



# Annual residency patterns and diet of common harbor seals (*Phoca vitulina concolor*) in a southern New Jersey estuary



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**Abstract** From 1996-2011, the Atlantic harbor seal (*Phoca vitulina concolor*) was observed on regional overwintering grounds in the Mullica River-Great Bay Estuary, New Jersey, primarily through opportunistic undergraduate research courses at Stockton University. Over this 15-year time series, 299 observations were completed, with maximum abundance estimates increasing from 100 individuals in 1996 to 160 individuals in 2011. Average annual arrival and departure times to the study area (October/November through May, respectively) remained consistent during this time period. In addition to abundance estimates, scat samples were collected to investigate foraging patterns via fish otoliths. A total of 142 scat samples were analyzed, resulting in 1,419 sagittal fish otoliths recovered. Positively identified otoliths were from four Orders, ten Families, and 15 species. Dominant recovered otoliths by Family and Order were as follows: 48% Phycidae/Gadiformes (Hakes - *Urophycis regia/Urophycis chuss*), 25% Clupeidae/Clupeiformes (Herrings - *Clupea harengus, Alosa sapidissima, Brevoortia tyrannus, Alosa pseudoharengus, Alosa aestivalis*), 13% Ammodytidae/Perciformes (Sandlance - *Ammodytes americanus/Ammodytes dubius*), 6% Pleuronectidae/Pleuronectiformes (Flounder - *Pseudopleuronectes americanus*), and 4% Scophthalmidae/Pleuronectiformes (Flounder - *Scophthalmus aquosus*). Phycids (Hakes) dominated identified prey in both the early (75% of prey in October) and later (67% of prey in April) months of seal occurrence, while Clupeids (Herrings) were best represented in January (41%) and May (65%). No detectable seasonal pattern was found in the Family Ammodytidae (Sandlance). Average back-calculated prey lengths across all prey groups (range 5-33cm, average =19.75cm) were consistent with similar studies, and indicate both estuarine and ocean environments may be utilized for foraging. New Jersey represents an interesting area to investigate due to the migratory nature of both the seals and their prey. These baseline results provide valuable ecological infrastructure for future harbor seal studies in the region.

## Introduction & Objectives

New Jersey is the southern extent of annual *P.v.concolor* seasonal occurrence at haul-out sites along the Atlantic coast, with consistent populations that occur from approximately October-May. We analyzed a 15-year data set (1996-2011) within the southern New Jersey Great Bay/Mullica River estuary in order to 1) document population trends and seasonality of *P.v.concolor*, and 2) determine food sources for the animals using this area. It is valuable to study a species at the extent of its range because changes in population or patterns (due to natural or anthropogenic causes) may first be detected there.

## Methods

- Number of hauled out seals was observed opportunistically (1996-2010) and daily (2010-11) using a 40-60x spotting scope. Observations were made from an observation blind or from Rutgers University Marine Field Station (Fig. 1).
- Scat samples were collected opportunistically when seals were not present. Samples were frozen for later processing.
- When analyzed, samples were passed through a elutriator and nested sieves. Fish otoliths were removed, dried, photographed and identified to Order/Family/Genus species (when possible), and assigned an erosion grade.
- Otolith lengths were measured with Image Pro Analysis (Fig. 2) and regression factors applied, where possible, to estimate original fish prey length.

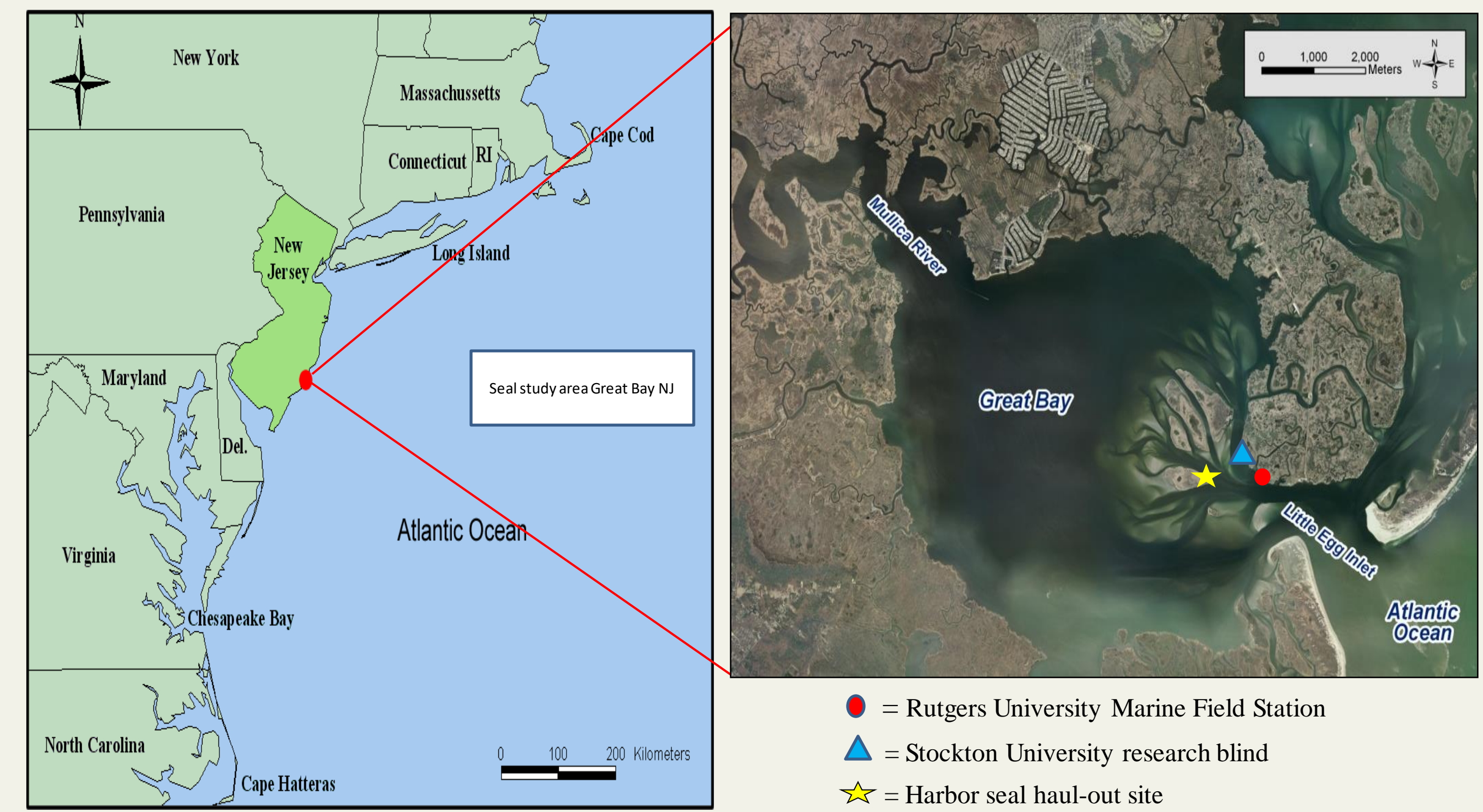


Fig. 1. Great Bay/Mullica River study area, New Jersey USA

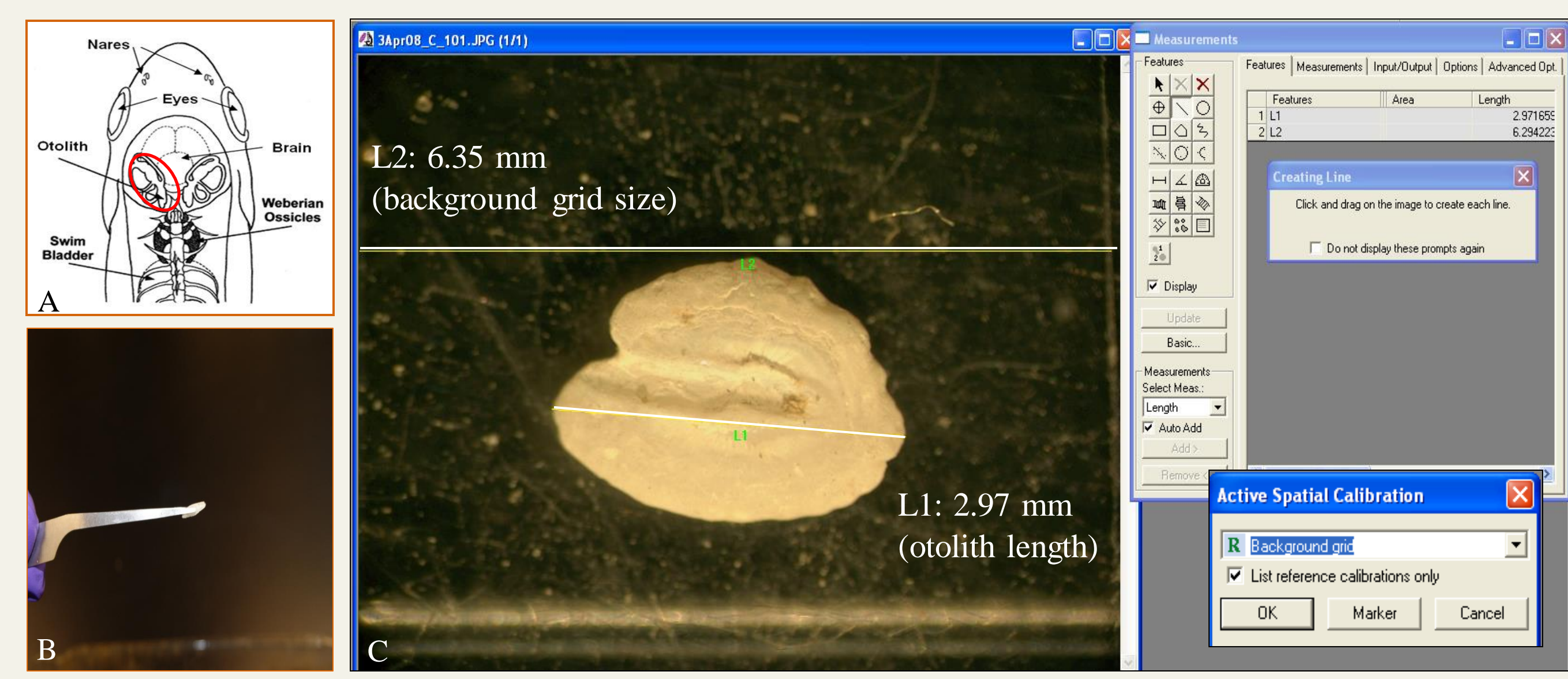


Fig. 2. Otolith orientation (A), Otolith relative size (B), and Image Pro software screenshot (C)

## Results

- 299 observations of the harbor seal haul-out area were completed. Maximum abundance estimates increased from 100 individuals in 1996 to 160 individuals in 2011. Average annual seas surface temperature during seal occurrence remained relatively consistent (Fig. 3).
- Seals occurred on the haul-out site during all tides (high tide 15% of all occurrences, low tide 11% of all occurrences, ebb tide 37% of all occurrences, and flood tide 34% of all occurrences).

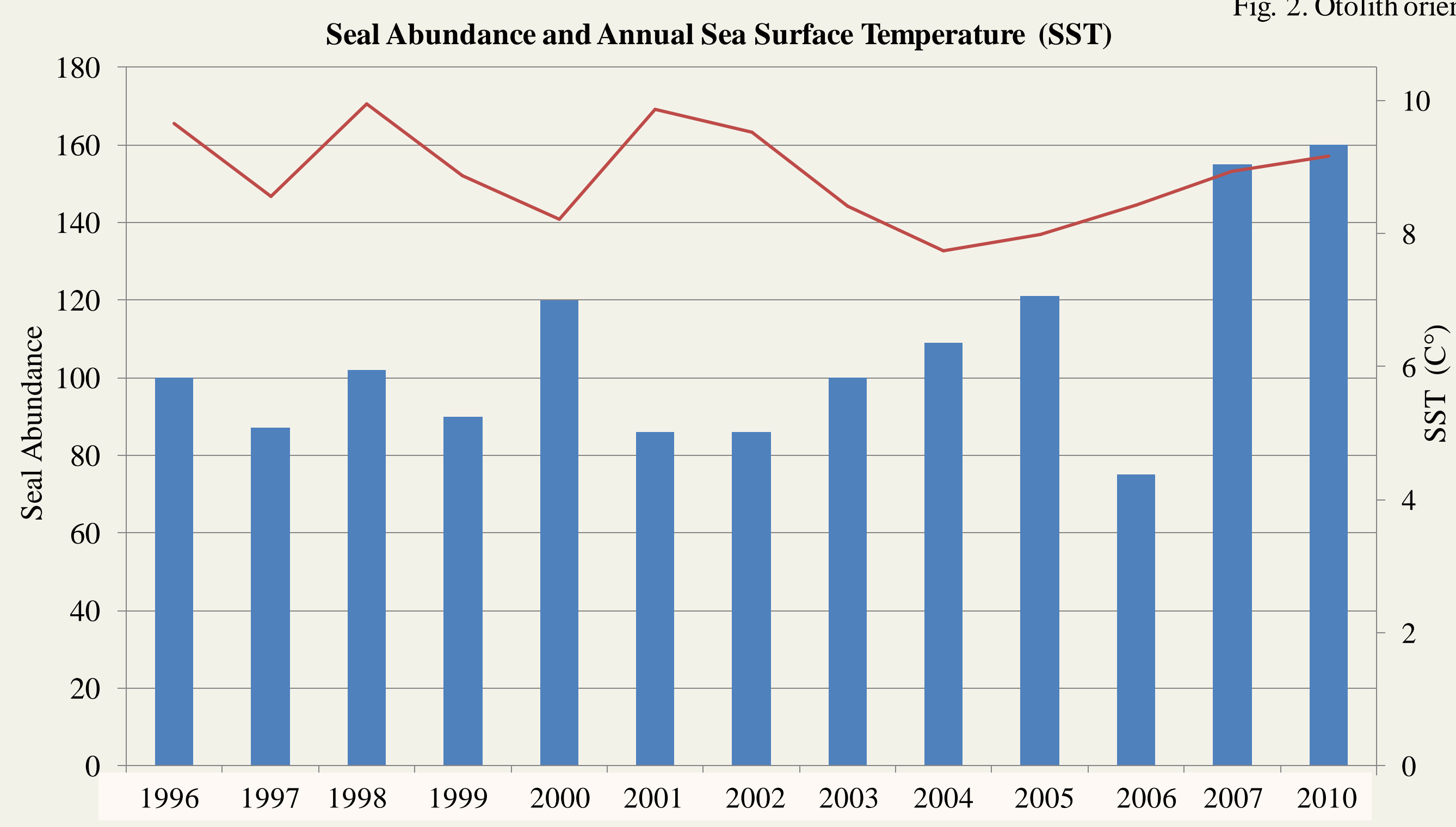


Fig. 3. Maximum annual seal abundance and average annual sea surface temperature in months of seal occurrence

- 142 scat samples were analyzed, with 1,419 sagittal fish otoliths recovered.
- Identified otoliths were from four Orders, ten Families, and 15 species.
- Dominant recovered otoliths by Order were as follows: 48% Gadiformes (Hakes), 25% Clupeiformes (Herrings), 13% Perciformes (Sandlance), 10% Pleuronectiformes (Flounders)(Fig. 4).
- Gadiformes dominated identified prey in both the early (75% of prey in October) and later (67% of prey in April) months of seal occurrence, while Clupeiformes were best represented in January (41%) and May (65%). No detectable seasonal pattern was found in the Order Perciformes (Fig. 5).
- Back-calculated prey lengths indicate that most fish were large juveniles or adults with average prey length of 19.75cm (±SD = 4.5cm), ranging from 5-33cm (Fig. 4)
- Adult winter flounder, *Pseudopleuronectes americanus* (Order Pleuronectiformes) represented the largest average original prey length (33cm ±SD 9.8)

**Acknowledgements** We thank the following for various assistance: dozens of Carol Slocum's Seal Study students, Alexandra Ulmke, Theresa Venello, Sarah Tanedo, Sean Martin, Jenna Rackovan, Tom Malatesta, Jay Turnure, Matt Yerger, Carol VanPelt, Stockton University Marine Field Station, Rutgers University Marine Field Station, The National Science Foundation, Stacy Moore Hagan Memorial Endowed Scholarship. **In Memoriam: Carol Slocum (1948-2010)**

## Results continued ...

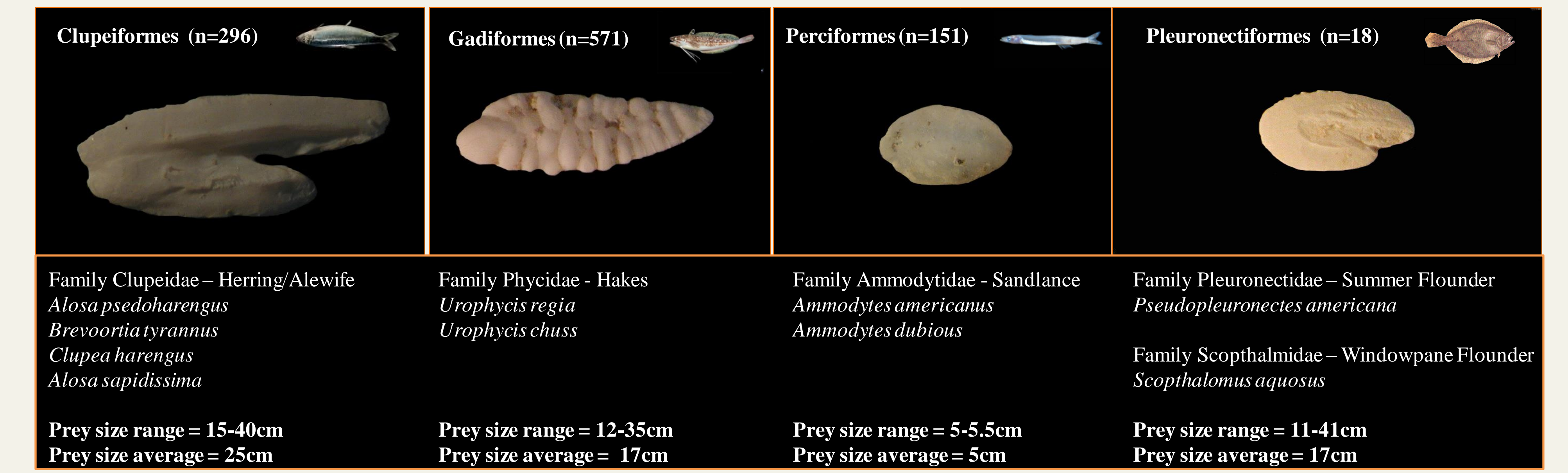


Fig. 4. Representative otoliths by Order and Family, possible prey by species within the Order, and back-calculated original prey lengths

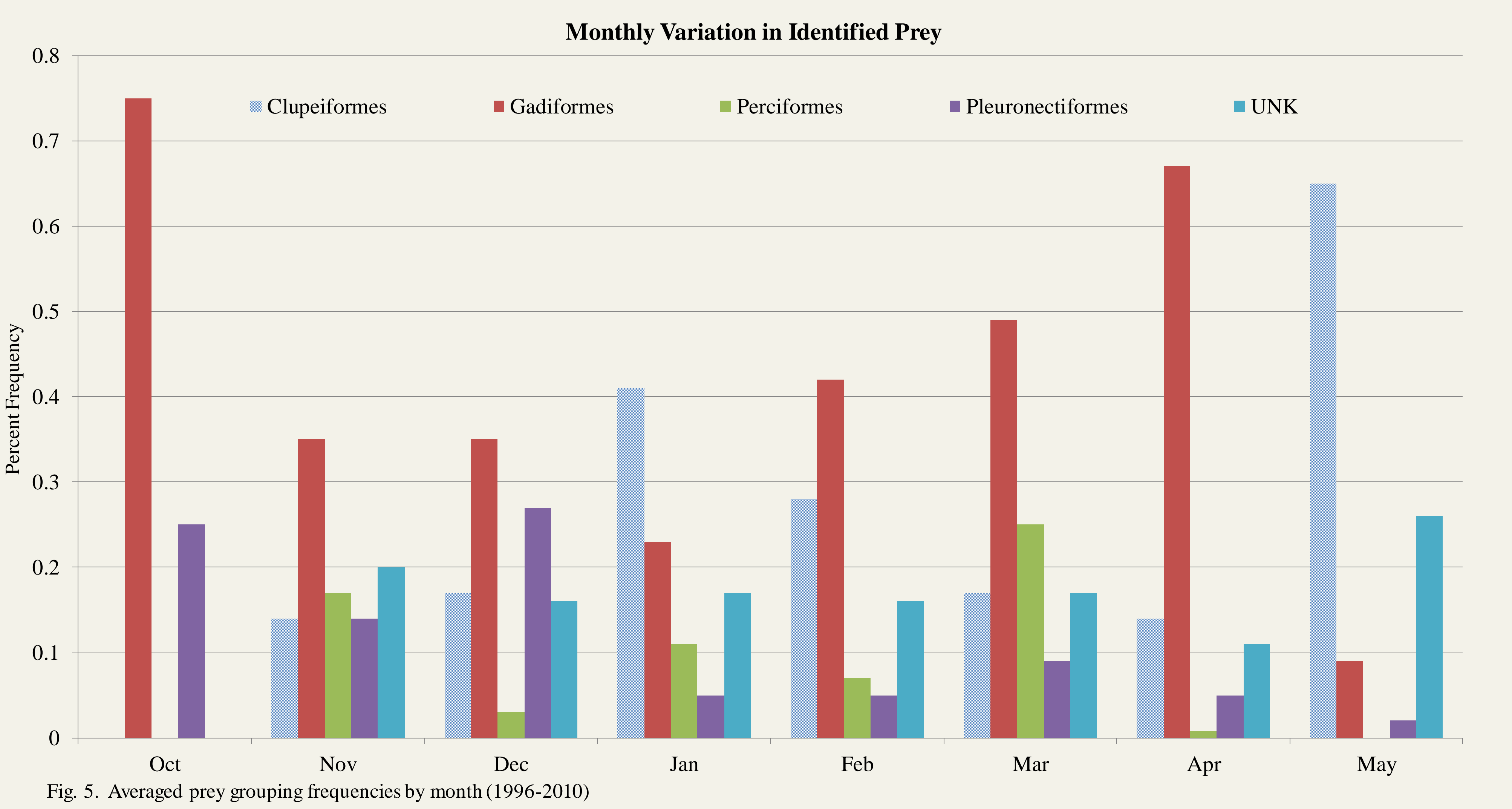


Fig. 5. Averaged prey grouping frequencies by month (1996-2010)

## Conclusion

- Water temperature at peak harbor seal abundance in New Jersey is consistent with average temperatures in the Gulf of Maine where seals reside year-round (Waring *et al.* 2013).
- The precise reason for increase in harbor seal abundance in New Jersey is not known, however this study provides a biological framework for a species whose movements and food habits may be affected by climate change both directly and indirectly.
- Studies show that all fishes consumed by this seasonal seal population are available in either the estuary or near coastal community from Oct-May (Able and Fahay, 2010). It is difficult, however, to determine precise source of prey (estuary/coast) because many are found in both habitats at the back-calculated lengths at the given time of year.
- Multiple hake species (Order Gadiformes) represented a substantial portion of identified otoliths. Both spotted hake (*U. regia*) and red hake (*U. chuss*) are abundant in the estuary and the coast year round, with *U. chuss* slightly more limited in the estuary (Able and Fahay 2010).
- Foraging preference varied monthly; most notably, Clupeiformes was non-dominant in early winter but became a major portion of the diet in late winter/early Spring. This timing corresponds to herring fishes moving up river to spawn during these months (Able and Fahay 2010).
- Back-calculated prey length averages ( $\bar{x}$  = 19.7 cm) were consistent with other studies that determine original prey length via sagittal otoliths. The length range of prey indicates that adult and larger young-of-year fishes were consumed (Able and Fahay 2010).
- Use of sagittal otoliths for prey identification is widely used in pinniped diet analysis, yet there are known limitations. This study does not attempt to capture the totality of food habits for these animals; rather, it presents preliminary findings on prey components for a *P.v. concolor* seasonal habitat that has not yet been documented.