

---

Oceanography Faculty Proceedings, Presentations, Department of Marine and Environmental Sciences  
Speeches, Lectures

---

10-10-2009

# Trophic Structure of the Northwest Hawaiian Islands and Resident Monk Seals (*Monachus schauinslandi*) During the Twentieth Century


Nina M. Thompson  
*Nova Southeastern University*

Amy Hirons  
*Nova Southeastern University, [hirons@nova.edu](mailto:hirons@nova.edu)*

Charles W. Potter  
*National Museum of Natural History - Smithsonian Institution*

Charles Littnan  
*NOAA Pacific Island Fisheries Science Center*

Follow this and additional works at: [http://nsuworks.nova.edu/occ\\_facpresentations](http://nsuworks.nova.edu/occ_facpresentations)

 Part of the [Marine Biology Commons](#), and the [Oceanography and Atmospheric Sciences and Meteorology Commons](#)

---

## NSUWorks Citation

Thompson, Nina M.; Hirons, Amy; Potter, Charles W.; and Littnan, Charles, "Trophic Structure of the Northwest Hawaiian Islands and Resident Monk Seals (*Monachus schauinslandi*) During the Twentieth Century" (2009). *Oceanography Faculty Proceedings, Presentations, Speeches, Lectures*. Paper 430.  
[http://nsuworks.nova.edu/occ\\_facpresentations/430](http://nsuworks.nova.edu/occ_facpresentations/430)

This Poster is brought to you for free and open access by the Department of Marine and Environmental Sciences at NSUWorks. It has been accepted for inclusion in Oceanography Faculty Proceedings, Presentations, Speeches, Lectures by an authorized administrator of NSUWorks. For more information, please contact [nsuworks@nova.edu](mailto:nsuworks@nova.edu).



# TROPHIC STRUCTURE OF THE NORTHWEST HAWAIIAN ISLANDS AND RESIDENT MONK SEALS (*MONACHUS SCHAUNDSLANDI*) DURING THE TWENTIETH CENTURY



Nina Thompson<sup>1</sup>, Amy C. Hirons<sup>1</sup>, Charles W. Potter<sup>2</sup>, and Charles Littnan<sup>3</sup>

<sup>1</sup>Nova Southeastern University Oceanographic Center, tnina@nova.edu, hirons@nova.edu, <sup>2</sup>National Museum of Natural History, Smithsonian Institution, potterc@si.edu, and <sup>3</sup>Pacific Island Fisheries Science Center, NOAA, charles.littnan@noaa.gov



**Abstract:** The Hawaiian monk seal (*Monachus schauinslandi*) is an endangered species only found within the Hawaiian Archipelago. The majority of the breeding population for this seal is located around six islands in the Northwest Hawaiian Island chain (NWHI). Overall, both juvenile and adult seals have a wide range in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  from 1912-2006 ( $\delta^{13}\text{C}$ : -12.5‰;  $\delta^{15}\text{N}$ : 12.6‰). Seals in the northern NWHI were enriched in  $\delta^{13}\text{C}$  by nearly 2‰ and depleted in  $\delta^{15}\text{N}$  by nearly 6‰ during the 96 years. Meanwhile, seals within the middle and southern extent of the NWHI showed little to very slight decreases in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . Preliminary comparison of modern monk seals with selected potential prey in the southern NWHI indicate possible trophic reliance on a mix of reef fish, eels, and lobster. Commercial fishery data post-WWII indicate an overlap between fisheries and monk seal diets in lobster, squirrelfish, and goatfish.

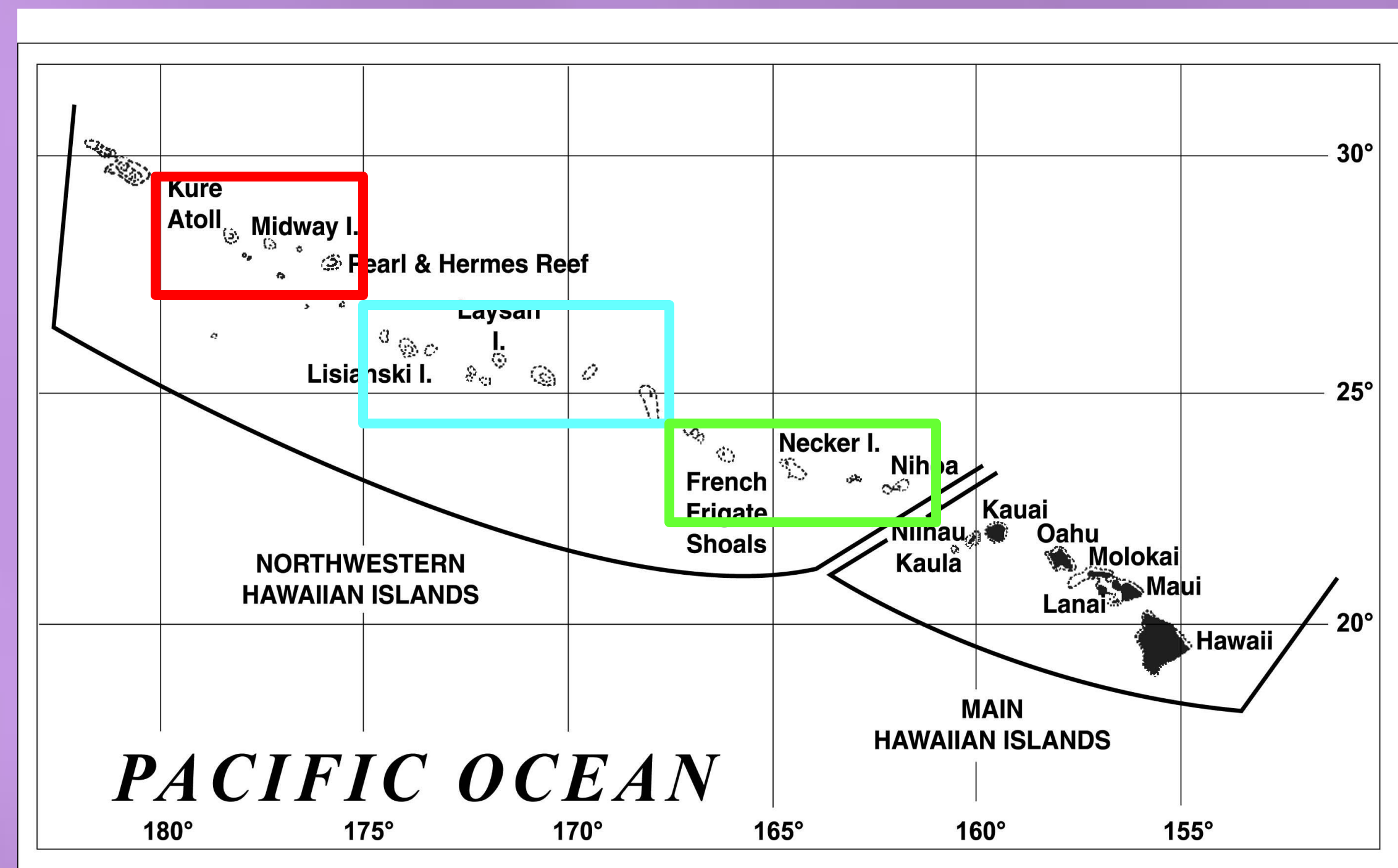


Figure 1. Map of the Northwest Hawaiian Island Archipelago. ([http://www.oar.noaa.gov/spotlite/archive/images/bottomfishing\\_NWHI\\_sm.jpg](http://www.oar.noaa.gov/spotlite/archive/images/bottomfishing_NWHI_sm.jpg))

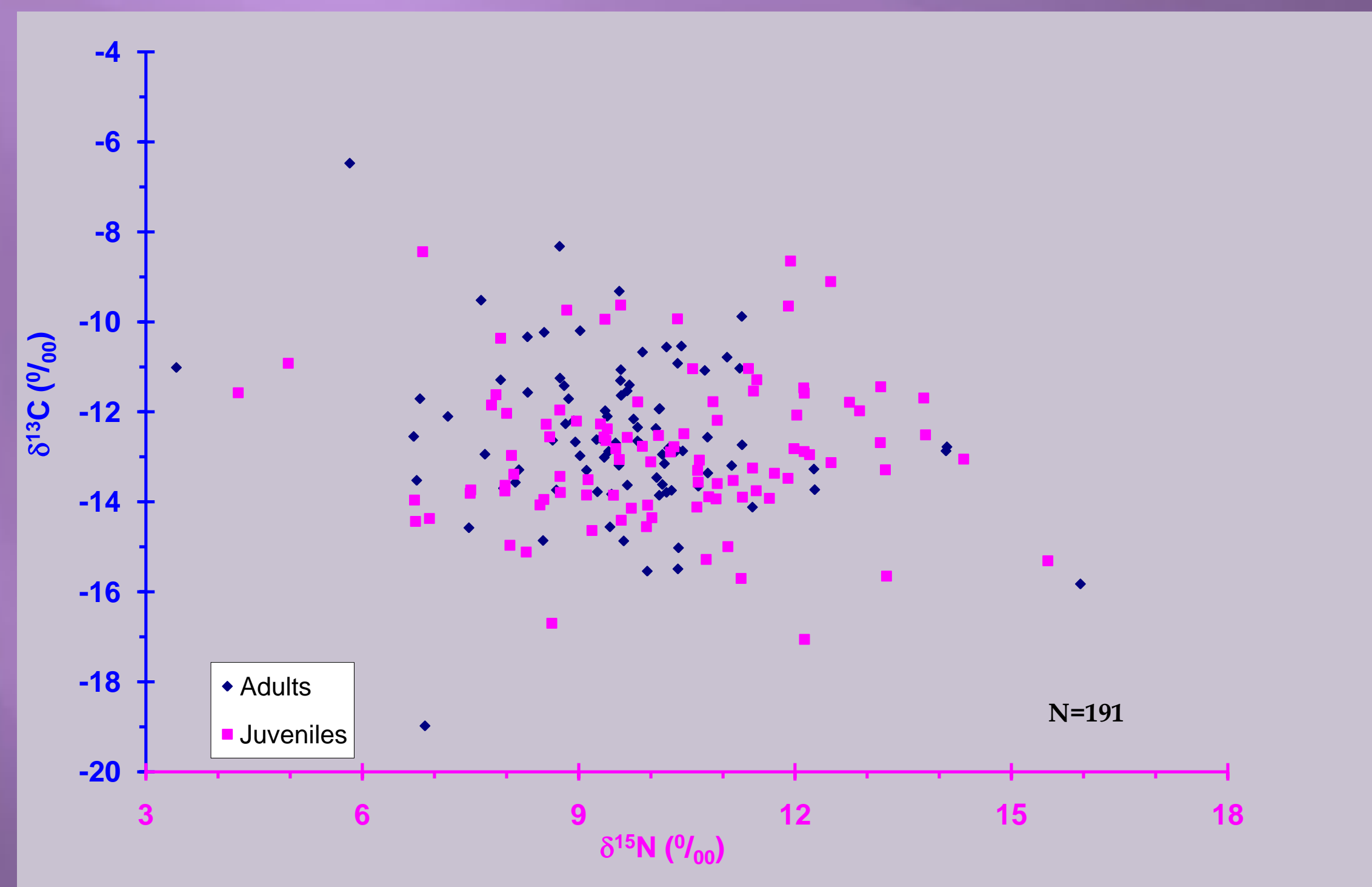


Figure 2. Stable Isotope ratios of Hawaiian monk seal bones.

**Background:** The unique formation and location of the Hawaiian Islands makes it a specialized ecosystem, and the Hawaiian monk seal is one of the few animals that rely entirely on the habitats of this island chain, along with the waters that surround it for habitat, food, and protection. The monk seal population is scattered throughout a number of small islands that spread over thirteen hundred nautical miles, with the largest population found at French Frigate Shoals. For this project we broke the NWHI into three distinct ranges. The northern NWHI range from 30°N, 180°W to 27°N, 175°W, and include the atolls of Midway, Kure, and Pearl and Hermes. The mid NWHI range from 27°N, 175°W to 25°N, 167°W and include the islands of Laysan, Lisianski, and Gardner's Pinnacles. The southern NWHI extend from 25°N, 167°W to 23°N, 161°W and include the islands of French Frigate Shoals, Necker and Nihoa (Figure 1). Commercial fishing did not become a prevalent force in the NWHI until after WWII, with a large increase in the pounds of fish caught throughout the 1980's and 1990's.

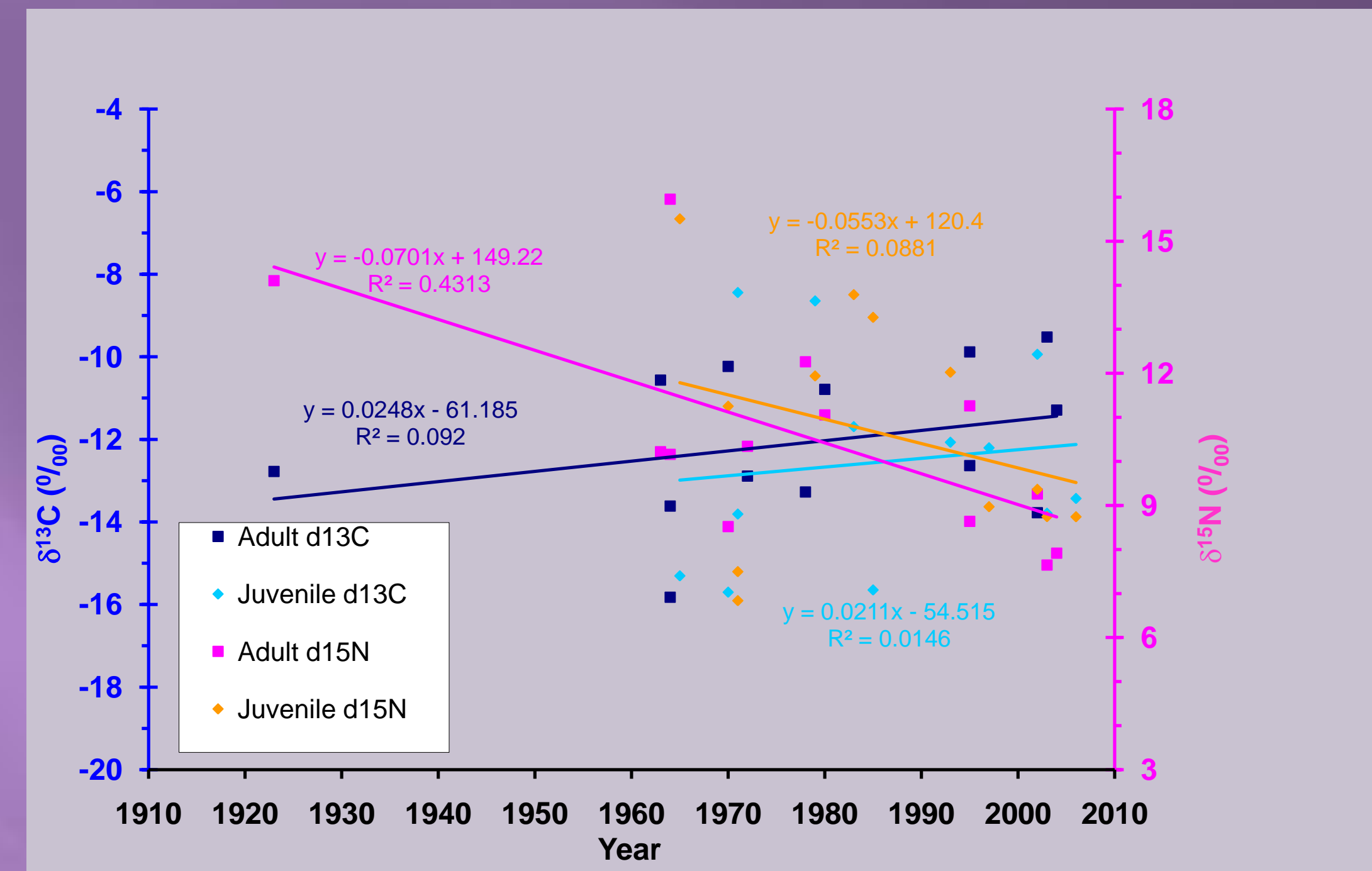


Figure 3.  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  of adult and juvenile monk seals in the northern islands of the NWHI.

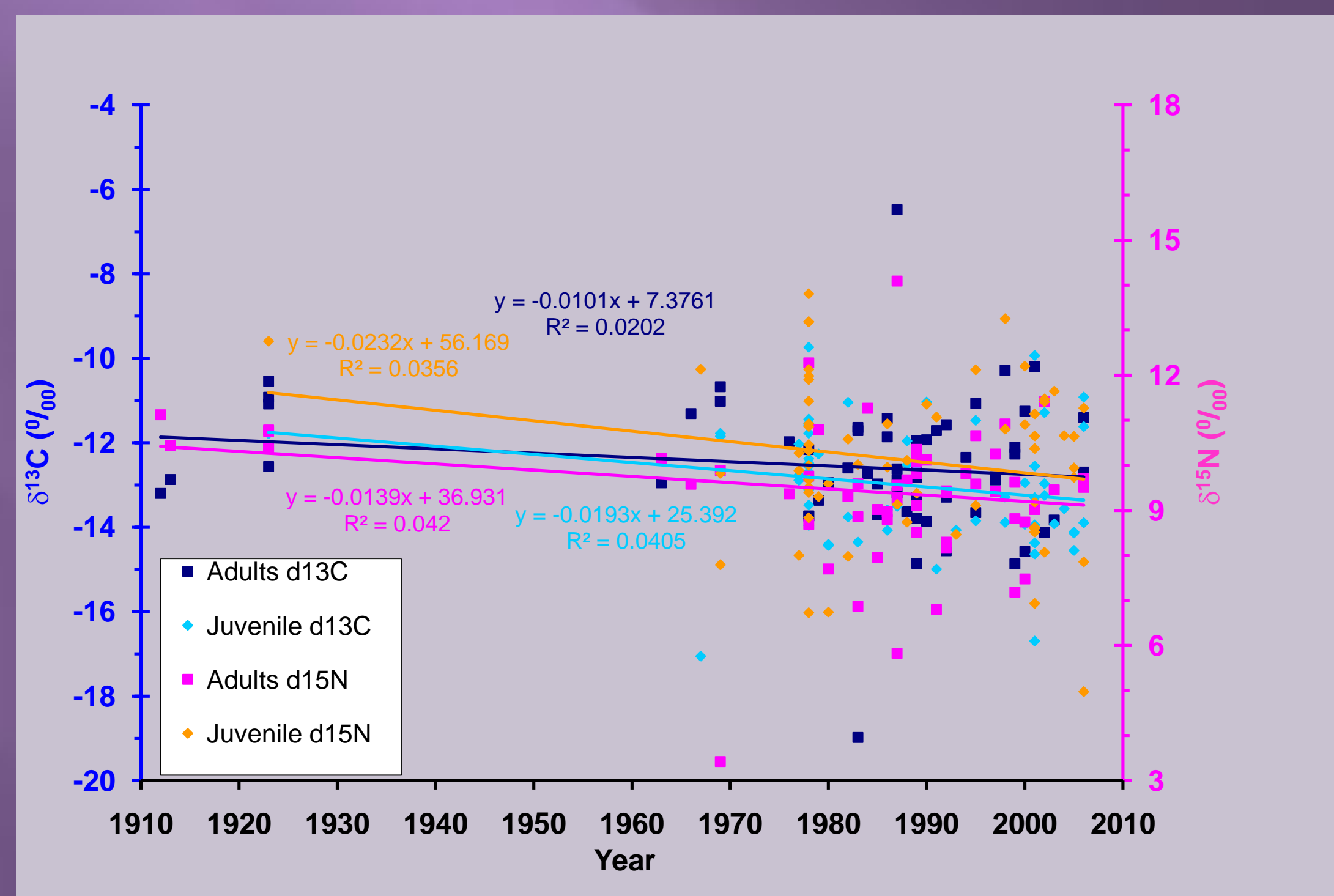


Figure 4.  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  of adult and juvenile monk seals in the mid islands of the NWHI.

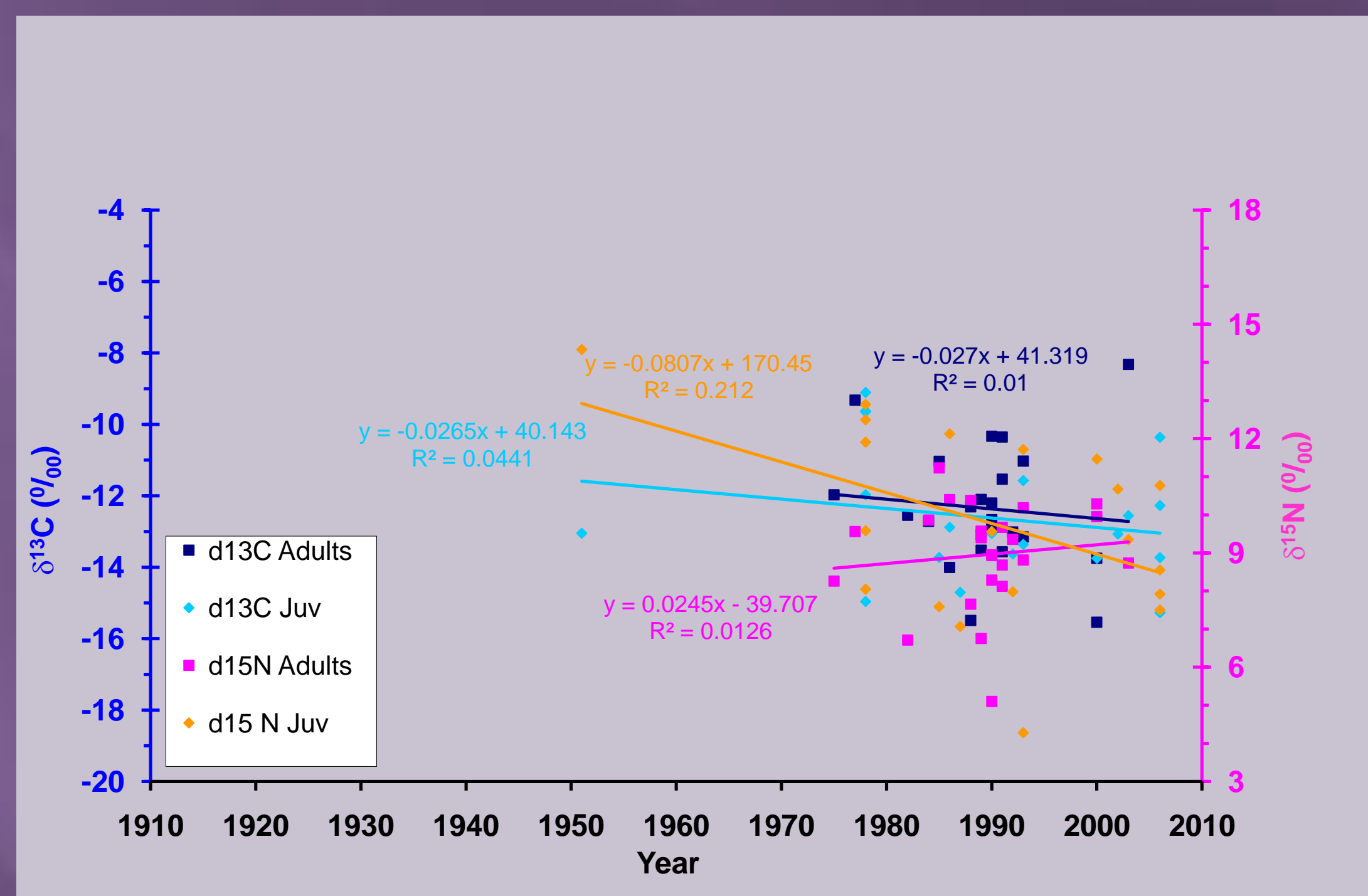


Figure 5.  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  of adult and juvenile monk seals in the southern islands of the NWHI.

**Acknowledgements:** Hawaiian monk seal bone samples and prey items were provided by NOAA's Pacific Island Fisheries Science Center, Hawaii, the National Marine Mammal Laboratory, Seattle, Washington, and the National Museum of Natural History, Smithsonian Institution, Washington, DC. Stable isotope analyses were conducted by Christine France from the Smithsonian Institution. This research was authorized under US Marine Mammal Protection Act Permit 764-1703-01, issued by the National Marine Fisheries Service. Fisheries statistics were provided by Reginald Kokubun, Div. Aquatic Resources, State of Hawaii. Funding was provided by the Southeast Florida chapter of The Explorers Club and the Society for Marine Mammalogy.

**Materials and Methods:** Bone collagen was extracted from 191 Hawaiian monk seals (96 adults and 95 juveniles/subadults) and analyzed for  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . Sample years ranged from 1912 to 2006. Gender distinction was often unrecorded for the samples. Bone collagen was corrected for fractionation differences to the seals' muscle, representative of a whole organism, of -0.3ppt  $\delta^{13}\text{C}$  and +0.3ppt  $\delta^{15}\text{N}$ . More than 350 potential prey samples (vertebrates and invertebrates) are being analyzed for  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  and the first 80 results are presented in Figure 6. All potential prey items were homogenized whole individuals collected from 1998 to 2004. All stable isotope values are reported relative to Pee Dee Belemnite (PDB) (carbon) and atmospheric (nitrogen) as:  $\delta$  (‰) =  $[(R_{\text{sample}} / R_{\text{standard}}) - 1] \times 1000$

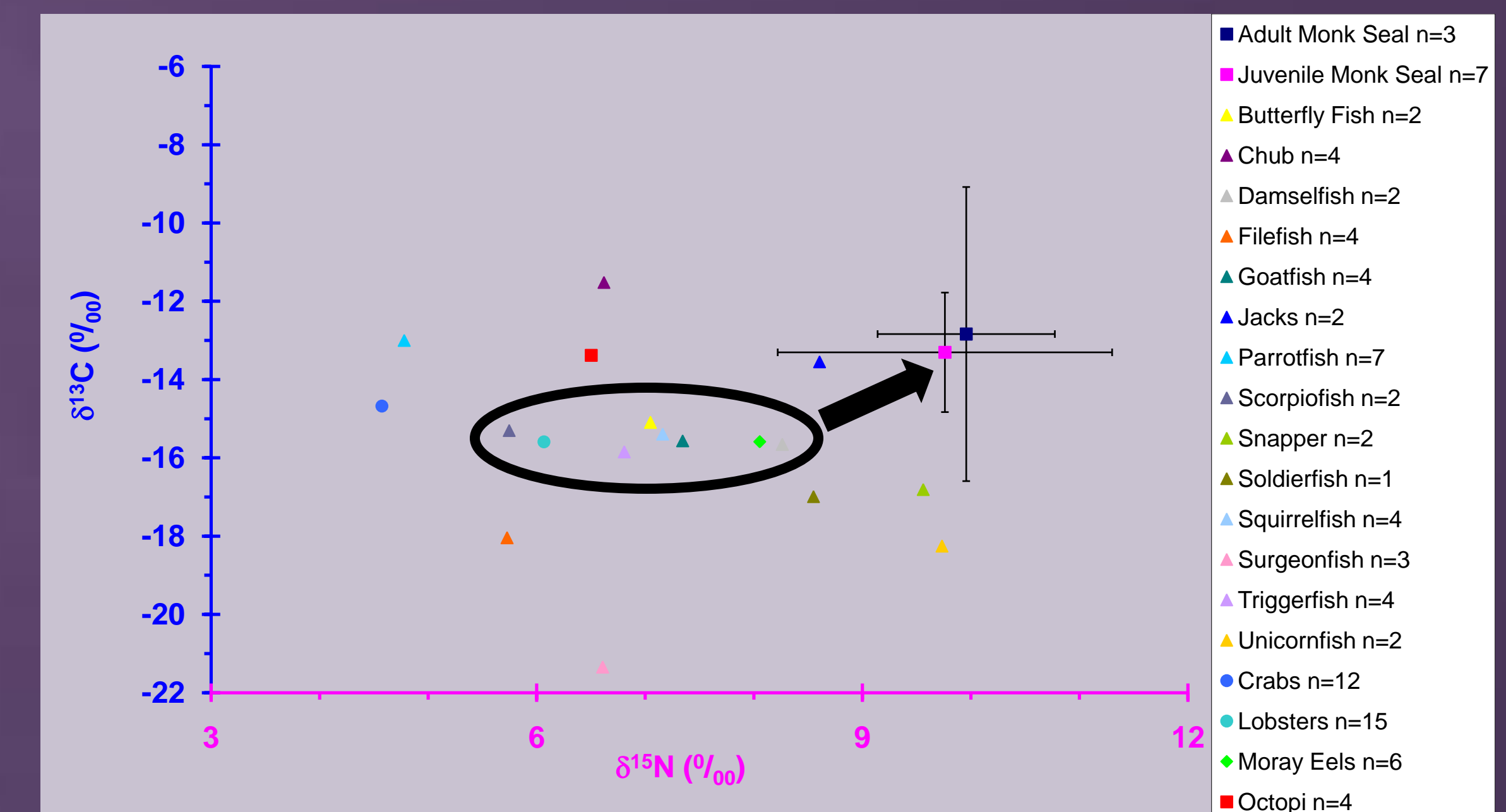


Figure 6. Average  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  of modern monk seals and potential prey species in the southern NWHI. Bone collagen was corrected for fractionation to muscle.

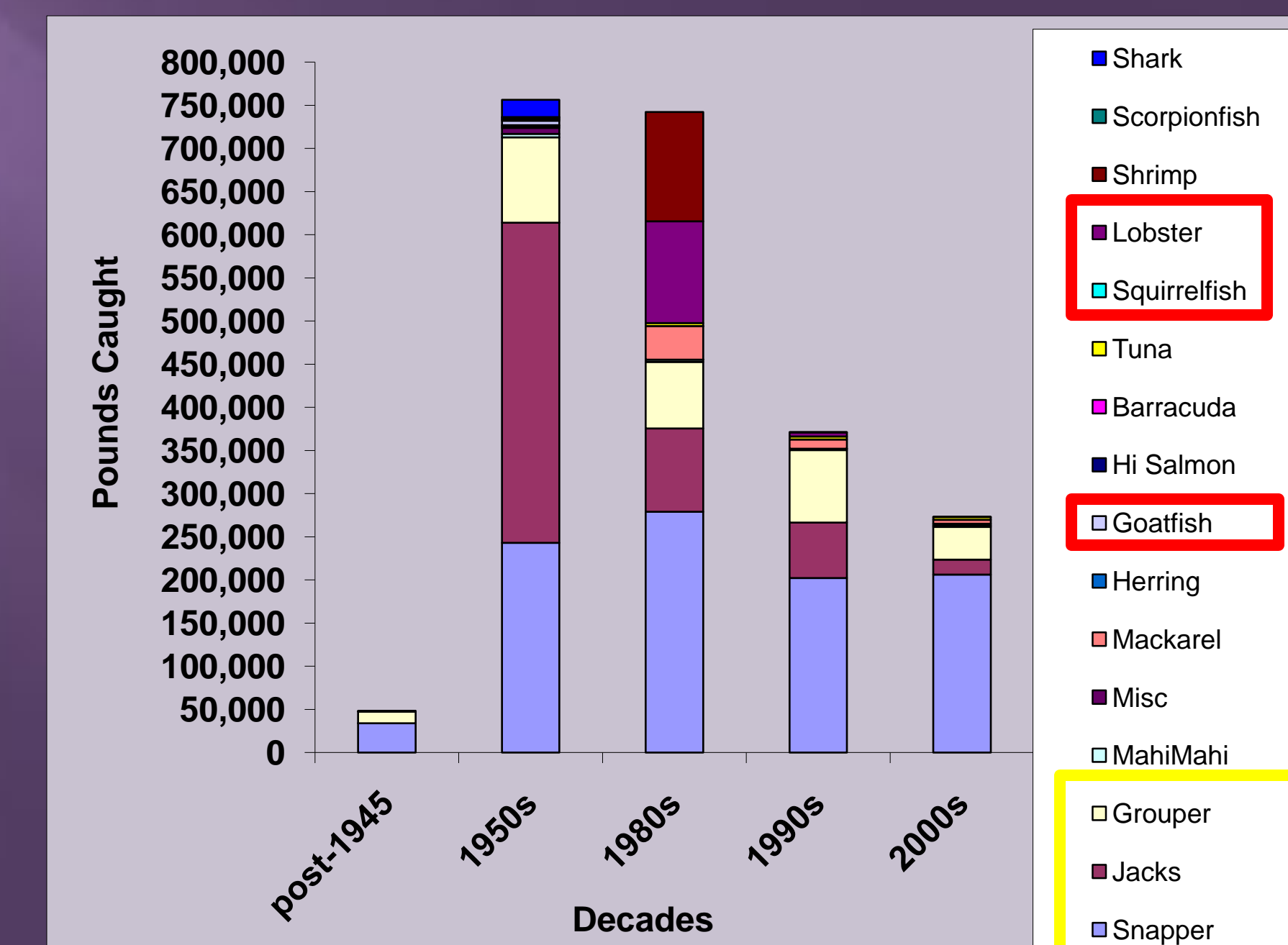


Figure 7. Fisheries data of primary target species per decade. No accurate pounds caught were recorded for the 1960's and 1970's.

	post-1945	1950s	1980s	1990s	2000s
Snapper	34,027	242,879	278,879	202,241	206,204
Jacks	35.05	370,924	96,530	64,158	17,195
Grouper	13,604	99,103	77,105	83,956	38,090
Mahi Mahi	99	3,831	2,663	1,581	1,512
Mackarel	0	1,756	38,724	10,730	4,509
Goatfish	0	5,061	0	0	0
Sharks	0	19,976	0	0	0
Tunas	0	1,878	3,637	3,473	3,095
Squirrelfish	0	125	0	0	0
Lobster	0	0	117,646	4,746	0
Shrimp	0	0	126,736	0	0
Scorpionfish	0	0	0	339	403

Table 1. Pounds of fish caught per decade of the most commercially fished species.

**Results/Discussion:** The overall carbon has a mean and standard deviation of  $-12.5 \pm 1.7$ ‰ for adults and  $-12.9 \pm 1.6$ ‰ for juveniles, with no significant difference between age classes ( $p$ -value 0.156). The nitrogen has a mean and standard deviation of  $9.6 \pm 1.7$ ‰ for adults and  $10.2 \pm 2.0$ ‰ for juveniles, with a significant difference between age classes ( $p$ -value 0.030). Adult and juvenile seals in the northern NWHI were enriched by 1.5‰ and 1‰ in  $\delta^{13}\text{C}$ , respectively, and depleted by 5.5‰ and 2.8‰ in  $\delta^{15}\text{N}$ , respectively over the 96 year period (Fig. 3). Adult seals in the middle and southern locations showed negligible depletion in  $\delta^{13}\text{C}$ , 1.2‰ depletion in  $\delta^{15}\text{N}$  in the mid and 1.7‰ enrichment in  $\delta^{15}\text{N}$  in the south. Juvenile seals in the middle and southern locations showed 1.3‰ and 1.2‰ depletion in  $\delta^{13}\text{C}$ , respectively, while  $\delta^{15}\text{N}$  in both regions were depleted at 1.4‰ and 4.4‰, respectively (Fig. 4 and 5). The northern NWHI may be becoming more productive, which would explain the inverse relationship between  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . Preliminary  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  results indicate reliance on small reef fish, eels, and lobsters (Fig. 6). Current data does not support a negative trophic impact to the seals due to commercial fishing (Fig. 7, Table 1).