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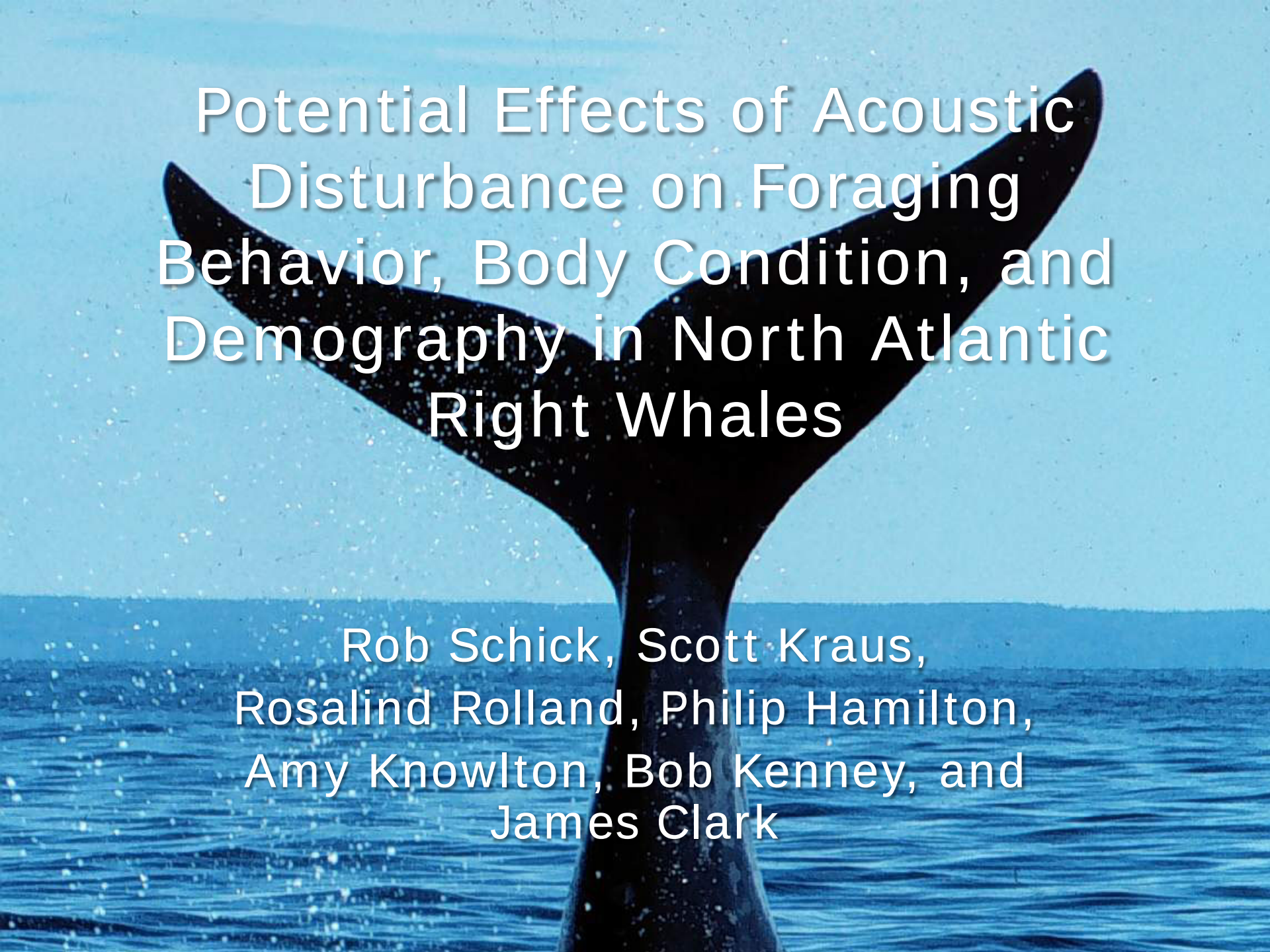

Potential Effects of Acoustic Disturbance on Foraging Behavior, Body Condition, and Demography in North Atlantic Right Whales

Rob Schick, Scott Kraus, Rosalind Rolland, Philip Hamilton, Amy Knowlton, Bob Kenney, and James Clark

Acknowledgements

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  - N00014-10-1-0516 to Jim Clark, Duke
  - N00014-09-1-0896 to UCSB
- Erica Fleishman, John Harwood, Dan Costa, and Peter Tyack
- PCAD working group
- Right Whale Consortium

Right Whale 411

- Current population ~400-450 whales
- Pop. growth rate -2 to + 2%
- Surveys starting in 1980
- Calve every 3-6 yrs, Dec-Mar
- Most right whales range within 50 miles of coast

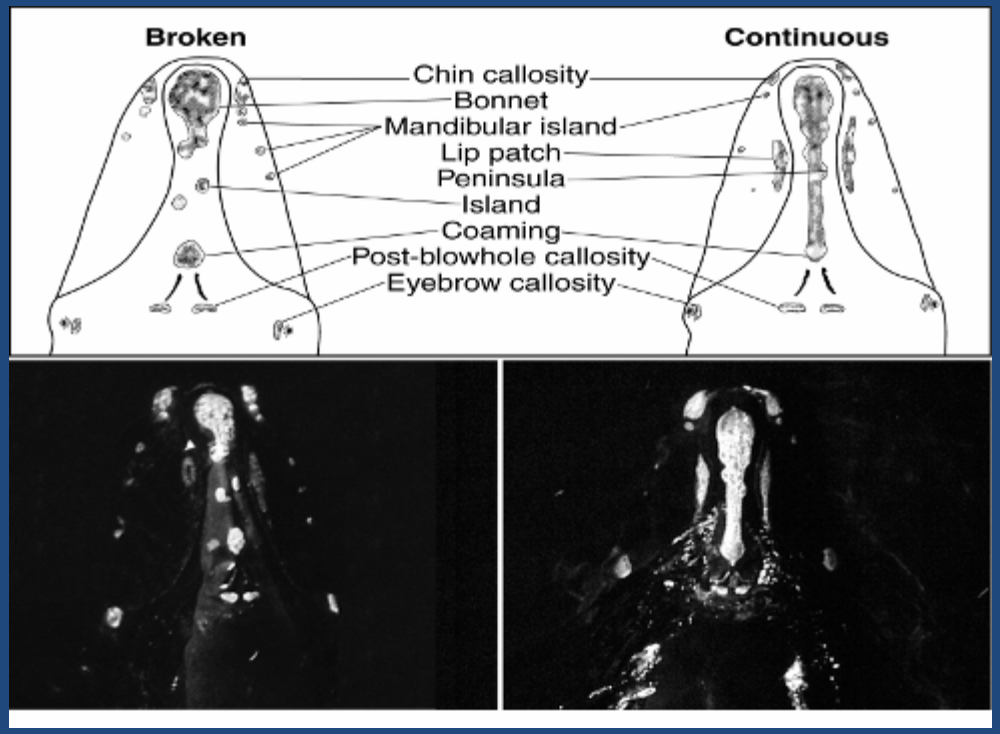
- Conservation challenges:
  - Ship collisions
  - Fishing gear entanglement
  - Reproductive dysfunction

NA Right Whale Catalog

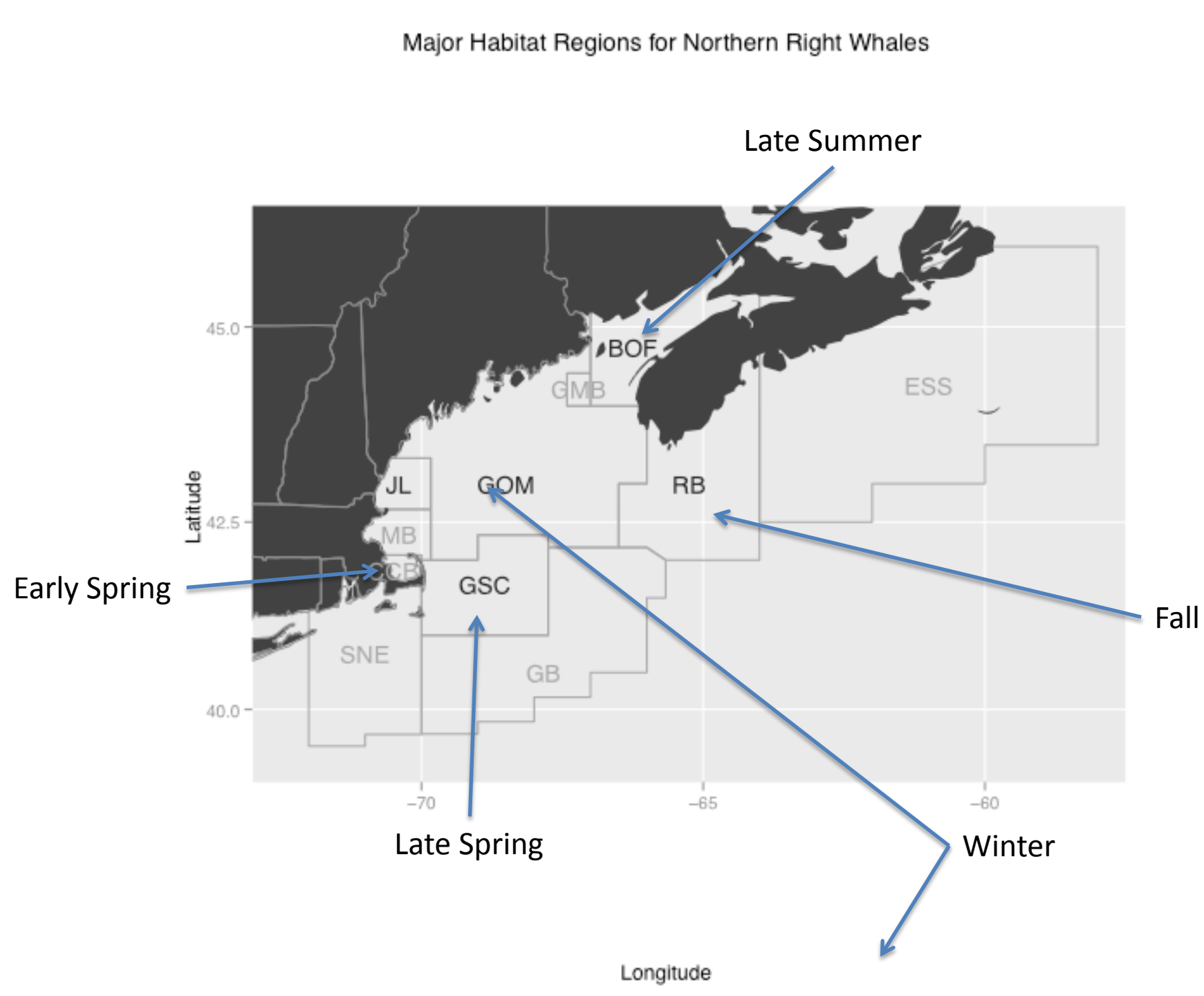
- Photo-identification of individuals

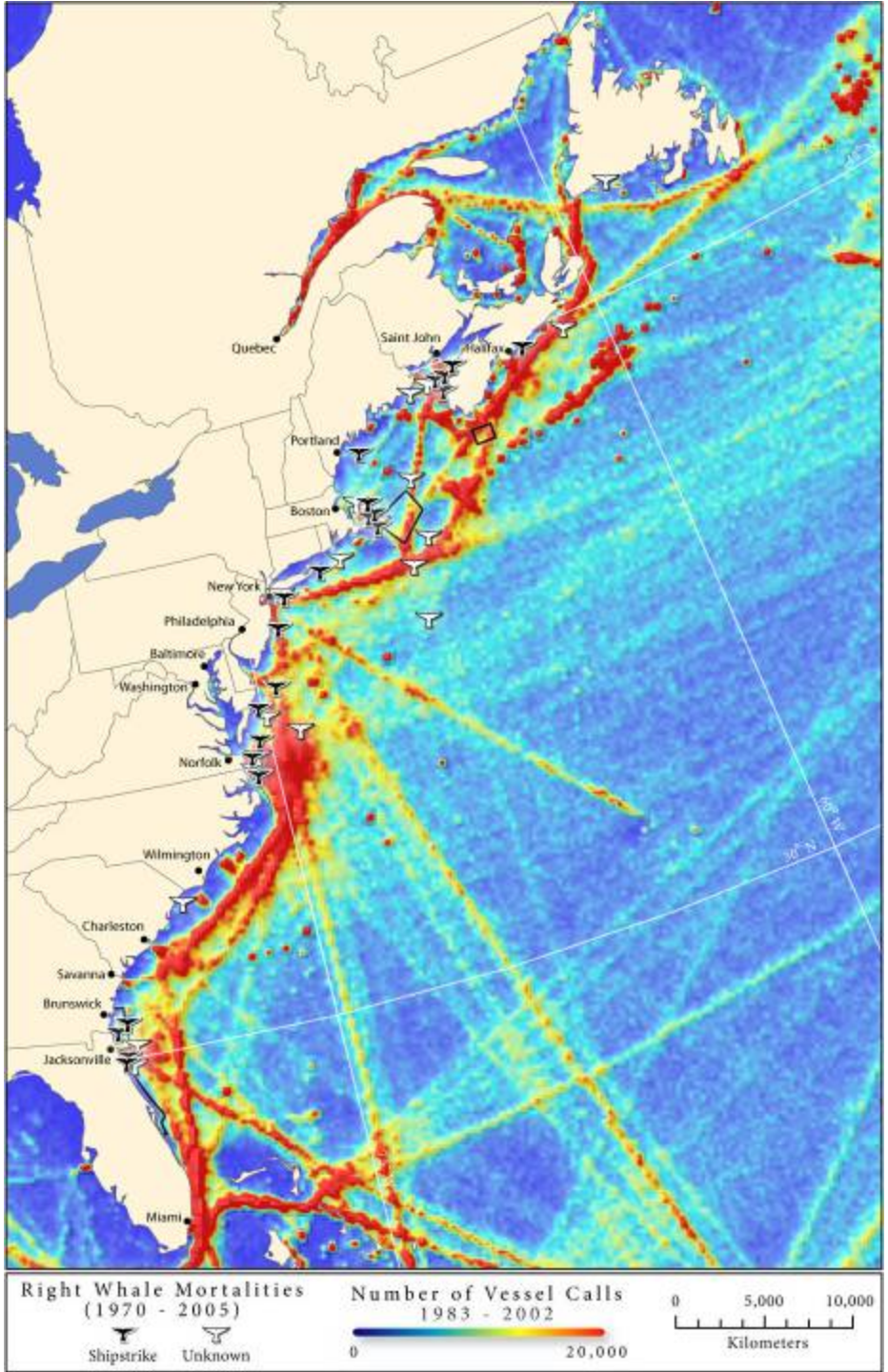
- Contains > 46,000 sightings (>500,000 images) of over 500 individuals (1935-present)

- Up to 30 years of life history data on individual whales:
  - Age/estimated age
  - Sex
  - Calving history
  - Habitat use patterns
  - Health
    - oBody Fat
    - oSkin Condition
    - oRake Marks
    - oCyamids



Labrador
Newfoundland
Quebec
Prince Edward Island
New Brunswick
Nova Scotia
Ontario
Maine
Grand Manan Basin
Roseway Basin
VT
NH
Cape Cod Bay
MA
New York
CT
R.I.
Pennsylvania
N.J.
Ohio
MD
DL
West Virginia
Virginia
Kentucky
North Carolina
Tenn.
South Carolina
Georgia
Florida
Southeast
Migration Route
45°N
60°W
75°W
Early Spring
Late Fall
The North Atlantic Right Whale
Major Habitat Areas
Canadian Critical Habitat Areas
United States Critical Habitat Areas
Primary right whale sighting locations
Occasional right whale sighting locations
0 200 400
Kilometres
0 150 300
Nautical Miles
Cartography by: Kerry Lagueux
Data Sources: Kraus and Rolland (2007), ESRI

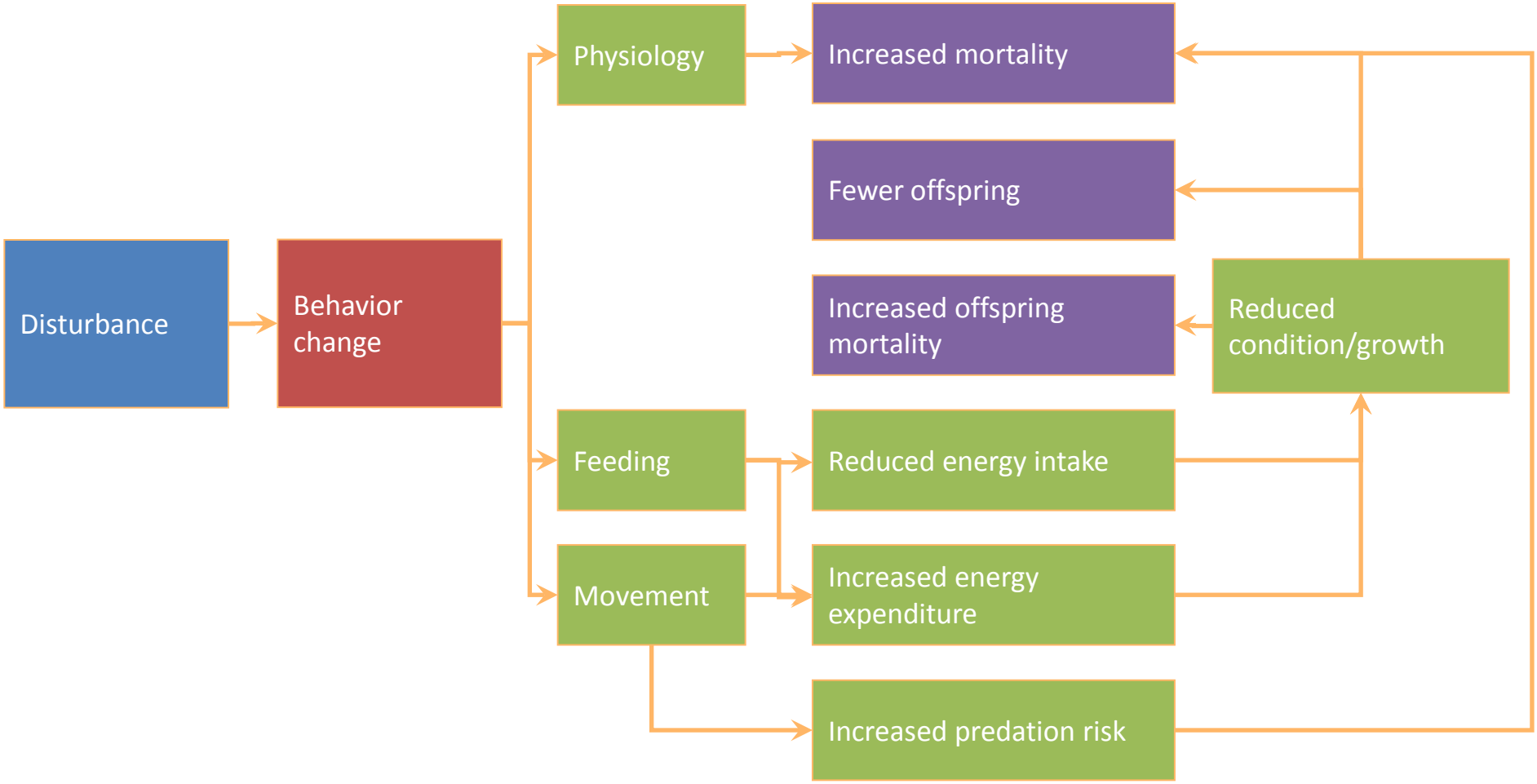

Major Habitat Regions for Northern Right Whales
Late Summer
BOF
GMB
ESS
JL
GOM
RB
MB
CB
GSC
SNE
GB
45.0
42.5
40.0
Latitude
−70
−65
−60
Longitude
Early Spring
Late Spring
Winter
Fall


Quebec
Saint John
Halifax
Portland
Boston
New York
Philadelphia
Baltimore
Washington
Norfolk
Wilmington
Charleston
Savanna
Brunswick
Jacksonville
Miami
30° N
Right Whale Mortalities
(1970 - 2005)
Shipstrike
Unknown
Number of Vessel Calls
1983 - 2002
0
20,000
0
5,000
10,000
Kilometers

Research Questions

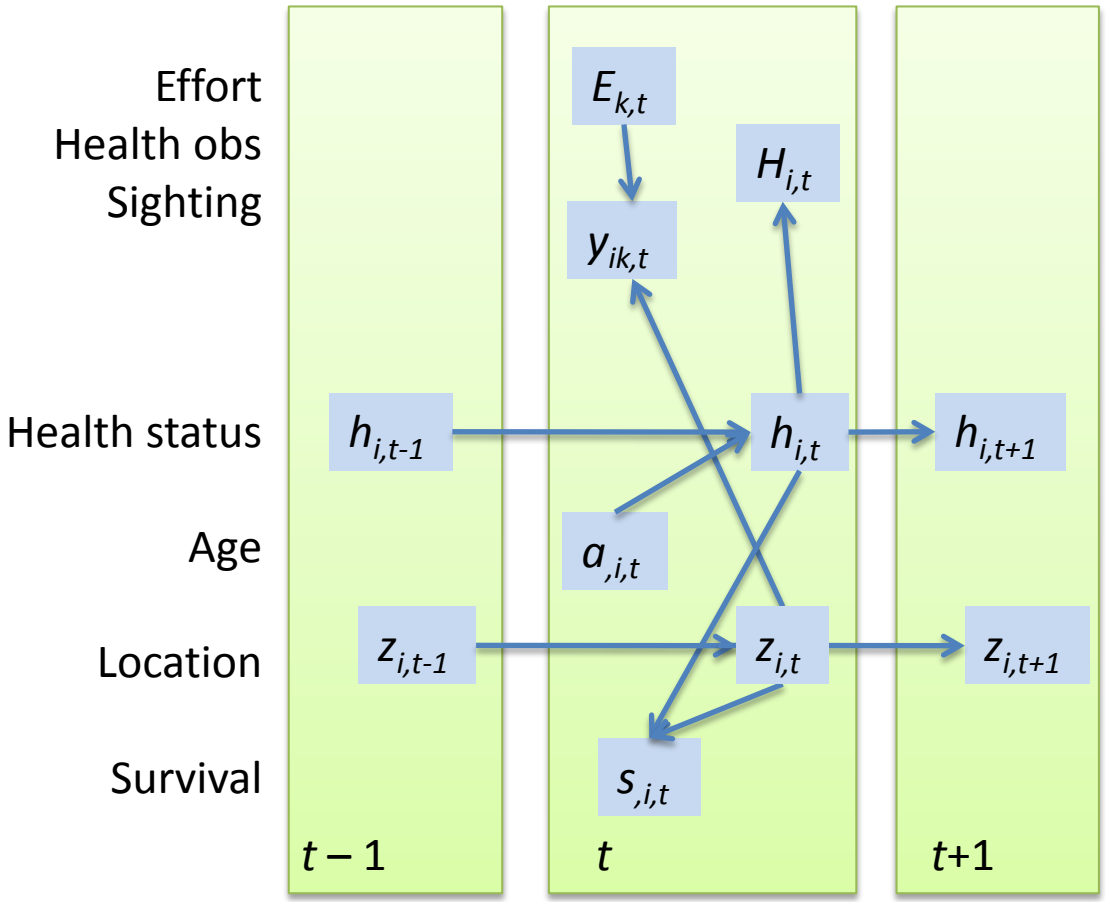
- What is the effect of these stressors on an individual's health?
- In turn, what is the affect of health on survival?
- Where are animals when they are not sighted?
- Do animals in different habitats have different health and survival?

PCAD model
From behavior to vital rates



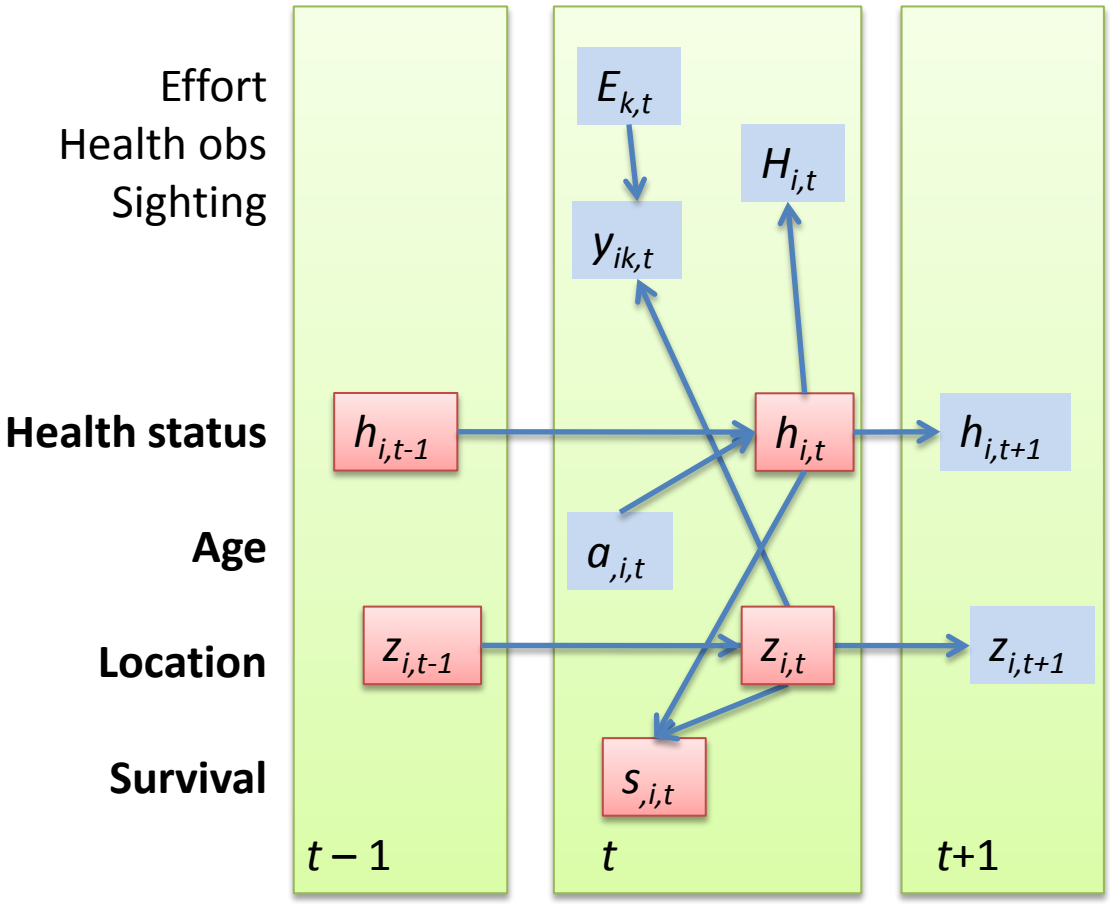
MODELING

Model framework



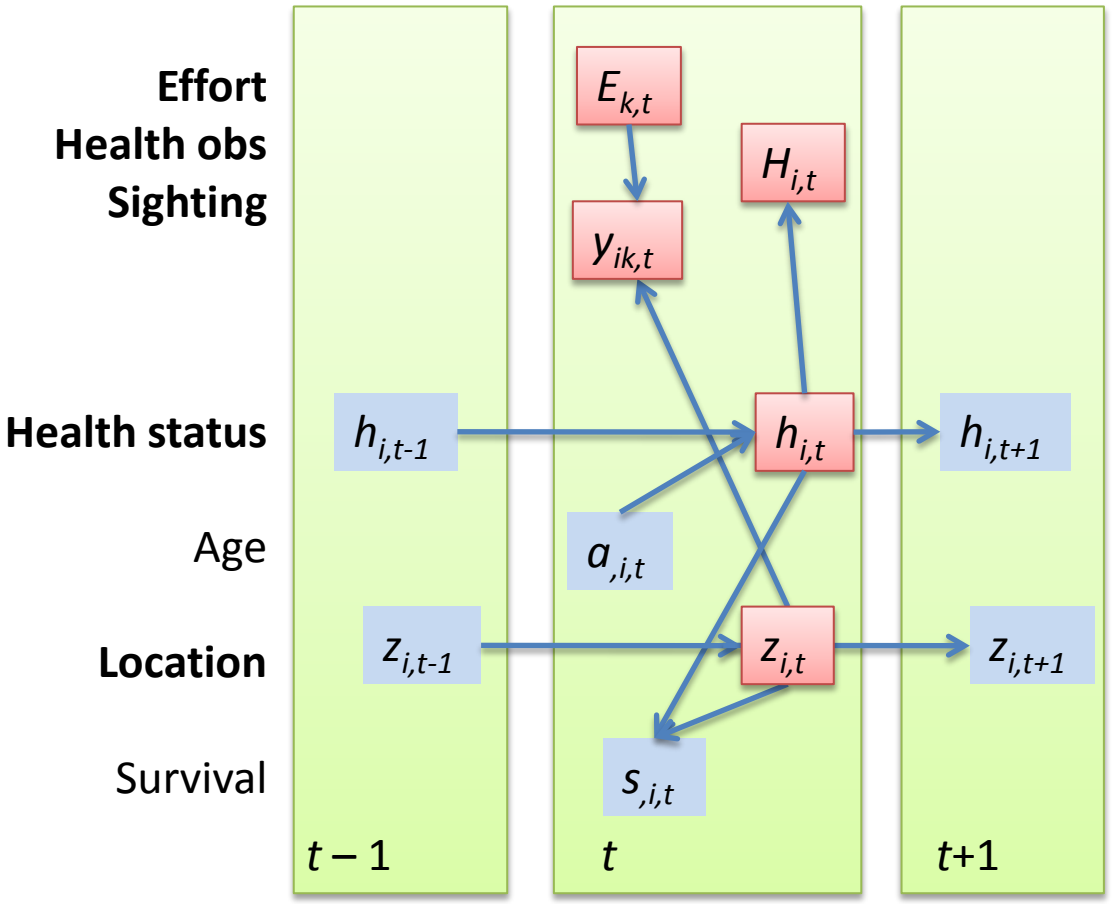
Process model

- Change in health status from aging
  - Can include entanglement or any other covariates
- Survival depends on health and locations
  - having different ship traffic (noise, gear)
- Survivors move with probabilities determined by environment, season

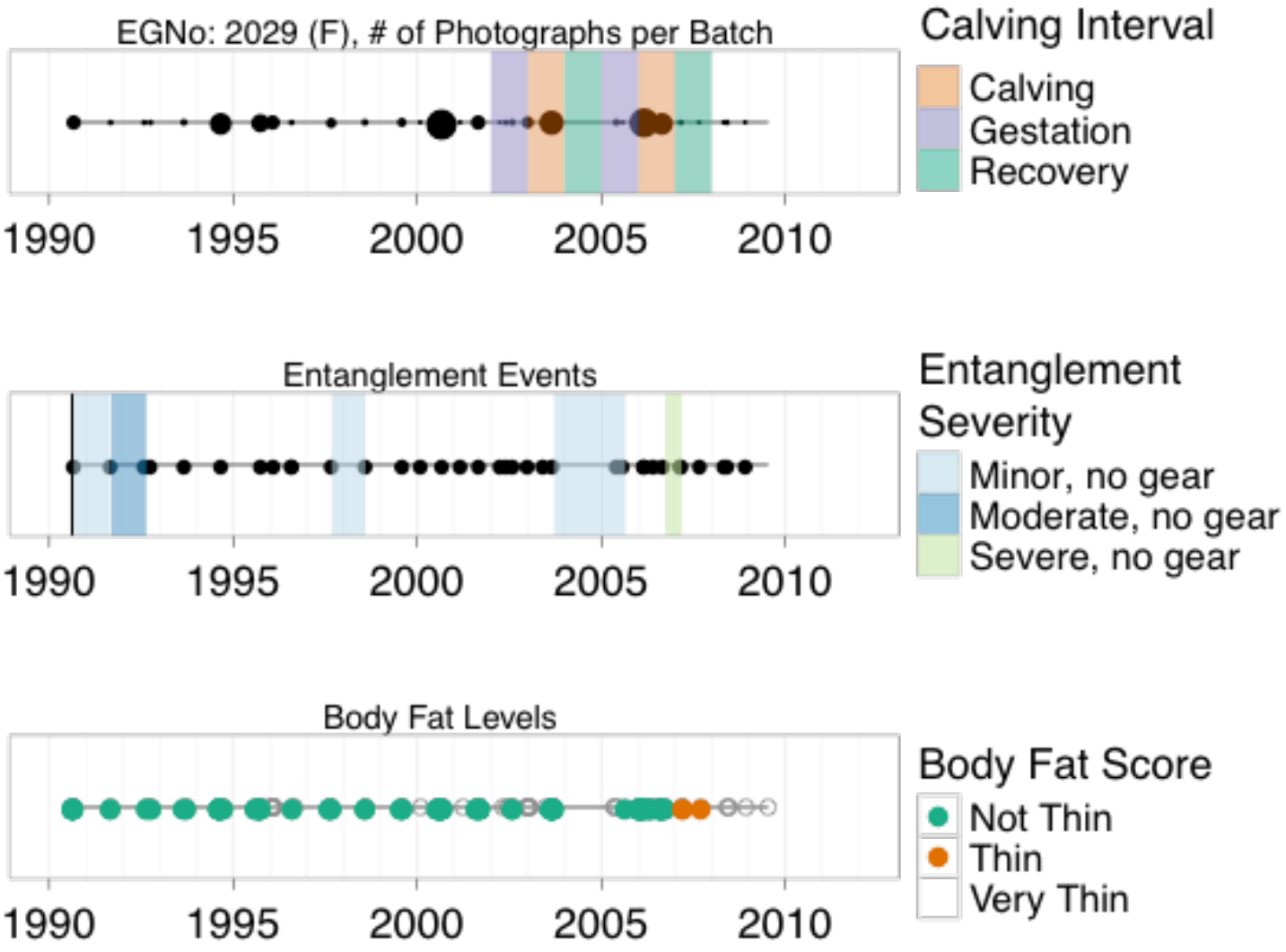


Data models

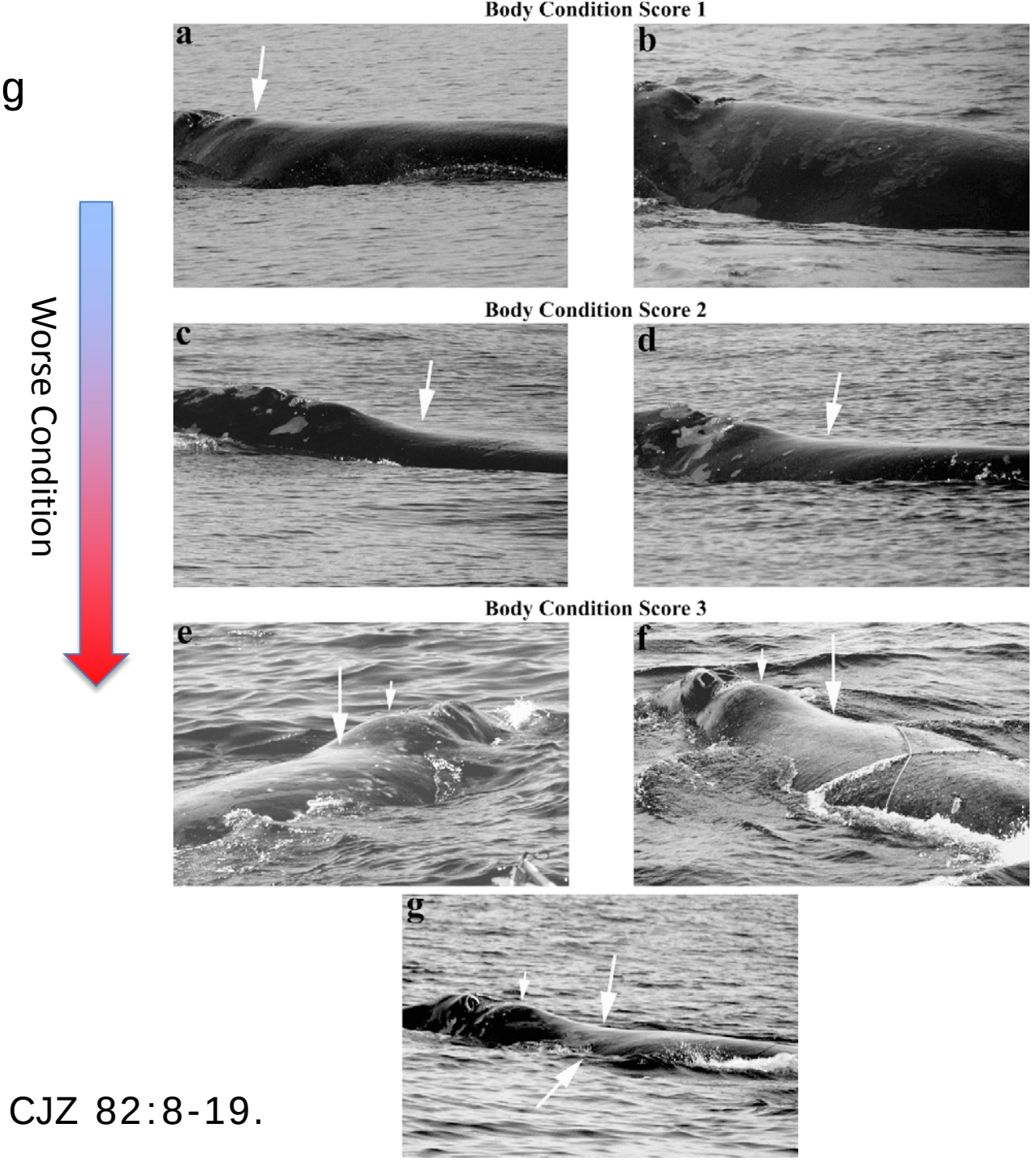
- Sightings
  - Effort
  - Imputed survival status
  - Imputed location
  - Individual differences in detection
- Health status
  - Ordinal multivariate logit
  - Imputed health status



Health Observations



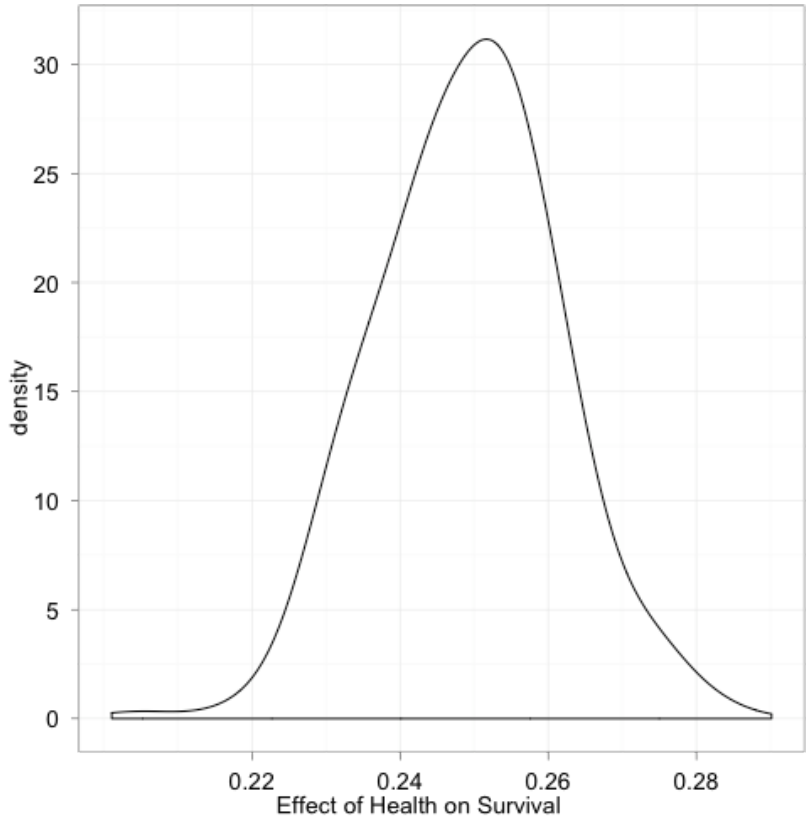
Visual Health Assessment Using Body Condition



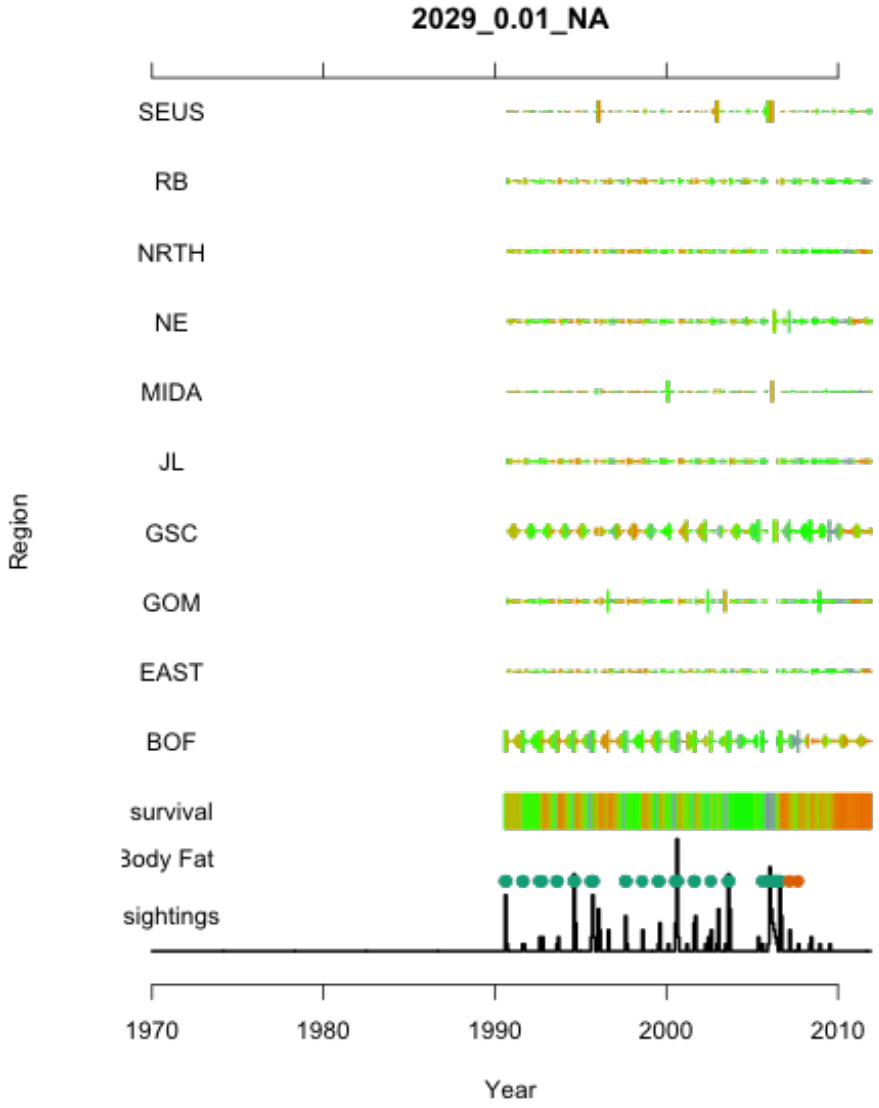
Pettis et al., 2004. CJZ 82:8-19.

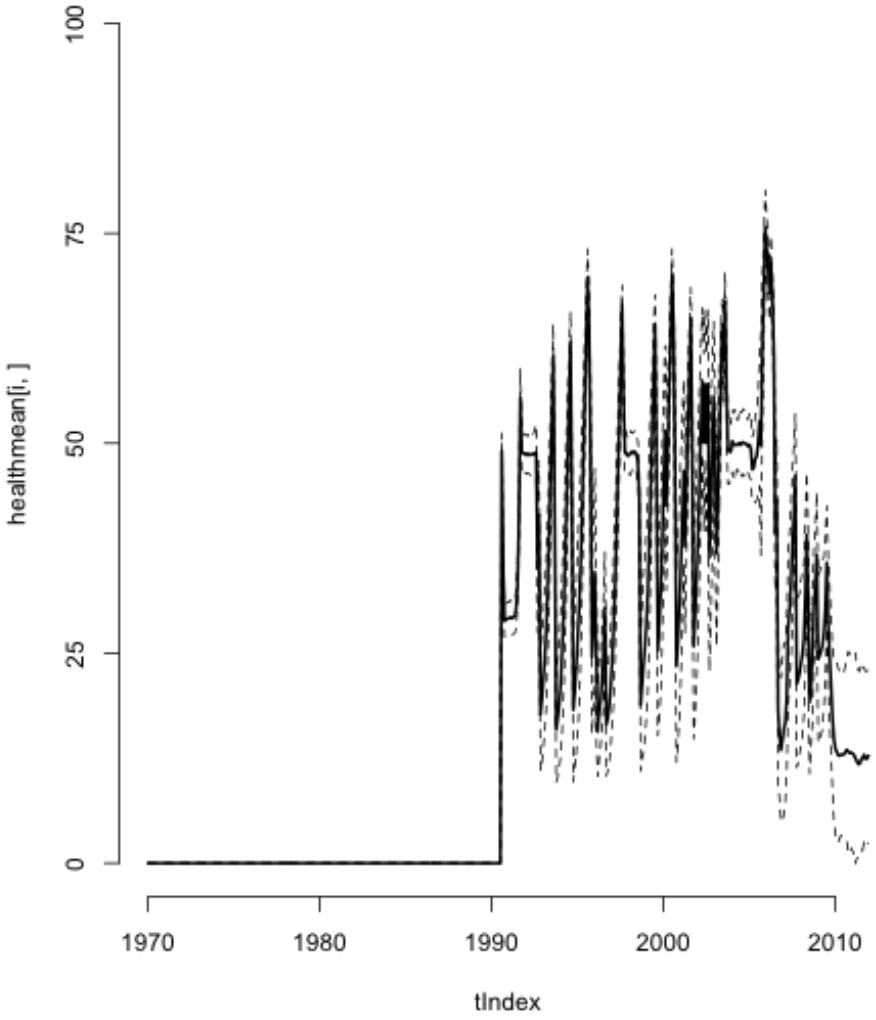
Inference

- Actual health status
- Factors affecting change in health
- Survival status
- Location
- Effect of health and location on survival

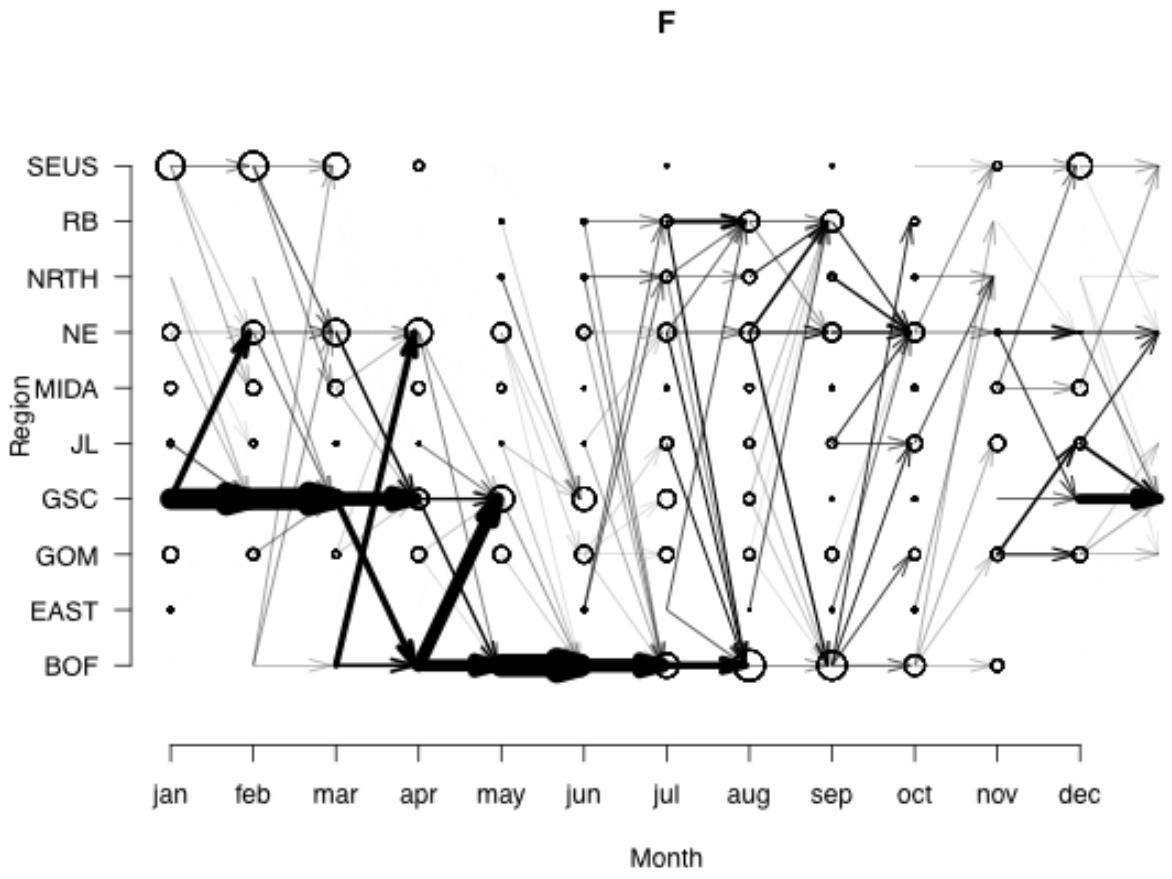


Inference - individual





Inference - population



Schick et al., *in prep*, Bayesian Anal

Applications of the Model

1. Schick et al., the modeling framework
2. Amy Knowlton et al. - entanglement and prop-scarring data
3. Roz Rolland et al. - health data

Manuscripts - Knowlton

- Detailed analysis of the entanglement and prop-scarring data
  - Entanglement severity and calving events
  - Entanglement severity and re-sighting and survival?
  - Is there a different effect of prop wounds vs. entanglement on health and survival?
  - Where was the animal in the time interval it could have been entangled?

Manuscripts - Rolland

- Detailed analysis of all the health status data
- What's the connection between VHA and condition and survival?
- Do whales in different habitats have more/less condition?
- Does calving change as a function of condition?

Manuscripts – Subsequent

1. Classifying the individuals into movement/re-sighting phenotypes (Hamilton)
2. Do variations in prey availability and abundance affect condition and reproductive function (Mayo, Pershing, Baumgartner)
3. Movement – are there areas that are associated with higher lethality (Schick, Moore)
4. Effects of sound on health (Clark)

From Inference to Management

- Knowledge of health and its effect on survival may provide crucial insight into *where* and *when* management will be most effective:
  - Ship strikes: by defining spatio-temporal progression in/between zones
  - Entanglements: where was the animal before it showed up entangled?
  - Acoustics: are animals in high-noise environments less healthy ?

Schick et al., *in prep*, Bayesian Anal

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