Assessment of Pacific Herring (*Clupea pallasii*) in the Northeast Pacific Ocean

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W2 "Methods and techniques for sampling and assessing small pelagic fish populations"

Questions to address:

a. What species/population is assessed, brief overview of biology (e.g., age of recruitment, basic life history, etc.)?

b. What is the role of this species in the ecosystem? (interactions with the ecosystem; how important is this species and for what?)

c. What are the field sampling programs (acoustic, spawn survey, juveniles, etc) that provide information (abundance, recruitment, others) that is or might be used in an assessment (not necessarily a traditional stock assessment model)?

d. What types of assessments (model, other) are used for the population?

e. How is information from field sampling programs incorporated into the assessment?

f. If there is no or limited field sampling data available, how is that addressed in the assessment of the population (commercial or not)? Are there better ways to collect the field data?

g. What are the challenges involved with assessing the population?

h. What are potential solutions to these challenges?

a. What species/population is assessed, brief overview of biology (e.g., age of recruitment, basic life history, etc.)?

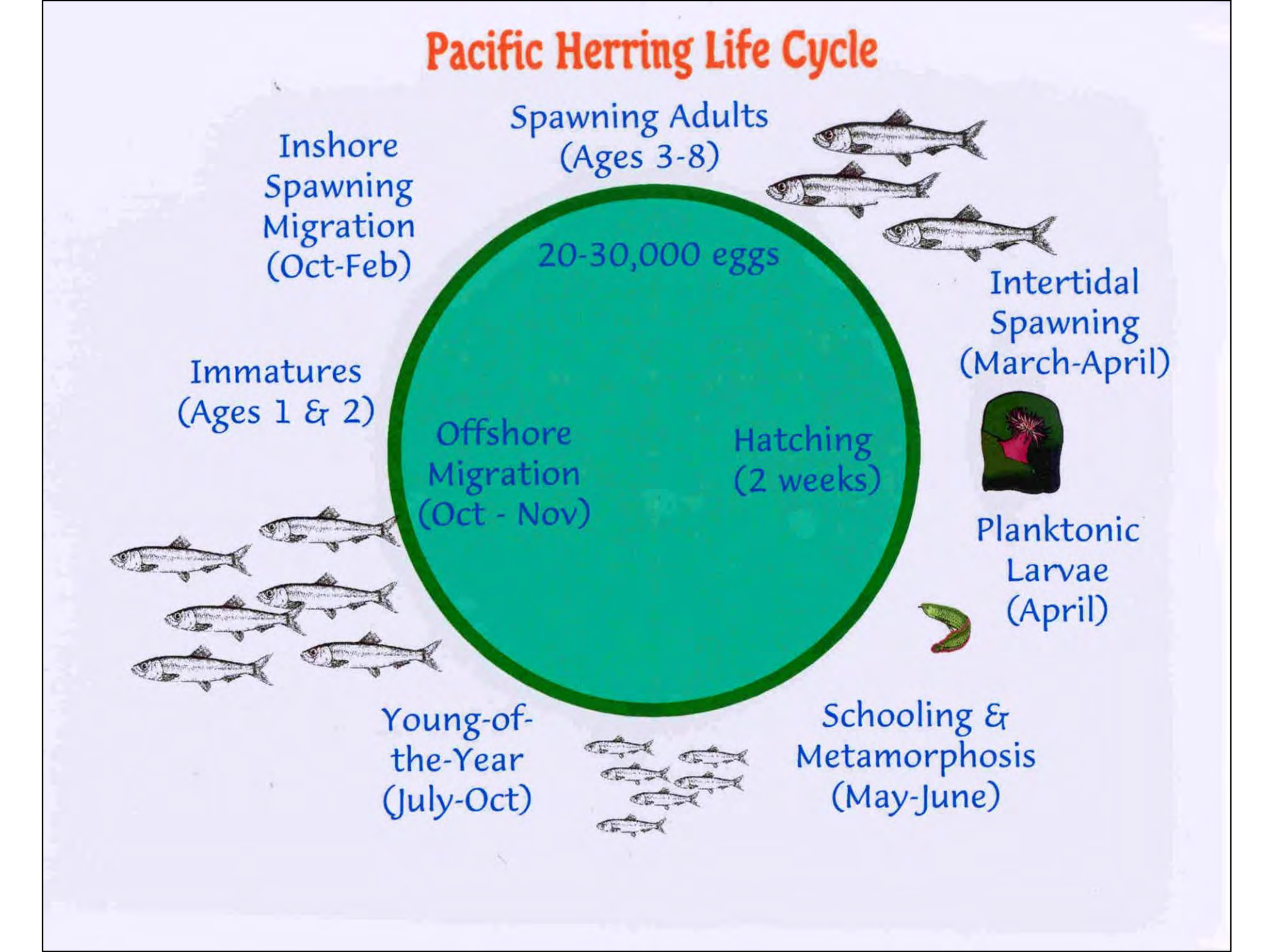
- Pelagic fish- generally found shallower than 100m
- Migratory, schooling
- Planktivores; Forage species
- Live 8 to 16+ yrs
- Mature at age-3 (GOA), age-4 (EBS), Repeat spawners
  - later age-maturity with increasing latitude
- Spawn inter- and shallow sub-tidal – permits egg survey methods
- Important commercial fisheries
  - Recruitment to roe fishery starting at age-3 or -4
- Herring diet varies with herring size (Wailes 1936)

  < 20mm Copepod nauplii, eggs, diatoms

  20 – 100mm Copepods, barnacle larvae, gastropods, cladocerans

  > 100mm Euphausiids, copepods

Pacific Herring Life Cycle

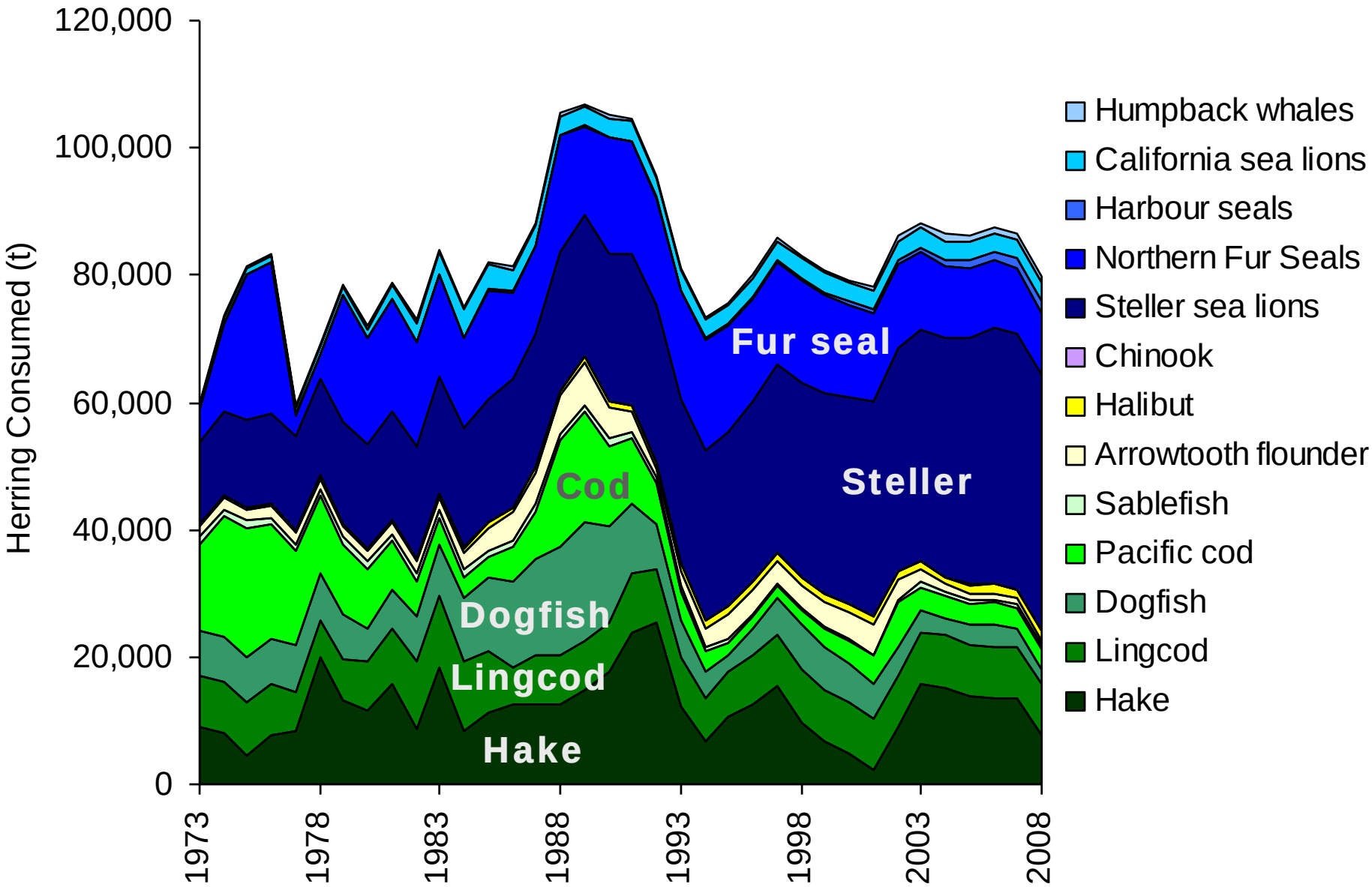


b. What is the role of this species in the ecosystem? (interactions with the ecosystem; how important is this species and for what?)

- Key forage species in the northeast Pacific Ocean
- Bottom up impacts on herring
  - –Temperature
  - –Salinity
  - –Water column structure
  - –Currents/transport
  - -Oxygen
  - -Nutrients/prey
  - -Upwelling
  - -Freshwater input
- Top down
  - – Humans and …

EXAMPLE: WCVI PREDATOR CONSUMPTION OF HERRING

(SCHWEIGERT ET AL. 2010)



c. What are the field sampling programs that provide information that is or might be used in an assessment?

Not currently used in assessment of herring stocks:

1) Juvenile herring surveys
   Strait of Georgia (1990-2016)
   Central Coast (2003-05, 2007-2011)

2) West coast Vancouver Island small pelagic ecosystem survey

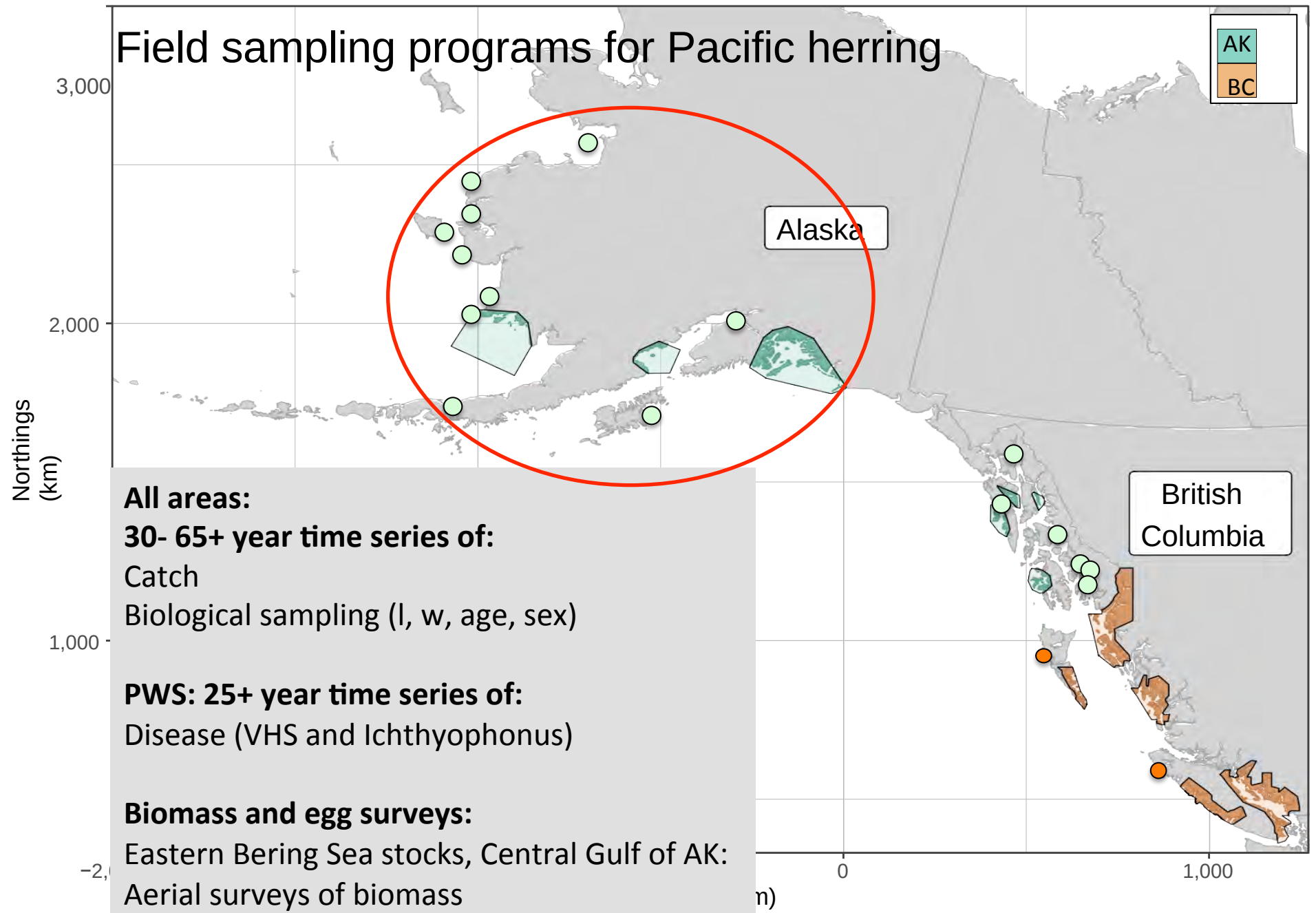
3) Sea lion and humpback whale counts from aerial surveys
   SE Alaska and PWS (1960's or 1970's – present)

4) Aerial surveys of biomass (largest daily biomass estimate)
   PWS (1970's –present)

5) EVOSTC-funded projects (post-1989)

6) Age, weight, length, sex
   Eastern Bering Sea (non-Togiak) stocks (1980 or earlier-2011)

Field sampling programs for Pacific herring

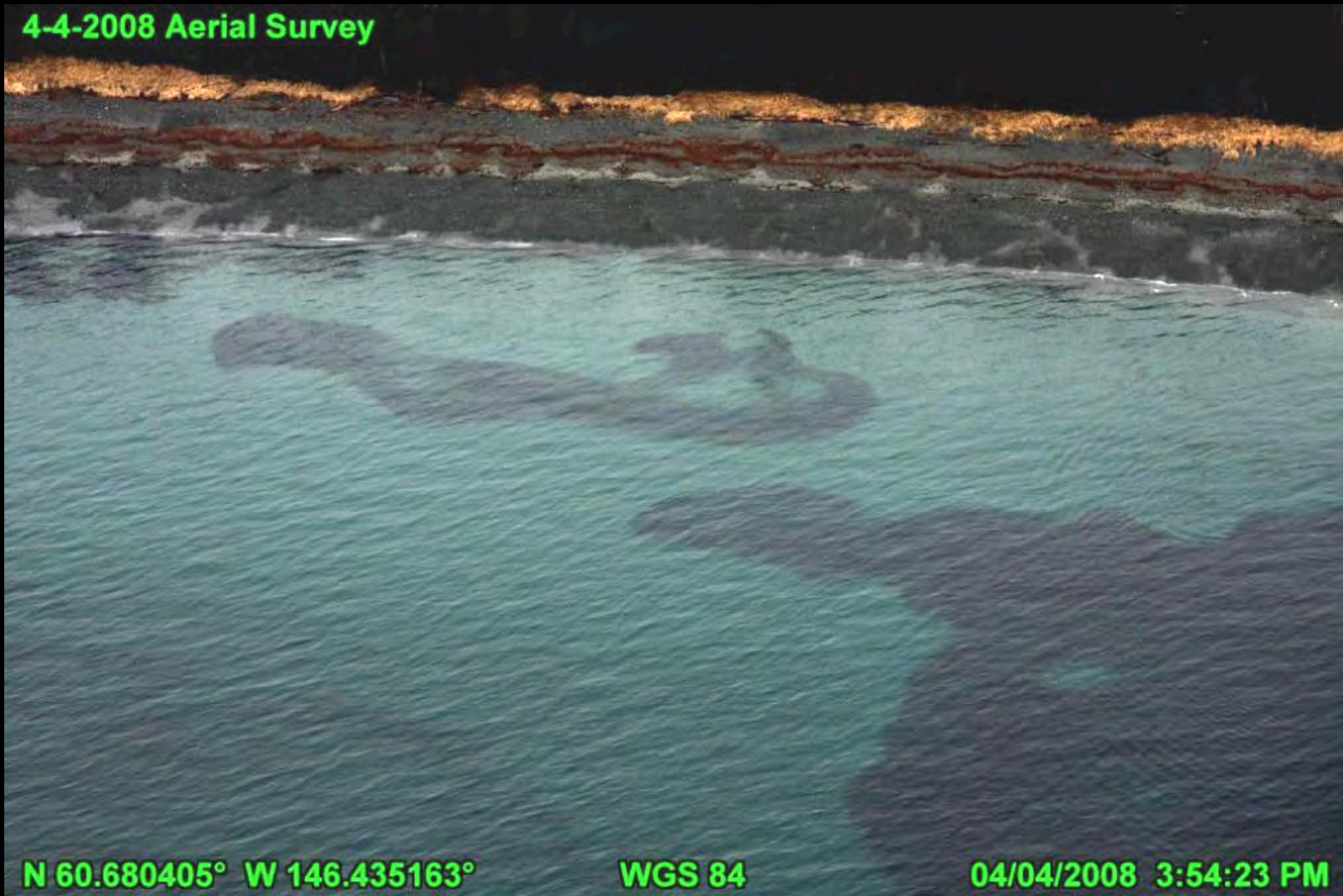


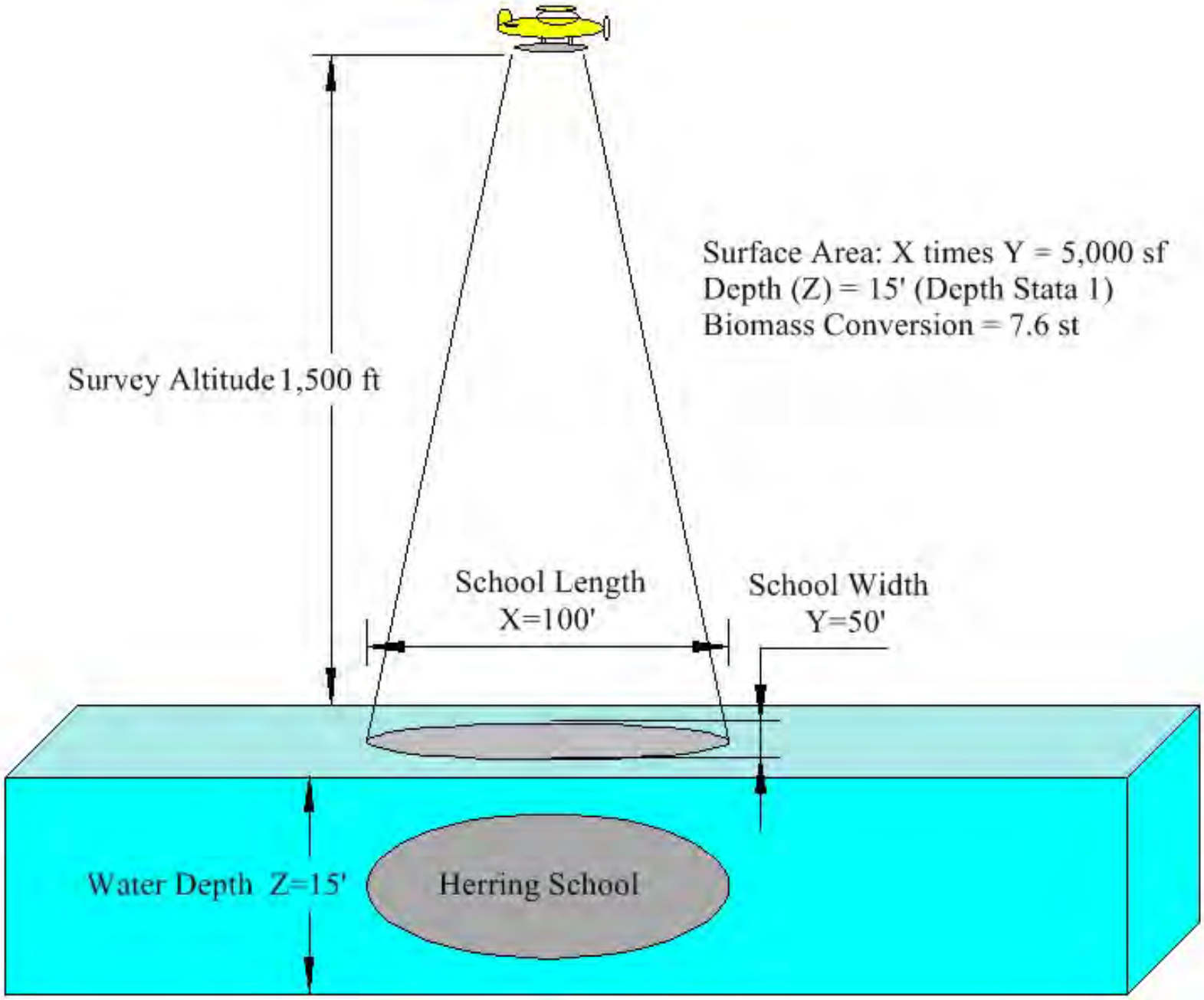
All areas:
30- 65+ year time series of:
Catch
Biological sampling (l, w, age, sex)

PWS: 25+ year time series of:
Disease (VHS and Ichthyophonus)

Biomass and egg surveys:
Eastern Bering Sea stocks, Central Gulf of AK:
Aerial surveys of biomass

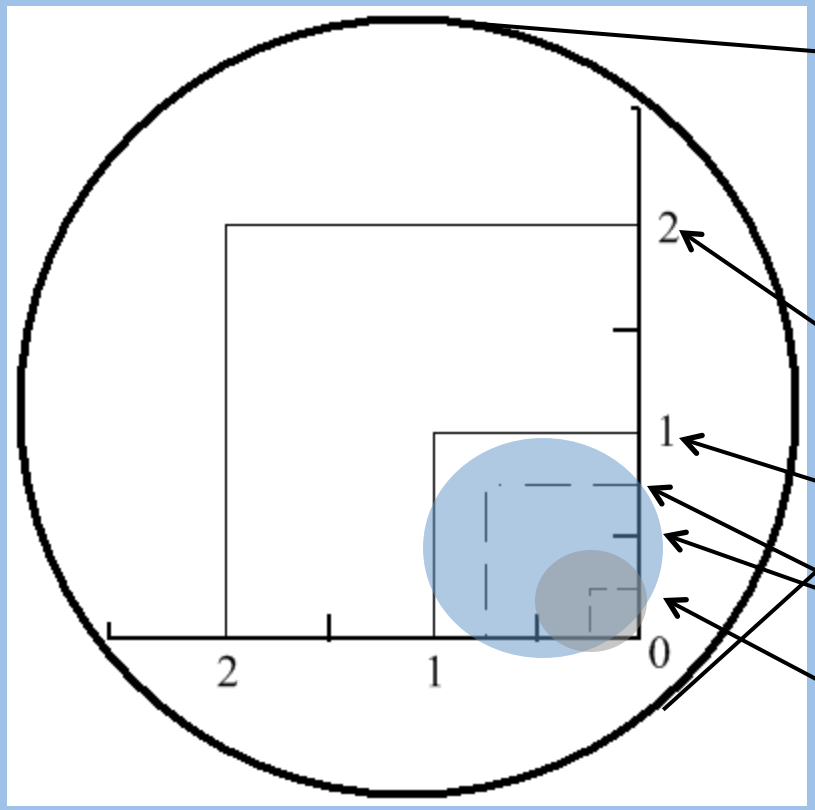
Projection: BC Albers (NAD 1983)


4-4-2008 Aerial Survey
N 60.680405° W 146.435163°
WGS 84
04/04/2008 3:54:23 PM


Surface Area: X times Y = 5,000 sf
Depth (Z) = 15' (Depth Stata 1)
Biomass Conversion = 7.6 st
Survey Altitude 1,500 ft
School Length
X=100'
School Width
Y=50'
Water Depth Z=15'
Herring School

The “Tube” Method (Surface Area)

- Tube with known focal length grid marks

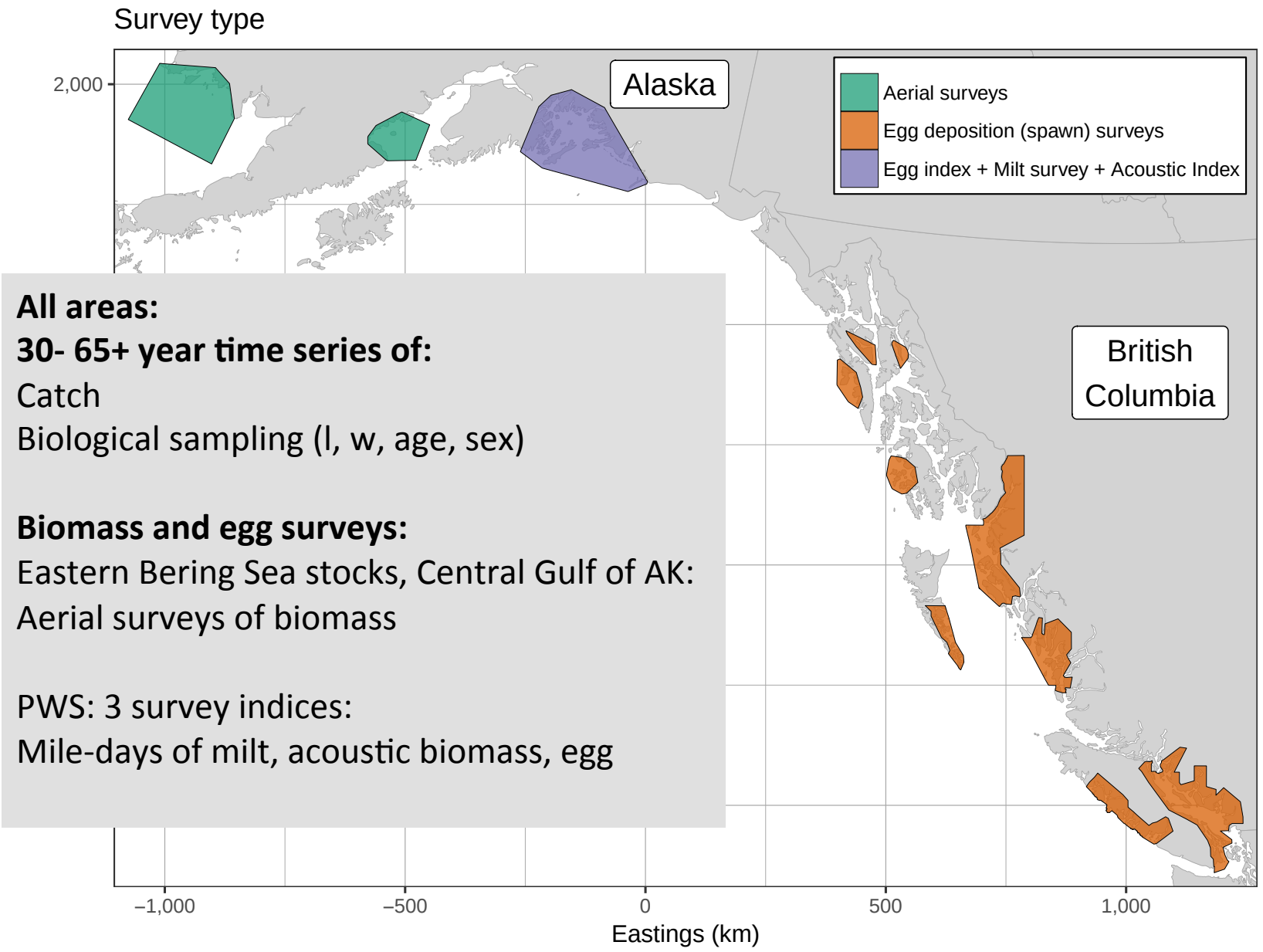


- XL (2^2 = 3,200 m^2)
- L (1^2 = 800 m^2)
- M (51-450 m^2)
- S (< 50 m^2)

Surface Area to Biomass Conversion Rates

- Based on a handful of “calibration sets”
- Entire school wrapped and pumped/weighed
- Limited to small and medium sized schools

Survey methods and locations:

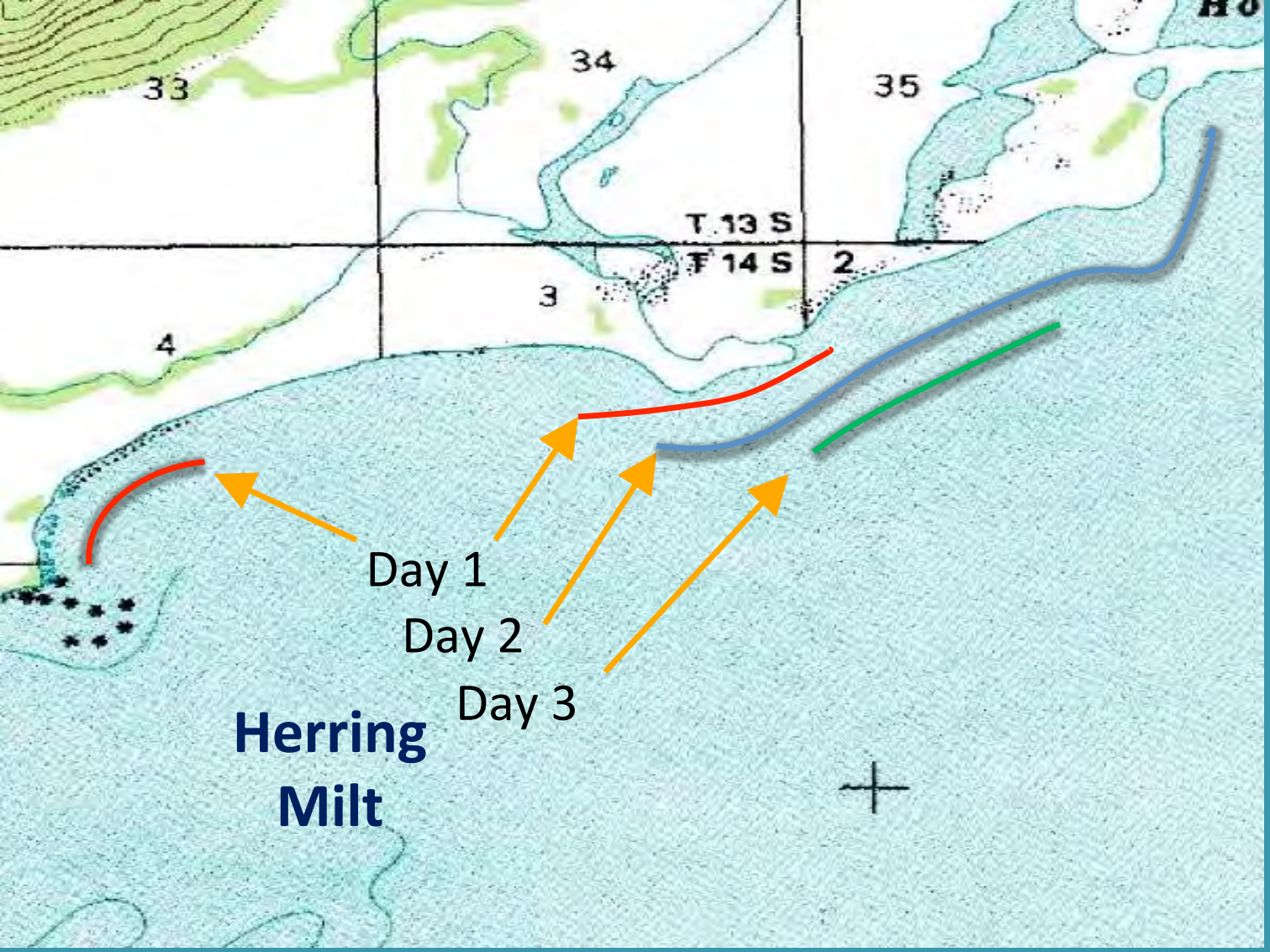


All areas:
30- 65+ year time series of:
Catch
Biological sampling (l, w, age, sex)

Biomass and egg surveys:
Eastern Bering Sea stocks, Central Gulf of AK:
Aerial surveys of biomass

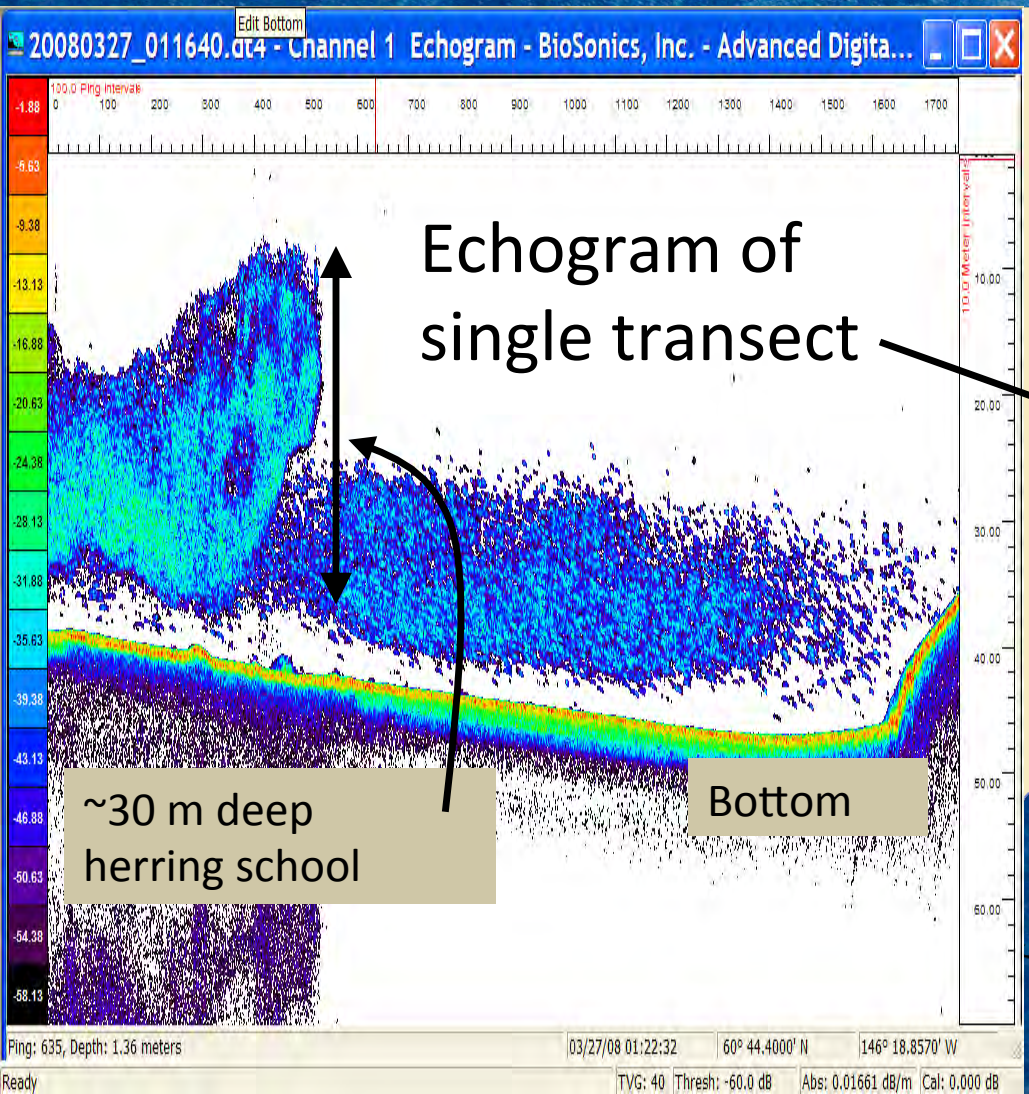
PWS: 3 survey indices:
Mile-days of milt, acoustic biomass, egg

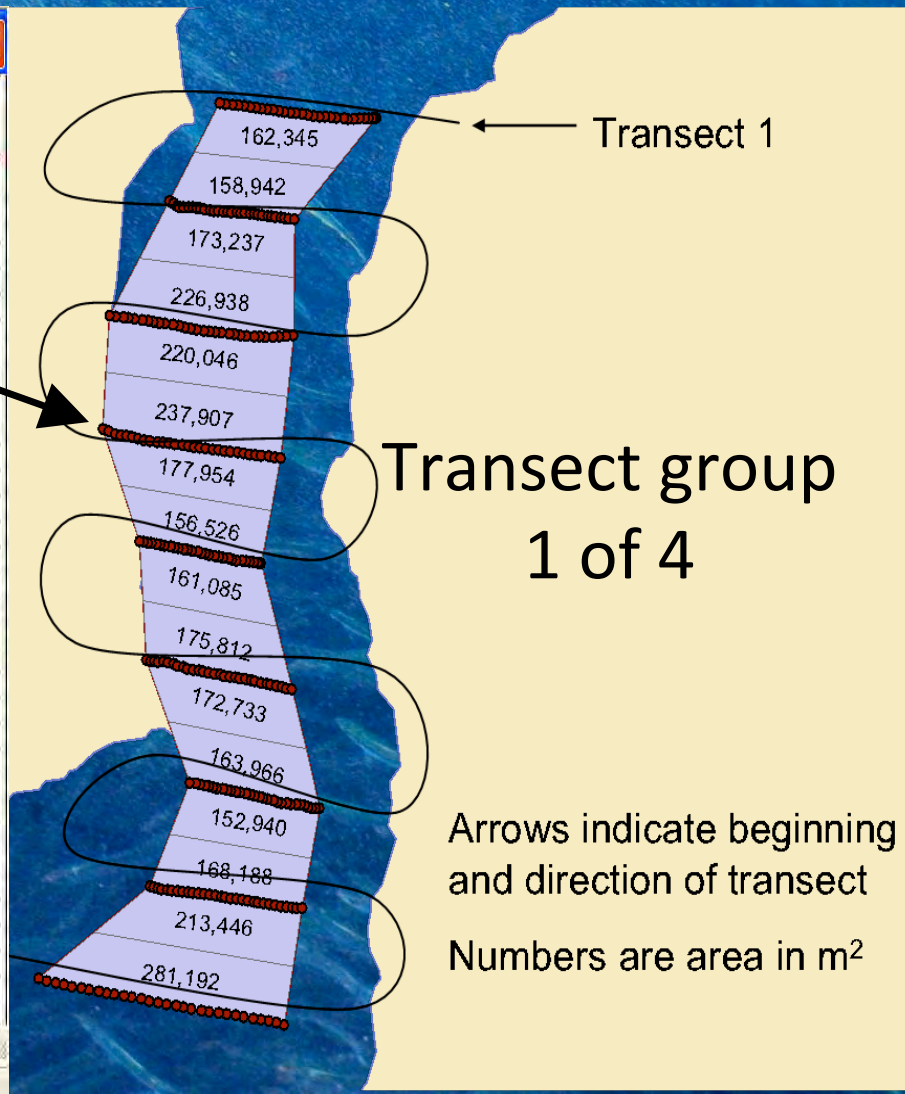

33
34
35
T.13 S
T 14 S
2
3
4
4-8-2008 aerial survey - SMoffitt photos
Herring
Milt
N 60.677507° W 146.428075°
WGS 84
04/08/2008 11:40:28 AM


33
34
35
T.13 S
T 14 S
2
3
4
Day 1
Day 2
Day 3
Herring
Milt

Acoustics summary

- Multiple transects runs on large aggregations





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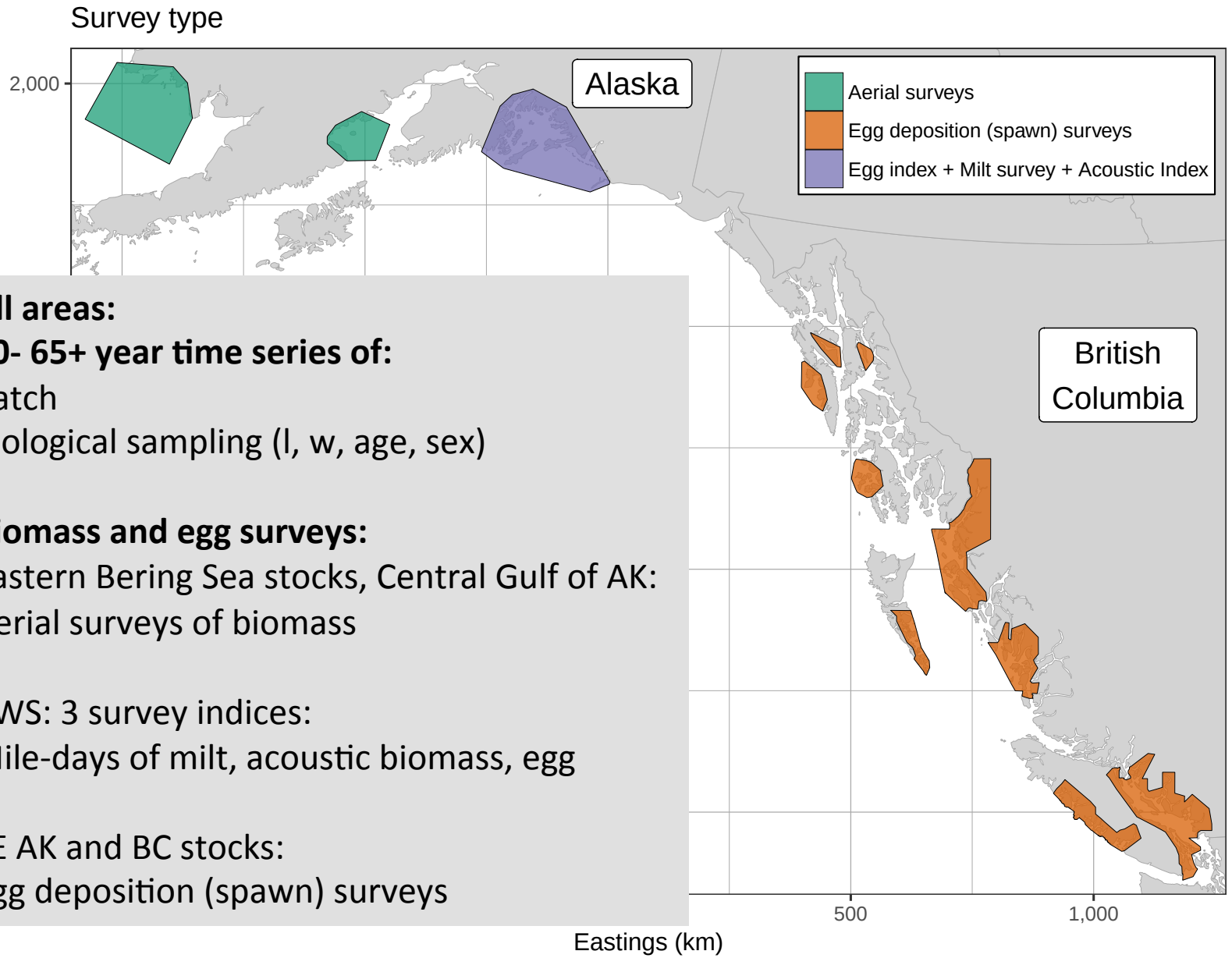

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Biomass and egg surveys:
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Aerial surveys of biomass

PWS: 3 survey indices:
Mile-days of milt, acoustic biomass, egg

SE AK and BC stocks:
Egg deposition (spawn) surveys

Feb-June: Aerial photos of herring spawn activity

Typical colour of Pacific ocean

Herring milt turning water aqua blue

Photo credit: K. Daniel

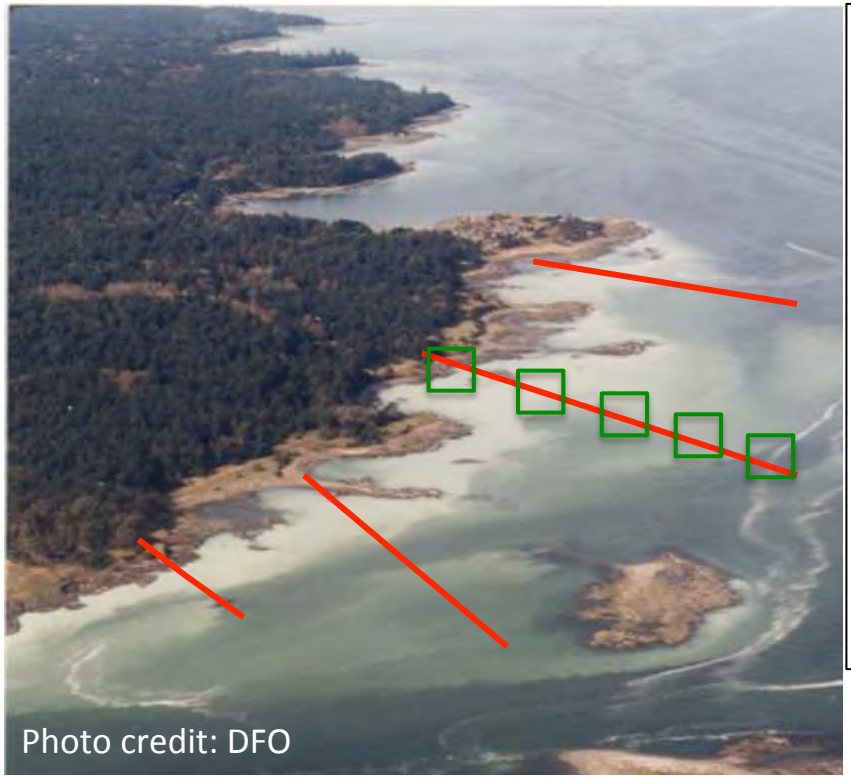


Photo credit: DFO

Herring egg surveys:

1) Identify spawn from flights
2) Determine shoreline length of spawn
3) Transect and quadrat placement
4) Collect quadrat data (egg layers/numbers, vegetation type and percent)
5) Extrapolate to total survey area (shoreline length, spawn width (i.e. transect length), egg density)


Photo credit: ADFG, S.Dressel

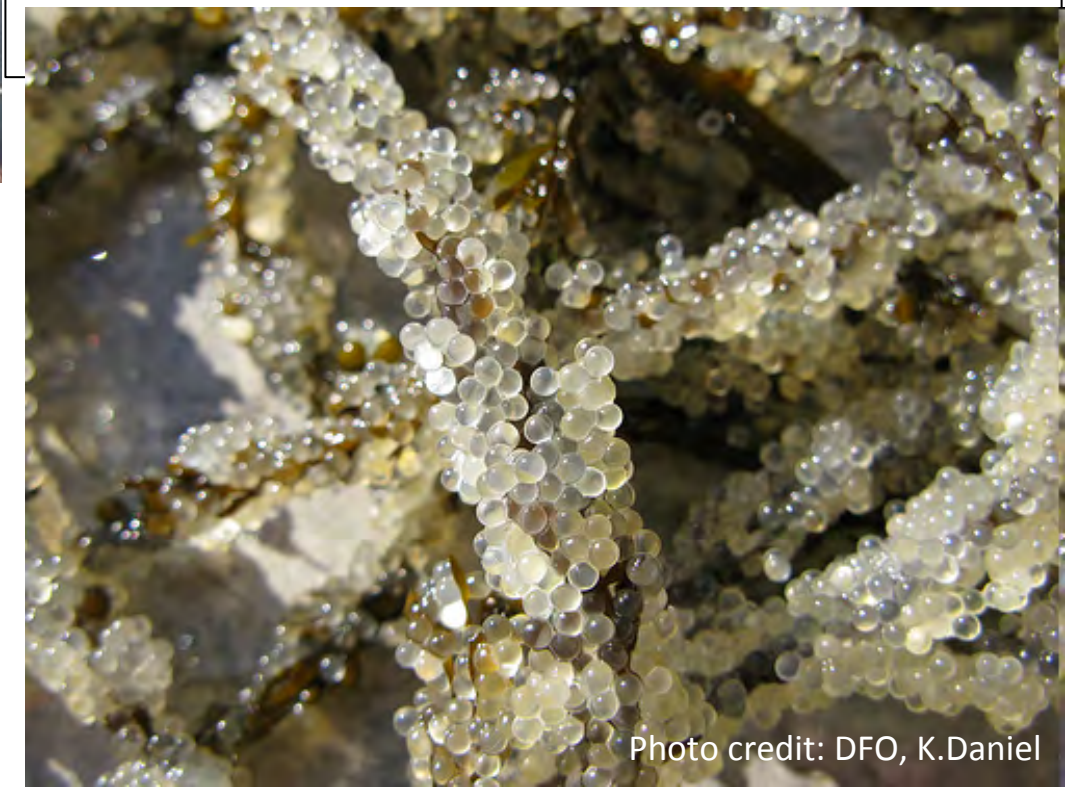
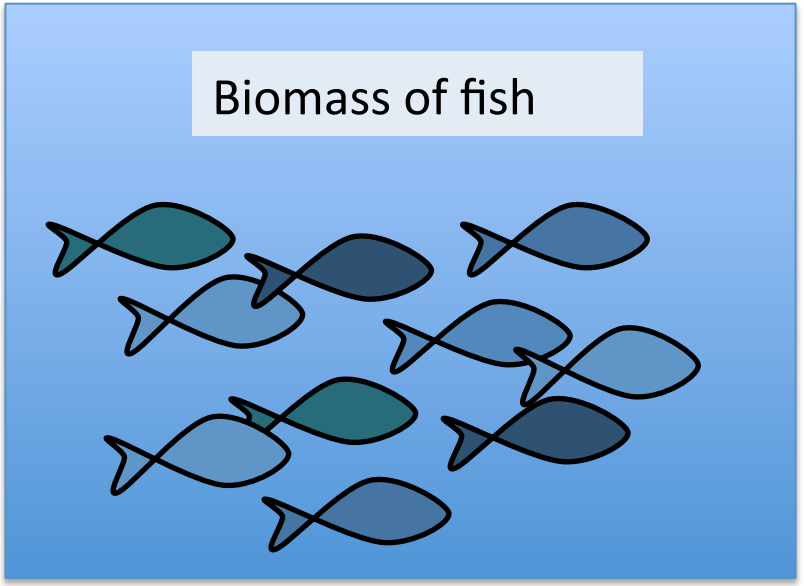


Photo credit: DFO, K.Daniel

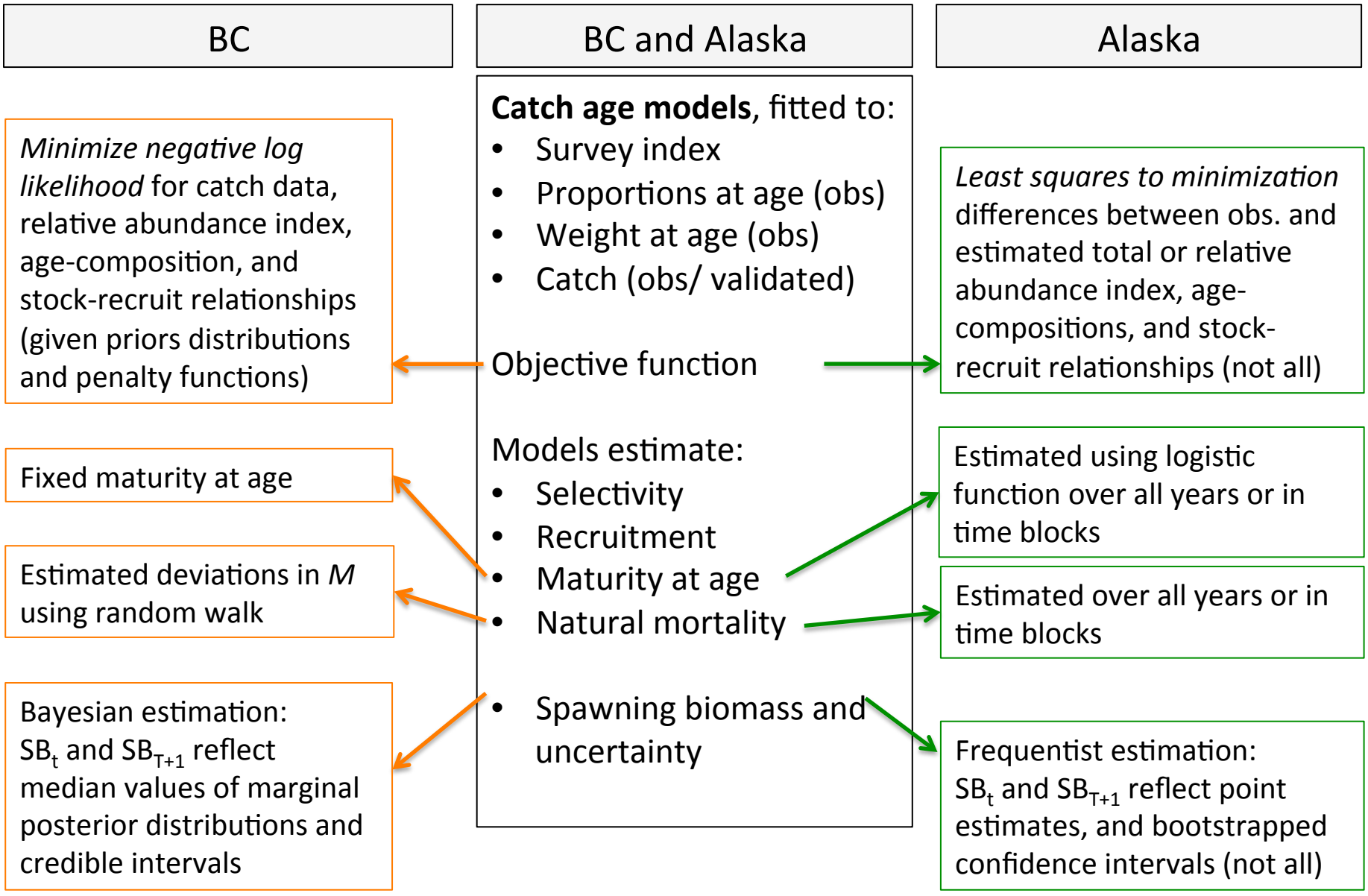
Eggs to fish

Fecundity relationship

Assume 50:50 sex ratio



d) What types of assessments (model, other) are used for the population? 12 predominant stocks with catch-age assessments



d) What types of assessments (model, other) are used for the population?

- 12 predominant stocks with catch-age assessments
- Small SE Alaska stocks use one year forecast
  - Eggs - maturity at age
  - Weight at age - natural mortality
  - Age composition - catch
  - Fecundity
- EBS (non-Togiak) stocks use long-term average annual aerial survey biomass

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e. How is information from field sampling programs incorporated into the assessment?

Through annual stock assessments

- Total abundance indices
- Relative abundance indices
- Disease indices to adjust natural mortality by year and age (PWS)
- Maturity at age as parameter
- Fecundity relationship to convert egg index to biomass

f. If there is no or limited field sampling data available, how is that addressed in the assessment of the population (commercial or not)? Are there better ways to collect the field data?

EBS (non-Togiak) stocks – long term average annual aerial survey biomass
Upper Cook Inlet – low fixed harvest level
Kodiak Island – primarily in-season management

g. What are the challenges involved with assessing the population?
h. What are potential solutions to these challenges?

Challenges…

- Nonstationarity: coping with time varying changes in growth, maturity and natural mortality in stock assessment and in the estimation of biological reference points

- Age at maturity

Potential solutions…

- Example: investigate nonstationarity in *M* within stock assessment models using a joint simulation study to identify best approaches for estimating *M* for herring
  - adopting similar approaches could provide consistent basis for estimating biological reference points (e.g., B_0) that are comparable across regions

- Joint field studies and combined scale/ histological analyses

Acknowledgements:

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