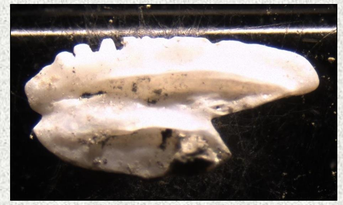
Great Bay (NJ) Atlantic harbor seal (*Phoca vitulina concolor*) abundance and fish prey-type variability during the winter / spring 2010-2011 season



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Abstract

Since 1994, the Atlantic harbor seal (*Phoca vitulina concolor*), a seasonally migratory species, has been documented overwintering in Great Bay, New Jersey through The New Jersey Seal Study initiated by Dr. Carol Slocum. To determine the diet of this piscivorous species, fecal prey remains are analyzed paying particular attention to sagital otoliths of fishes. Building on the efforts of this long-term research, scat samples were collected from harbor seals during the entire 2010-2011 field season from Great Bay. Scat samples were frozen and subsequently processed using elutriation techniques with nested sieves. Otoliths were recovered from processed samples. Of 48 scat samples processed, 35 contained fish otoliths. In total, 359 otoliths were retrieved and assigned a prey type number based on shape (1-3). Otoliths assigned an "unknown type" were either cracked or exhibited severe degradation due to digestion. Previous scat samples (58 total) analyzed by Rutgers REU intern A. Ulmke recovered a total of 270 otoliths that were also assigned type numbers. Of the 629 otoliths retrieved, 32% were Type 3 (Pleuronectiformes), 24% were Type 2 (Gadiformes), 23% were Type 1 (Clupeiformes) and 21% were of an unknown type. Concomitant seal abundance / haul out information was collected using a spotting scope from the Rutgers University Marine Field Station cupola (with a peak observed in March 2011). The maximum number of hauled out seals observed during this time was 160 on several different days. These datasets, combined, provide comprehensive seal abundance and prey type information over one season in Great Bay, NJ. Otolith types were compared to ocean / estuarine use patterns for the dominant fish species in each type category.

Materials and Methods

- The study site was located inside the barrier islands bordering the Mullica River – Great Bay Estuary (**Fig. 1A, Fig. 2A**).
- Samples were collected during the 2010-2011 field season, deposited into labeled jars and frozen.
- Frozen stored samples (48 for current work) were thawed and using detergent and warm water passed through an elutriator (**Fig. 1B**) and nested sieves.
- Otoliths were extracted from the elutriated sample, dried, and stored dry in labeled scintillation vials.
- Photographic images of the otoliths were obtained using a microscope with an attached digital camera and image analysis software (**Fig. 1C**).
- Otoliths were assigned a type number (1, 2 or 3) based on shape (**Fig. 3**).
- T1 were characterized as Clupeiformes, T2 - Gadiformes, and T3 - Pleuronectiformes.
- Type data was combined with a previous analysis (conducted by Alexandra Ulmke, Rutgers U. – 58 samples) to complete a full sample season prey type data set.

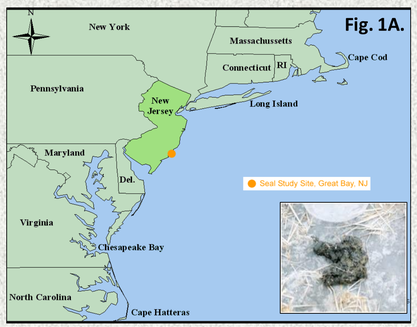
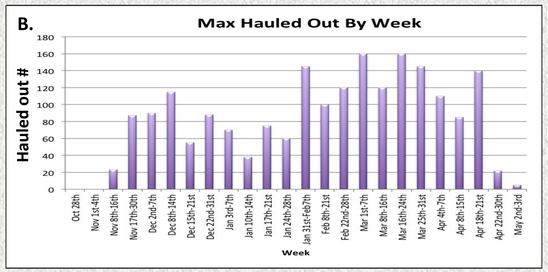
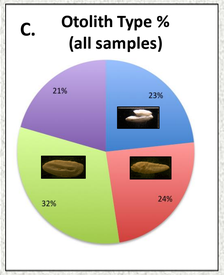
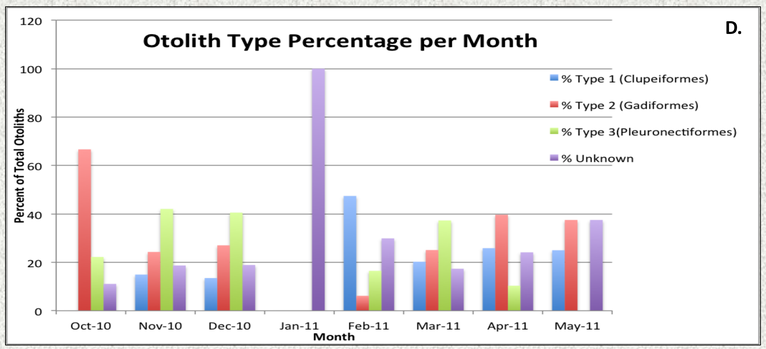


Figure 1A. Harbor seal sampling location in the Mid-Atlantic region (scat sample, inset lower right). **B.** Seal scat elutriator system. **C.** Image analysis system used to photograph otoliths.

Fig. 2A.







E.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Blueback herring			x	x	x			
	x	x				x	x	x
Menhaden	x	x					x	x
	x	x					x	x
Spotted hake	x	x	x	x	x	x	x	x
			x	x	x	x	x	x
Red hake	x	x	x	x	x	x	x	x
						x	x	x
Winter flounder			x	x	x	x	x	x
	x	x	x	x	x	x	x	x
Windowpane	x	x	x	x	x	x	x	x
						x	x	x

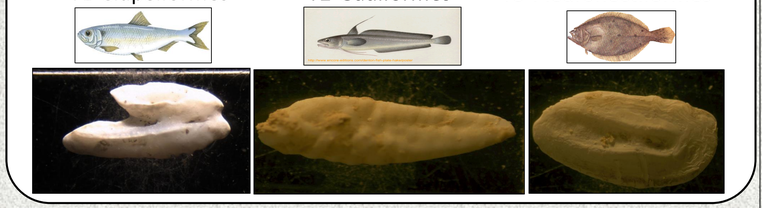
Figure 2A. Hauled out harbor seals (MRGB). **B.** Maximum number of hauled out seals observed by week. **C.** Percentage of otolith types over all samples. **D.** Otolith type percentage by month. **E.** Corresponding distribution of available fish species (2 per Type); blue = ocean; brown = estuary (from Able and Fahay, 1998, 2011).

Results

- Haul out observations revealed a max of 160 individuals on three different dates: March 2, 2011, March 18, 2011, and March 22, 2011 (**Fig. 2B**).
- Total otolith type composition observed was 32% Type 3, 24% Type 2, 23% Type 1 and 21% unknown (**Fig. 2C**).
- Dominant otolith types varied by month with a shift towards Type I in the late winter / early spring (**Fig. 2D**).
- Distribution of common coastal fish species of each otolith type (ocean and estuary use shown, **Fig. 2E**) correspond with shifts in seal diet (as expected).

Fig. 3. Fish Prey Otolith Types and Common Species

T1-Clupeiformes | T2-Gadiformes | T3-Pleuronectiformes



Type 1 Clupeiformes (herring-like): *Clupea harengus* (Atlantic herring), *Alosa aestivalis* (Bluback herring), *Alosa pseudoharengus* (Alewife), *Alosa sapidissima* (American shad), *Brevortia tyrannus* (Atlantic menhaden).

Type 2 Gadiformes (hake-like): *Urophycis regia* (Spotted hake), *Merluccius bilinearis* (Silver hake), *Gadus morhua* (Atlantic cod), *Urophycis chuss* (Red hake).

Type 3 Pleuronectiformes (flatfish-like): *Scophthalmus aquosos* (Windowpane flounder), *Pseudopleuronectes americanus* (Winter flounder), *Glyptocephalus cynoglossus* (Witch flounder), *Ammodytes americanus* (American sandlance – non flatfish)

Conclusions

- The prey-type variability and seal abundance data are shown over a complete time series (winter/spring 2010-2011).
- Harbor seals arrive into the Great Bay area in increasing numbers throughout the overwintering season (late October-late May).
- The population peaks in March and significant numbers remain in the area into late April.
- Seal diet consists mainly of Pleuronectiformes (T3), which can be found year round in the area.
- An increase in predation among Gadiformes (T2) is seen as the season progresses, with peaks in October, April and May.
- Clupeiform (T1) predation also increased during the season with a peak in February.
- The high population numbers in March and April may be reflected in the prey-type data, as increased predation of all three prey types were observed.
- Atlantic Harbor seal diet is dominated by Pleuronectiformes (32%), followed by a shift to Gadiformes and Clupeiformes (24 and 23% respectively).

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In Memoriam: Carol Slocum (1948-2010) and Stacy Moore Hagan (1971-2007)