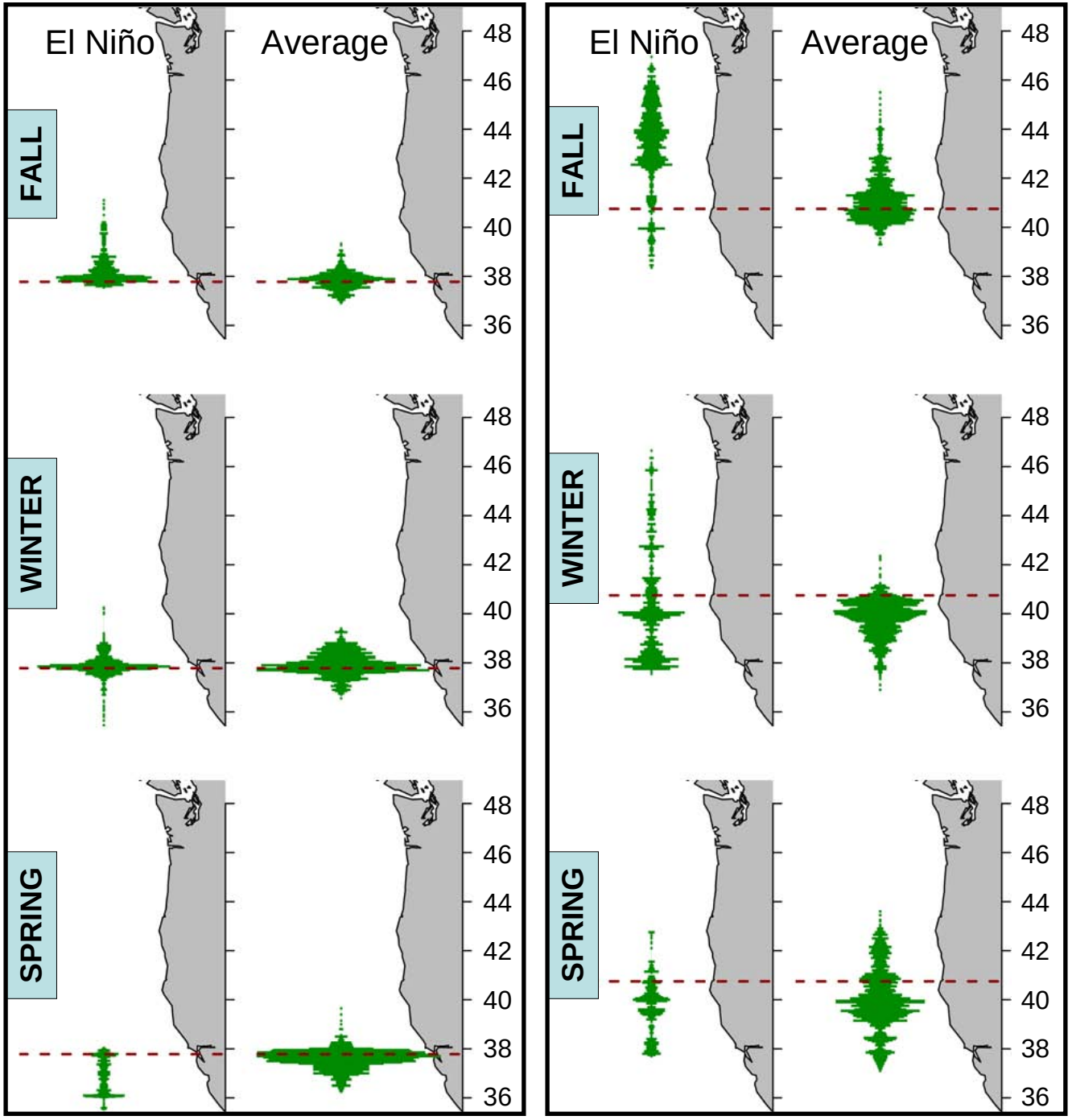

Juvenile
CSIRO


Adult
Hans
Hillewaert

Model Scenarios

- 1997-2003
- Release in fall, winter & spring
- Release from San Francisco Bay & Humboldt Bay
- Temperature controls development
- Current control movement

Season, Location & Circulation Anomalies



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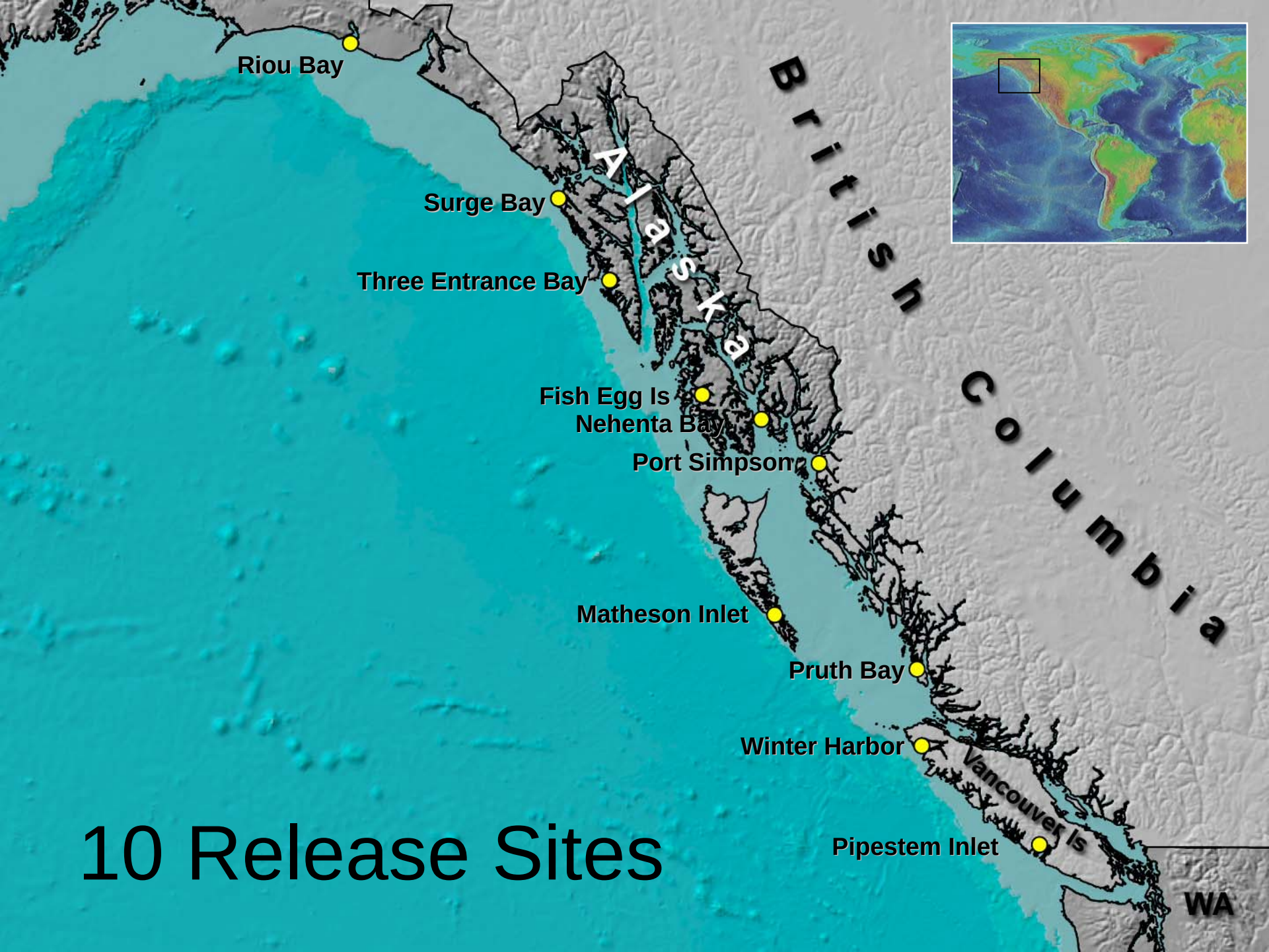
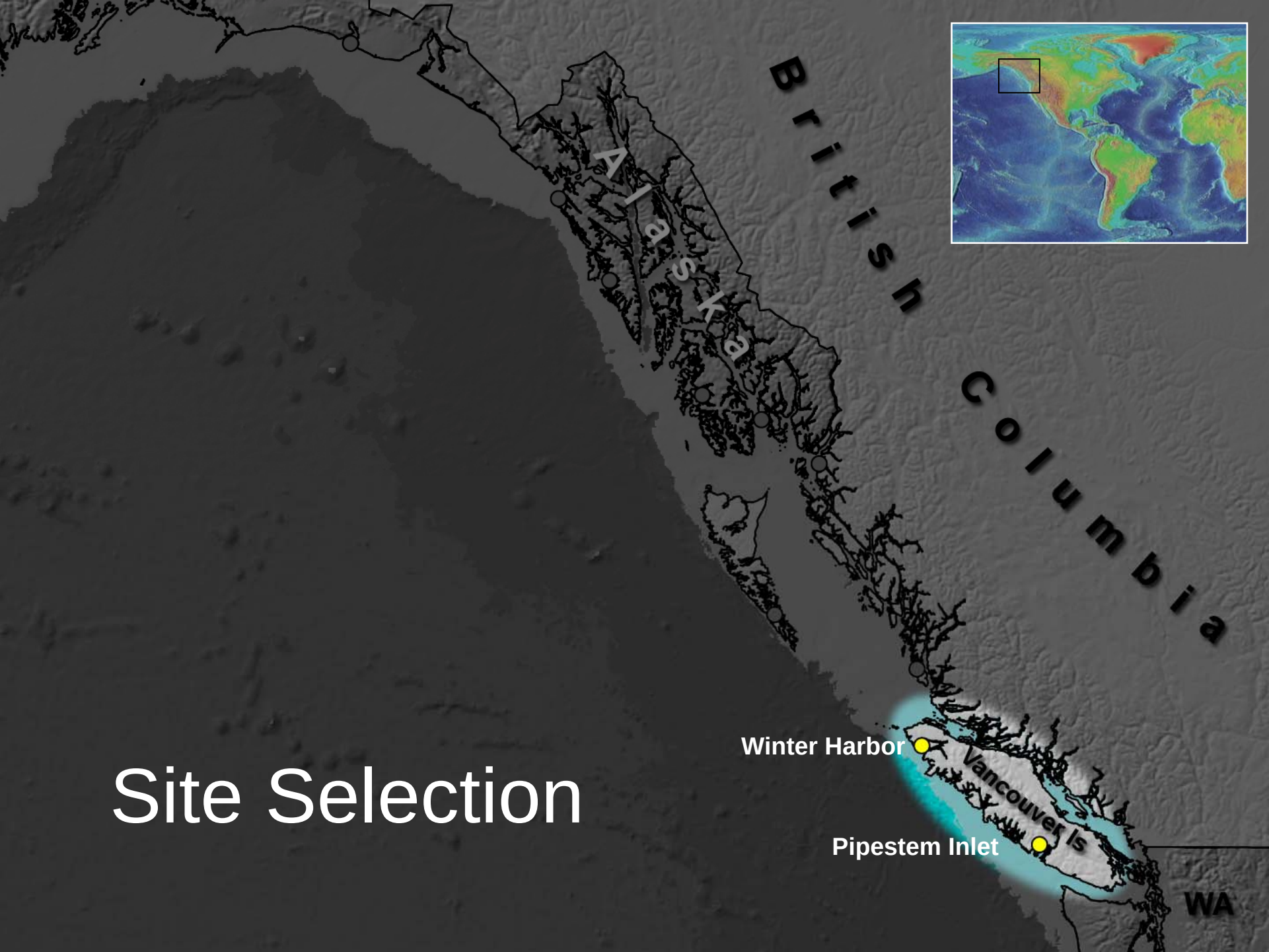
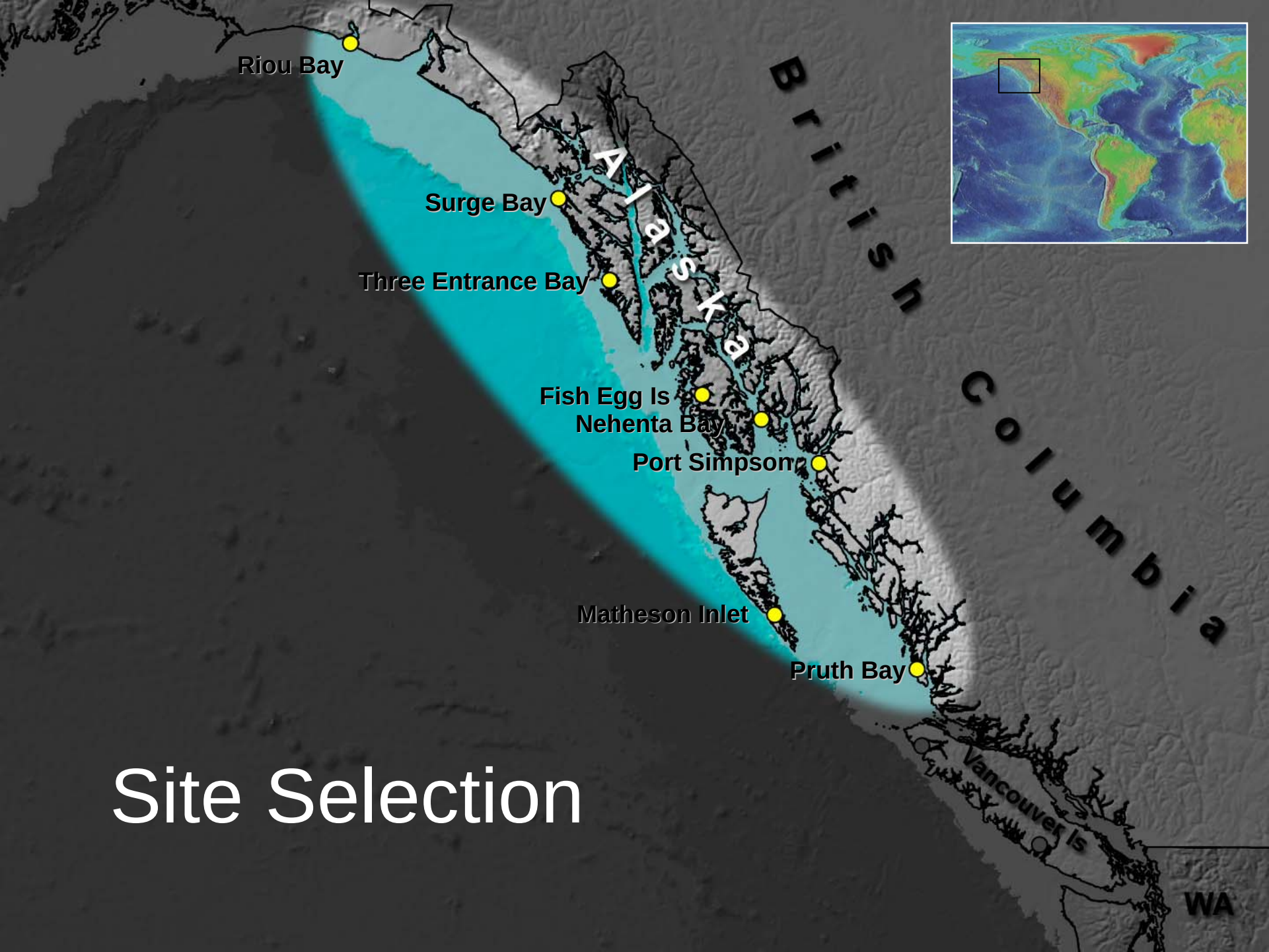


10 Release Sites

Site Selection

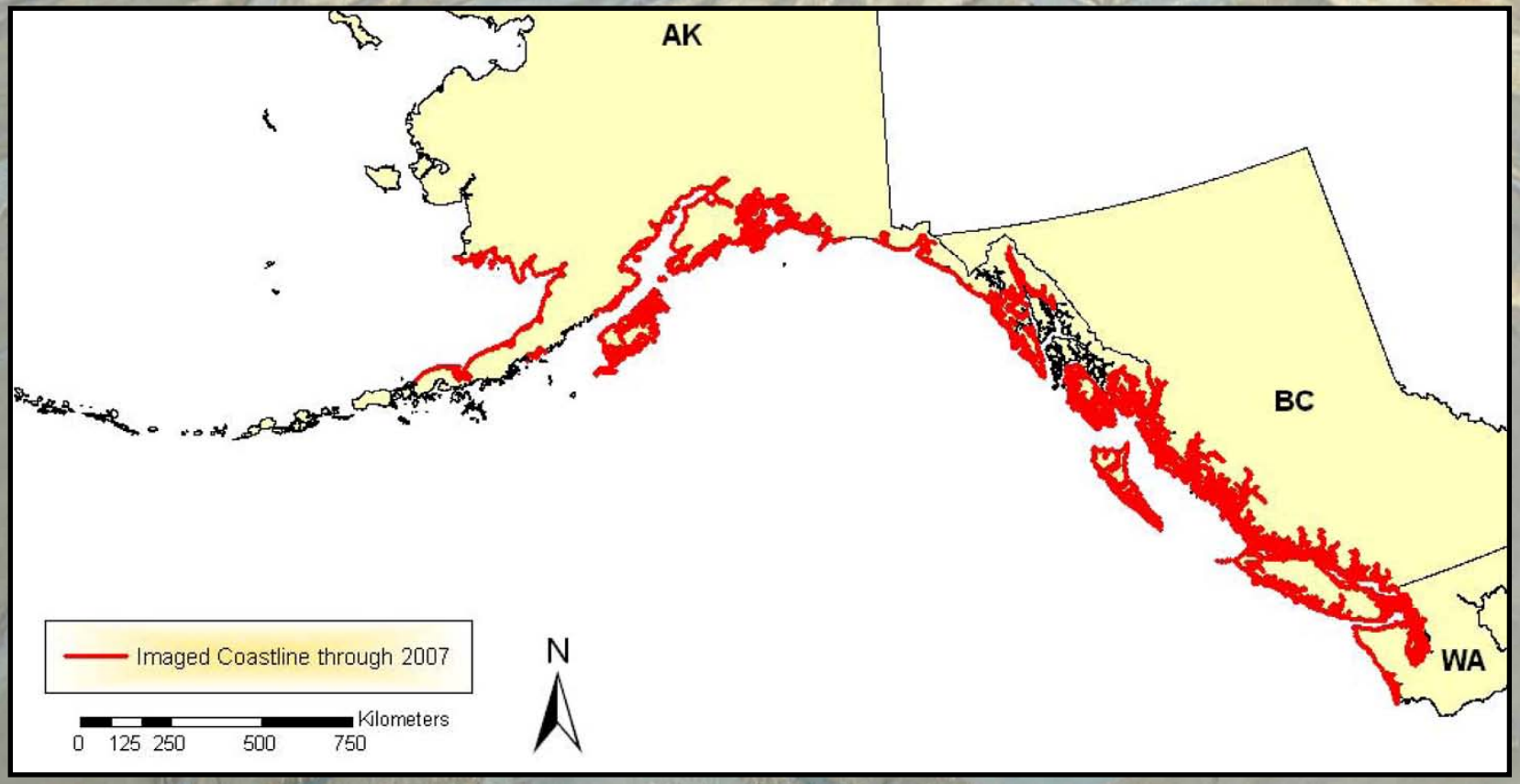


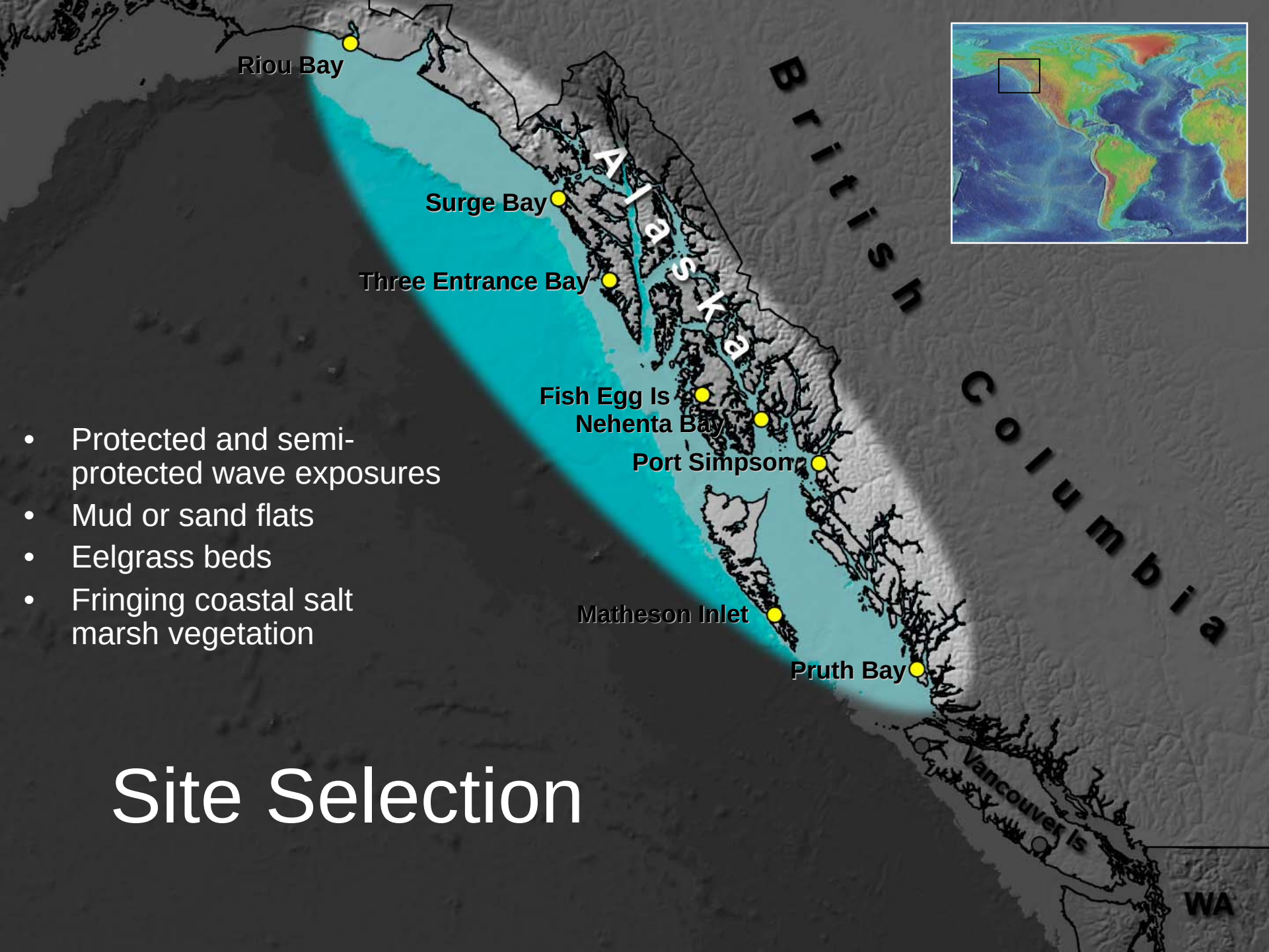


Site Selection

Coastal & Ocean Resources Inc.

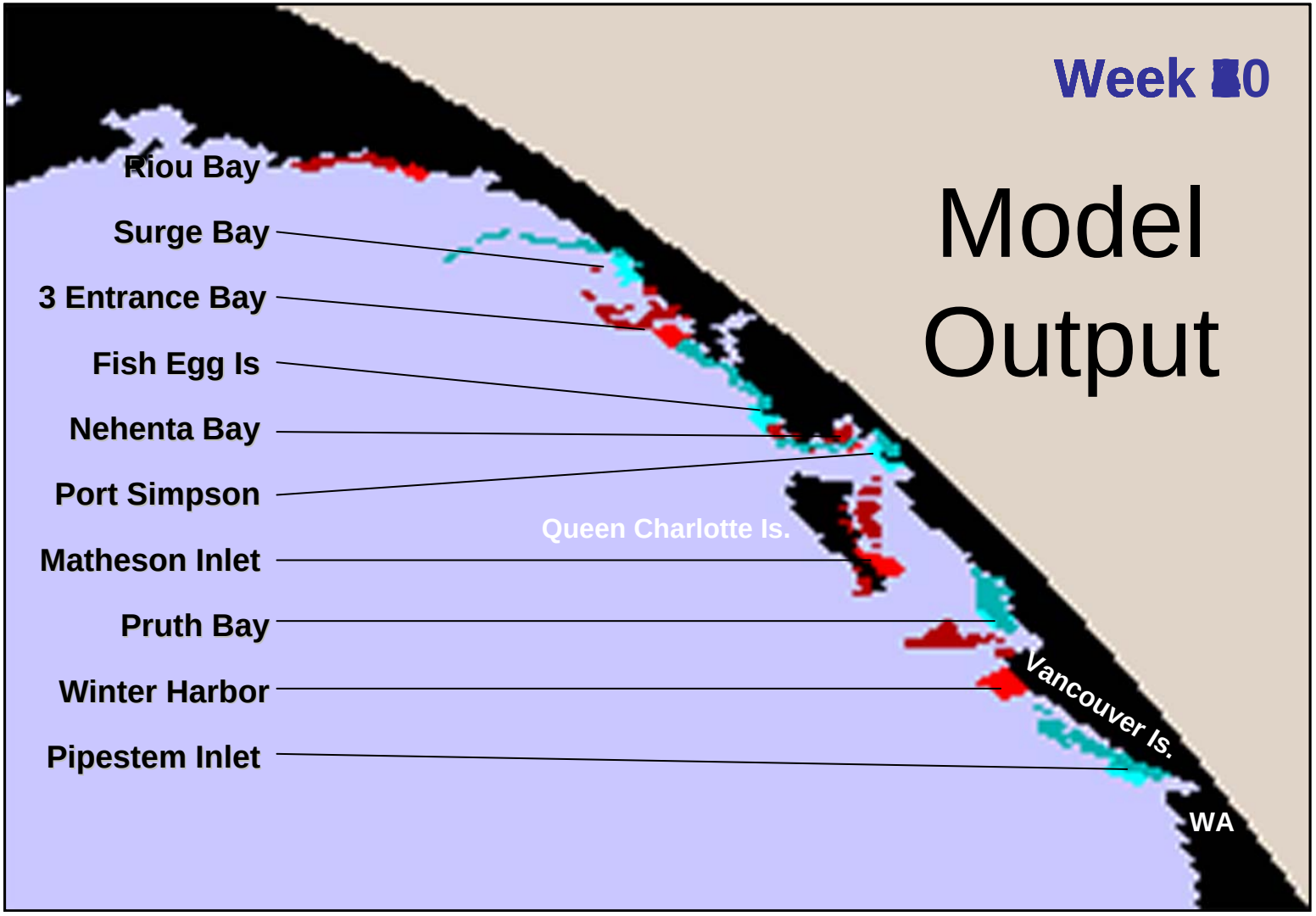
ShoreZone





- Protected and semi-protected wave exposures
- Mud or sand flats
- Eelgrass beds
- Fringing coastal salt marsh vegetation

Site Selection


Week 10
Model Output
Riou Bay
Surge Bay
3 Entrance Bay
Fish Egg Is
Nehenta Bay
Port Simpson
Matheson Inlet
Pruth Bay
Winter Harbor
Pipestem Inlet
Queen Charlotte Is.
Vancouver Is.
WA

Conclusions

- San Francisco is an unlikely source population for green crab on Vancouver Island, BC
- larval transport is augmented during El Niño events and in the fall
- It is possible that larvae could be transported to estuaries and embayments north of Vancouver Island
- When coupled with existing habitat suitability mapping projects can be used to assist with early detection

Acknowledgments

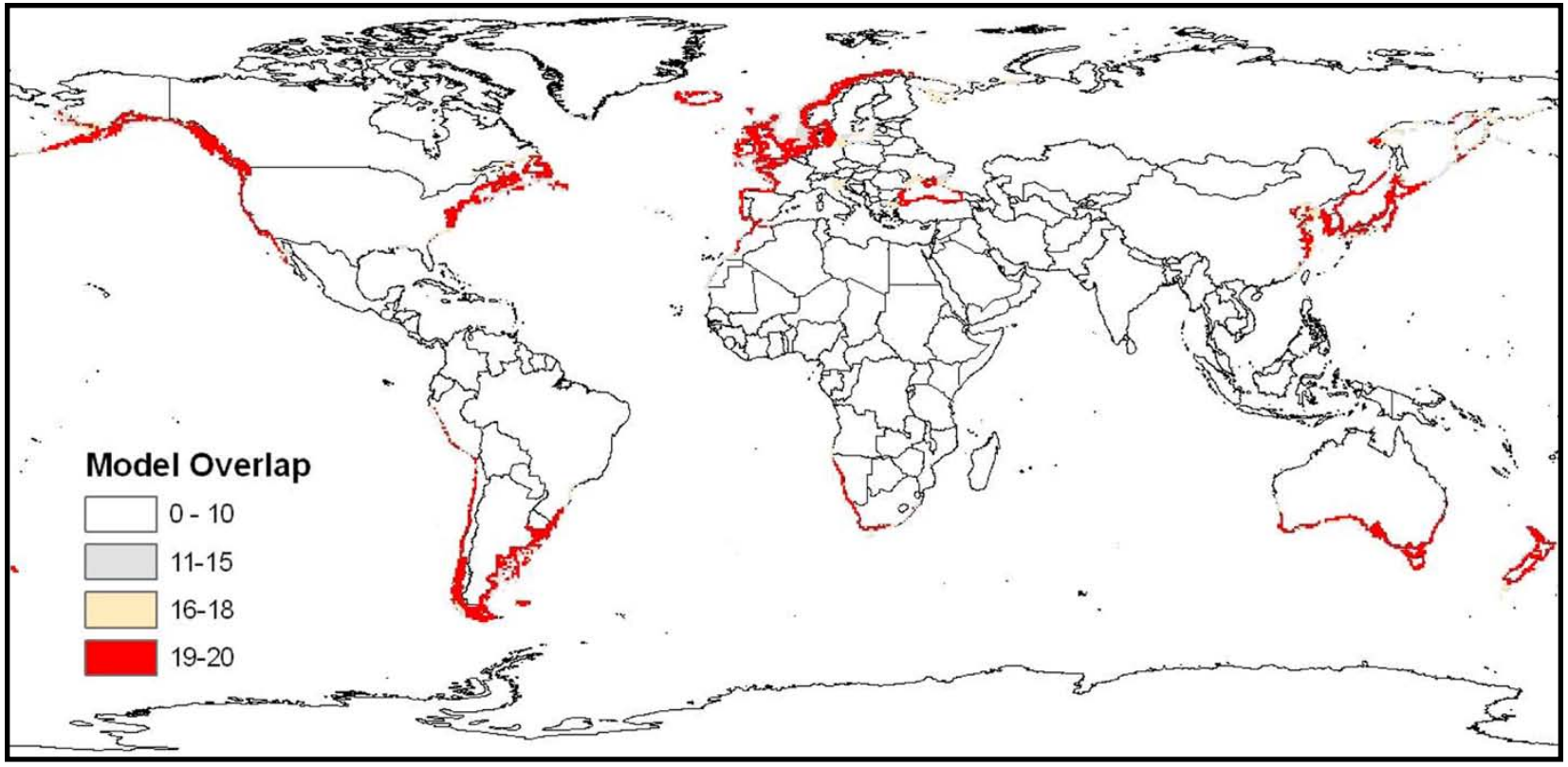
- Funding
  - NOAA Aquatic Invasive Species Program
  - Mathematical Biology Program, NWFSC
- Collaborators
  - Linda Shaw (NOAA/NMFS Alaska Region)
  - Al Hermann (NOAA - PMEL)
  - Jodi Harney (Coastal and Ocean Resources, Inc.)
  - Graham Gillespie (DFO Canada)
  - David Armstrong (University of Washington)
  - P. Sean McDonald (University of Washington)

Regional Ocean Modeling System (ROMS)

- “A free-surface, terrain-following, primitive equations ocean model widely used by the scientific community for a diverse range of applications” (e.g., Haidvogel et al. 2000; Marchesiello et al. 2003; Peliz et al. 2003; Di Lorenzo 2003; Dinniman et al. 2003; Budgell 2005; Warner et al. 2005; Wilkin et al. 2005)
- Computational nonlinear kernel algorithms (Shchepetkin and McWilliams 2003, 2005)
- Tangent linear and adjoint kernels and platforms (Moore et al. 2004)

http://www.myroms.org/

Potential Future Range



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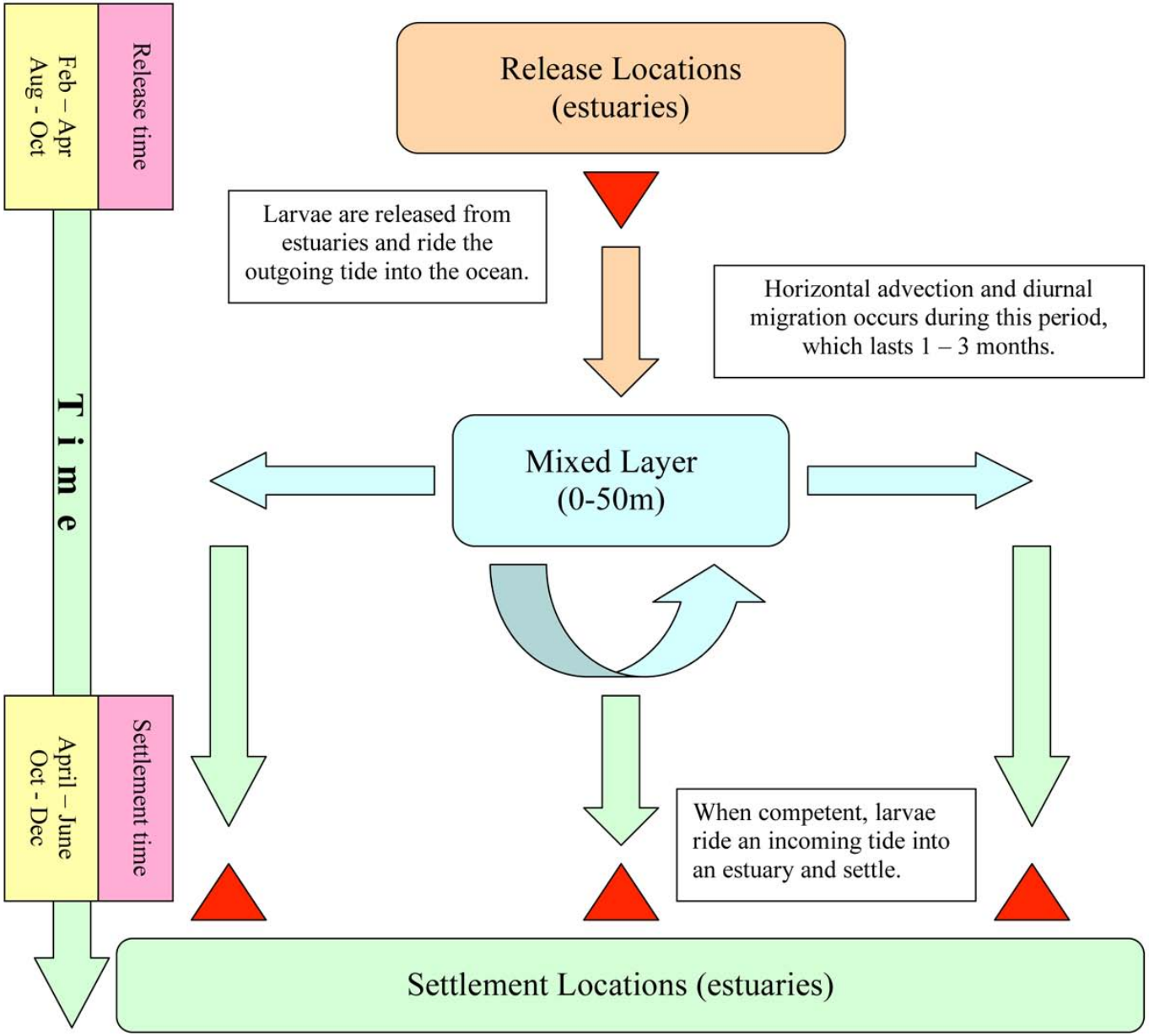
Green Crab Life History



See 2007, M.S. Thesis

Growth Functions

- 1st zoeal: 44.40 - 13.04 * ln X
- 2nd zoeal: 23.64 - 6.31 * ln X
- 3rd zoeal: 20.65 - 5.34 * ln X
- 4th zoeal: 25.51 - 6.69 * ln X
- All zoeal: 122.96 - 34.47 * ln X
- Megalopal: 77.76 - 21.72 * ln X

X = temperature

De Rivera 2007