Spatial & temporal dynamics of Pacific capelin (*Mallotus catervarius*) in the Gulf of Alaska: using data synthesis to improve monitoring of small pelagic fishes in the Northeast Pacific

David W. McGowan

NOAA Alaska Fisheries Science Center, Seattle, WA, U.S.A

david.mcgowan@noaa.gov

PICES 2020

W6: FIS Topic Workshop

Research priorities for understanding the population dynamics of small pelagic fish in the North Pacific

NOAA FISHERIES

Spatial patterns and population dynamics of small pelagic fish species are poorly monitored in Alaska

Ecosystem-based fisheries management requires knowing how small pelagic fishes impact managed predators

- Small pelagic fishes are not commercially exploited or directly monitored in U.S. waters off Alaska
- Abundance indices are based on predator diets or data from surveys designed for other species

There are limitations associated with using data from surveys designed for commercial species to assess non-targeted species

- Survey spatial coverage and sampling gear used may not be appropriate to quantify small pelagic fish occurrence and density

Synthesizing data from multiple sources can improve monitoring of non-targeted species by compensating for limitations of individual data series

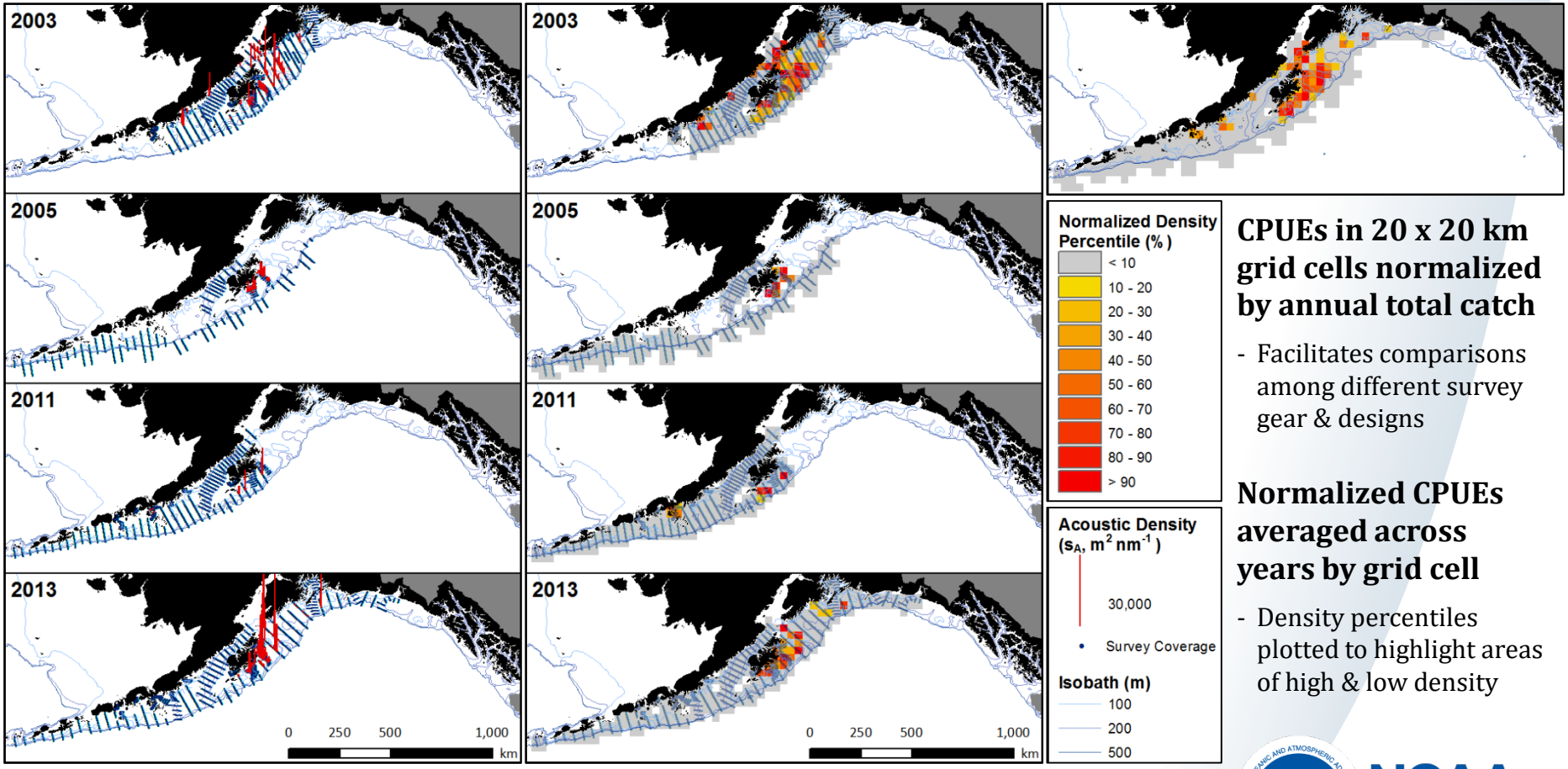
- Composite spatial patterns can identify core areas where a population consistently occurs and concentrates
- Coherence among multiple indices of relative abundance reduces uncertainty when interpreting abundance trends

Case study: using data synthesis to quantify spatial patterns and population dynamics of Pacific capelin (*Mallotus catervarius*) in the Gulf of Alaska (GOA) from 2000–2019

NOAA FISHERIES

Synthesizing Spatial Patterns I: Normalize catch-per-unit-effort (CPUE) data

Capelin CPUE by year → Normalized density percentiles by year → Density percentiles across all years



CPUEs in 20 x 20 km grid cells normalized by annual total catch

- Facilitates comparisons among different survey gear & designs

Normalized CPUEs averaged across years by grid cell

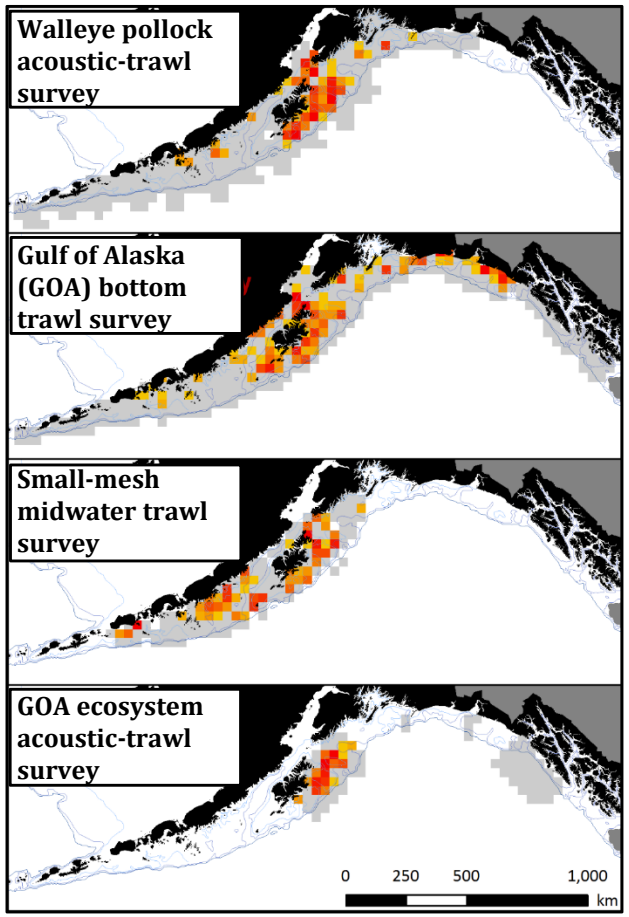
- Density percentiles plotted to highlight areas of high & low density

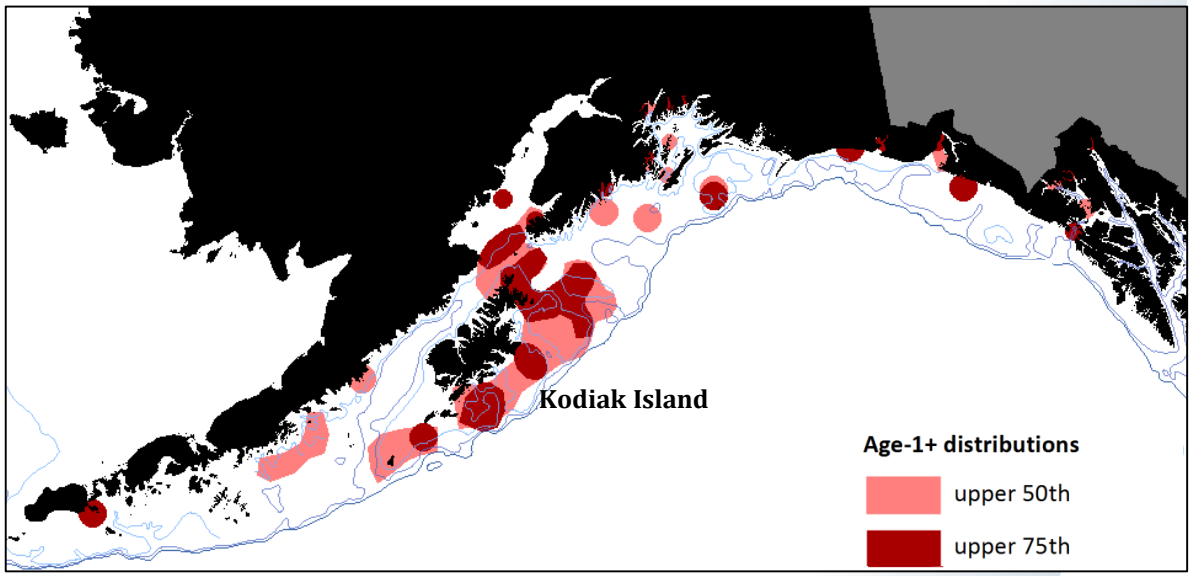
Gulf of Alaska summer walleye pollock acoustic-trawl survey. McGowan et al. 2020, *MEPS* 637: 117–140

NOAA FISHERIES

Synthesizing Spatial Patterns II: Combine distributions from all surveys

Normalized density by survey → Composite spatial pattern created from all surveys reveals distribution of population





Composite plot created by retaining all grid cells with normalized CPUEs in upper 50th density percentile from each survey

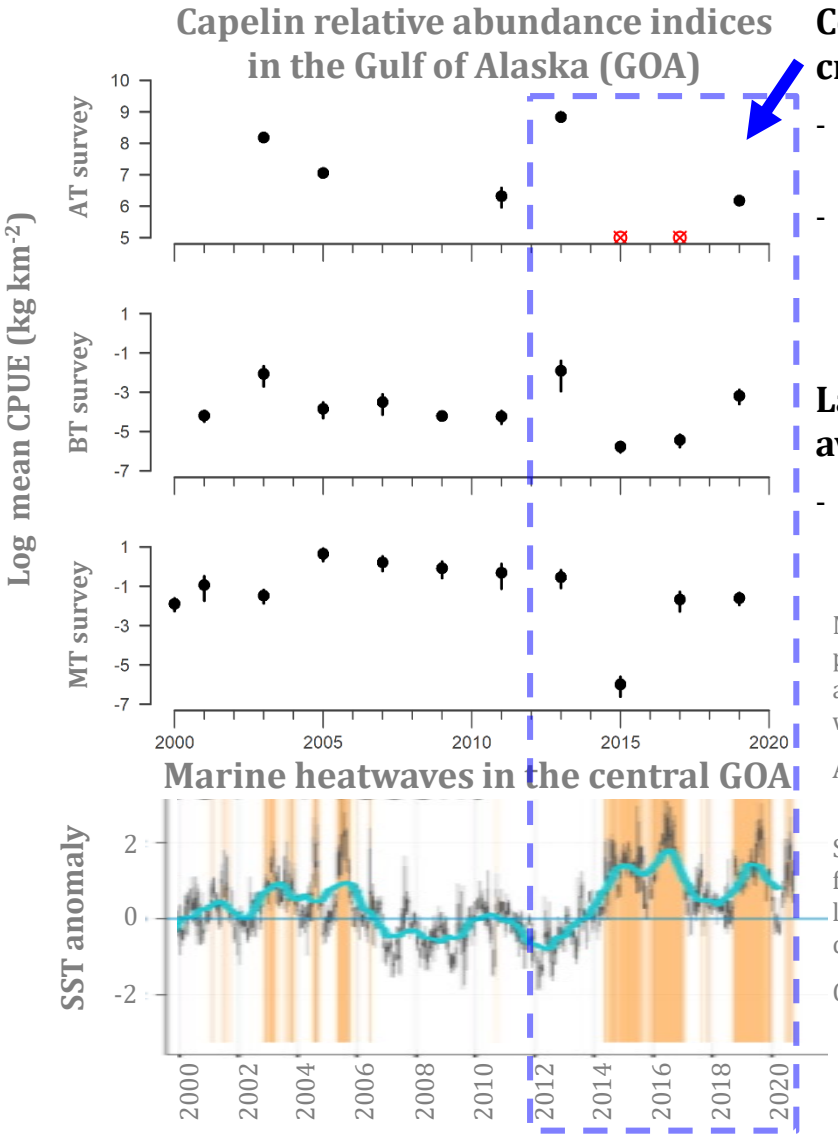
Core areas where capelin concentrate identified by concentrations of grid cells in upper 75th density percentile

- Capelin primarily concentrate over the shelf near Kodiak Island, with high density aggregations along or near edges of shallow banks (<100 m)

McGowan et al. 2020, *MEPS* 637: 117–140

NOAA FISHERIES

Population Dynamics: detecting abrupt changes in abundance trends despite data limitations



Coherence among indices from 2013-2019 shows population crashed during marine heatwave & is slowly recovering

- Sharp decline in 2015 followed high abundance levels in 2013 at end of an extended period of cold conditions in the GOA
- Supports hypothesis that abrupt decline in forage species was a major contributing factor to mass mortality of fish and apex predators in the NE Pacific from 2014-2017 (Piatt et al. 2020, *PloS ONE* 15(1), e0226087)

Lack of coherence among indices from 2000-2011 indicates availability of capelin to surveys is highly variable

- Improved accuracy and precision of survey estimates for capelin and other small pelagic fishes still requires changes in sampling & analysis

Mean catch per unit effort (CPUE) on log scale for age-1+ capelin sampled in the GOA pollock summer acoustic-trawl (AT) survey, GOA summer bottom trawl (BT) survey, and small-mesh midwater trawl (MT) survey (night catches only). Capelin abundance was too low for the AT survey to estimate capelin backscatter in 2015 and 2017.

Adapted from McGowan et al. 2020, *MEPS* 637: 117–140

Sea surface temperatures (SST) from NOAA High-resolution Blended Analysis Data for GOA (145-160° W, < 300 m depth, baseline 1982-2012). Daily SST anomaly (dark line), 360 day rolling average (cyan line), and time periods of marine heatwave conditions (orange shading).

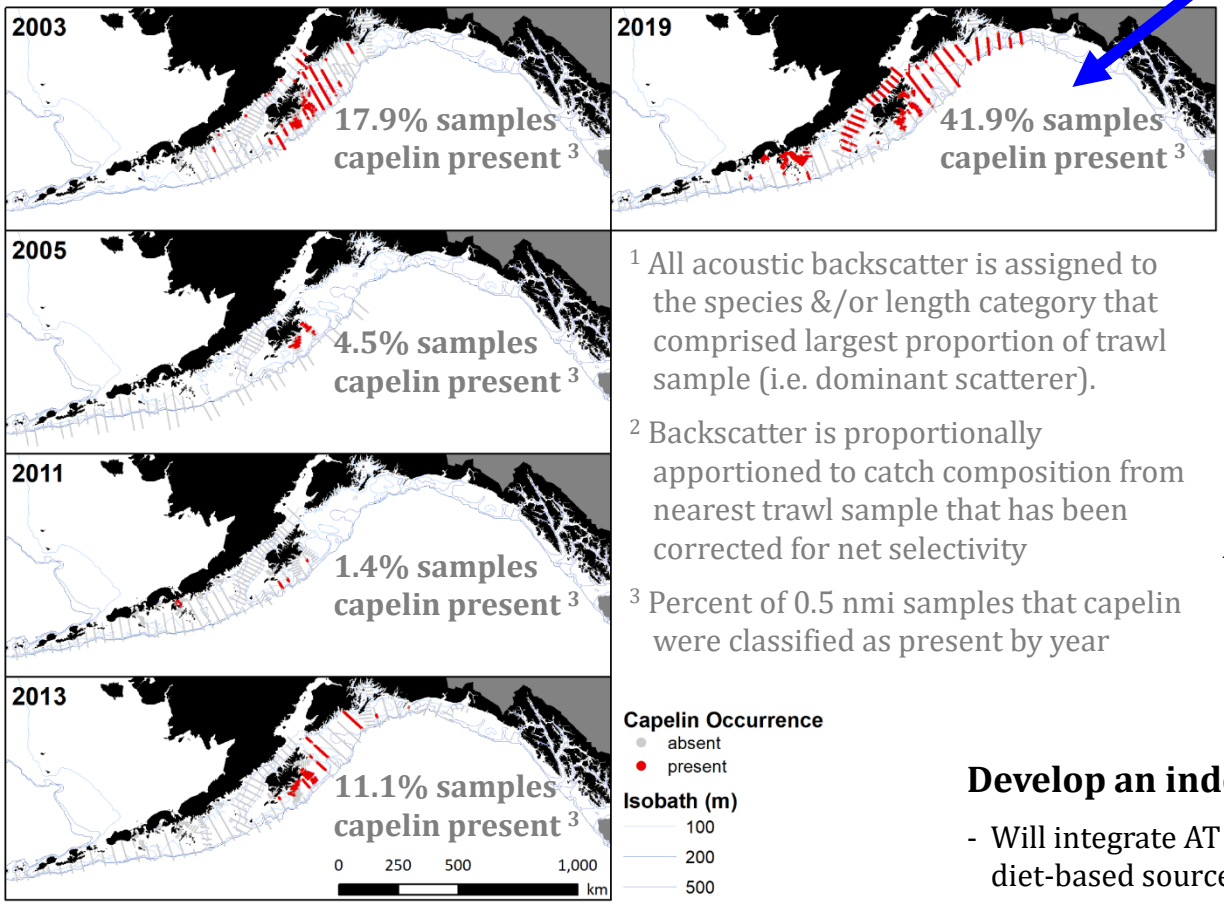
Credit: Stephen J. Barbeaux, NOAA AFSC (NOAA central GOA marine heatwave watch)

NOAA FISHERIES

Improving monitoring of small pelagic fishes (SPF) in the Northeast Pacific

Method for allocating backscatter among species

Assigned to dominant scatterer [1] | Proportional allocation [2]



[1] All acoustic backscatter is assigned to the species &/or length category that comprised largest proportion of trawl sample (i.e. dominant scatterer).

[2] Backscatter is proportionally apportioned to catch composition from nearest trawl sample that has been corrected for net selectivity

[3] Percent of 0.5 nmi samples that capelin were classified as present by year

Gulf of Alaska summer walleye pollock acoustic-trawl survey.

Recent or proposed changes to collection and analysis of acoustic-trawl (AT) data to improve survey estimates of capelin and other SPF

- Adoption of a new approach for assigning backscatter to species in the trawl catch that improves coverage of low and high density distributions
- Use of new midwater trawl with finer mesh codend liner to improve retention of SPF
- Standardized use of pocket nets to estimate species-specific net selectivity
- Application of new classification approach to historical data to update capelin time series
- Proposed changes to increase sampling of capelin core areas in the Gulf of Alaska

Adoption of model-based estimator

- Allows for incorporation of catchability and habitat covariates to improve interpolation of density over unsampled areas

Develop an index-standardization model for capelin

- Will integrate AT survey data with other survey and predator diet-based sources

NOAA FISHERIES

Acknowledgements

Co-authors & collaborators: M. Arimistu, K. Coyle, A. Deary, A. De Robertis, E. Goldstein, K. Holderied, J. Horne, O. Ormseth, J. Piatt, L. Rogers, K. Williams, M. Wilson, and S. Zador

Funding Sources: North Pacific Research Board
NOAA Fisheries
University of Washington, School of Aquatic & Fishery Sciences

References:

McGowan, D. W., and colleagues. (2020). Spatial and temporal dynamics of Pacific capelin *Mallotus catervarius* in the Gulf of Alaska : implications for ecosystem-based fisheries management. *Marine Ecology Progress Series*, *637*, 117–140. https://doi.org/10.3354/meps13211

Piatt, J. F., and colleagues. (2020). Extreme mortality and reproductive failure of common murres resulting from the northeast Pacific marine heatwave of 2014-2016. PloS ONE, 15(1), e0226087. https://doi.org/10.1371/journal.pone.0226087