Fatty acid signature profiles of harbor seals and prey species determined by flame ionization detection (FID) for samples collected in the San Juan Islands of Washington State in 2007-2008 (Seal_response_to_prey project)

Website: https://www.bco-dmo.org/dataset/3799
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Project
» Responses of Seals and Sea Lions to Increased Rockfish Density (Seal_response_to_prey)

Contributors	Affiliation	Role
Acevedo-Gutierrez, Alejandro	Western Washington University (WWU)	Lead Principal Investigator
Bromaghin, Jeffrey F	United States Geological Survey (USGS)	Co-Principal Investigator
Jeffries, Steven J	Washington Department of Fish and Wildlife	Co-Principal Investigator
Kennish, John M	University of Alaska, Anchorage (UAA)	Co-Principal Investigator
Lance, Monique M	Washington Department of Fish and Wildlife	Co-Principal Investigator
Levin, Philip S.	National Marine Fisheries Service (NMFS)	Co-Principal Investigator
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

Dataset Description

Fatty acid signatures reported as raw flame ionization detection (FID) values for tissue samples from harbor seals and their prey species in the San Juan Islands of Washington State. Samples were collected from 2007 to 2008 and analyzed at the Applied Sciences, Engineering, and Technology (ASET) Laboratory at the University of Alaska, Anchorage. Refer to the calculated limits of detection (PDF) for these compounds.

Data and methods are further described in:

Bromaghin, J. F., Lance, M. M., Elliot, E. W., Jeffries, S. J., Acevedo-Gutierrez, A. & Kennish, J. M. 2013. New insights into the diets of harbor seals in the Salish Sea of western North America revealed by quantitative fatty acid signature analysis. Fishery Bulletin 111: 13-26.

Methods & Sampling

Methods below are from Bromaghin et al. (2013):

Seal samples

From 2007 to 2008, harbor seals were captured at 3 sites in the San Juan Islands of Washington State (Padilla Bay, Vendovi Island, and Bird Rocks), and at a fourth site in the adjacent Gulf Islands of British Columbia (Belle Chain Islets). Seals were captured in salmon landing nets, restrained, and processed following Jeffries et al. (1993). The left side of the pelvic region was shaved with a razor, rinsed with isopropyl alcohol, scrubbed with Betadine, and again rinsed with isopropyl alcohol. A complete cross-section of blubber from skin to muscle was collected with a sterile 6-mm biopsy punch. The biopsy site was then filled with antiseptic cream and left open to drain. Samples were placed immediately in chloroform with 0.01% butylated hydroxytoluene in glass vials with Teflon lids, placed on ice while in the field, and subsequently stored frozen at –80 degrees C until analysis.

Prey samples
Fish and cephalopod species that are known to be consumed by harbor seals were sampled. Some adult salmon samples were obtained from seafood processors and staff of the NOAA Northwest Fisheries Science Center (NWFSC). The lab ID numbers of the NWFSC samples begin with "SOW" (sockeye), "PKW" (pink), and "03AC" (blackmouth chinook). Other prey were captured throughout the study area between June and December of 2008 using a variety of gear (including hook and line, longline, and trawl). Samples were obtained from the following species: black (*Sebastes melanops*), yellowtail (*S. flavidus*), copper, and Puget Sound (*S. emphaeus*) rockfish; Chinook, chum (*Oncorhynchus keta*), coho (*O. kisutch*), sockeye (*O. nerka*), and pink (*O. gorbuscha*) salmon; Pacific herring, walleye pollock; Pacific sand lance (*Ammodytes hexapterus*); northern anchovy (*Engraulis mordax*); shiner perch (*Cymatogaster aggregata*); plainfin midshipman (*Porichthys notatus*); spiny dogfish (*Squalus acanthias*); opalescent inshore squid (*Loligo opalescens*); kelp greenling (*Hexagrammos decagrammus*); Pacific staghorn sculpin (*Leptocottus armatus*); and starry flounder (*Platichthys stellatus*). Prey samples were placed in airtight plastic bags and stored at -80 degrees C.

In the lab, specimens were given unique ID numbers, partially thawed, weighed and measured, and homogenized with a mechanical blender. The smallest speicmens were homogenized with a mortar and pestle. Stomach contents were not removed from prey specimens, to mimic ingestion by predators. Samples of 5-10 g of homogenate were placed in scintillation vials and stored in a -80 degree C freezer, then shipped on dry ice to the Applied Sciences, Engineering, and Technology (ASET) Laboratory at the University of Alaska, Anchorage.

Fatty acid extraction
All samples were processed at ASET through the use of a Dionex ASE 200 automated solvent extraction system (Thermo Fisher Scientific, Waltham, Massachusetts). The total body mass, percent fat composition, and fat mass of prey specimens were obtained. Total mass data were not available for mature Chinook, sockeye, and pink salmon obtained from the Northwest Fisheries Science Center; therefore, an approximate mean mass for these prey classes (e.g., Quinn, 2005) was used in calculation of fat mass.

Extracted lipids were dissolved in hexane to a concentration of 100 mg/mL, hydrolyzed by a base-catalyzed reaction with potassium hydroxide, and then esterified to form fatty acid methyl esters (FAMEs) by reaction with boron trifluoride in methanol. Each sample was spiked with a C21:0 internal standard (25 ug/mL) and separated on a Hewlett-Packard 5890 gas chromatograph (GC) with flame ionization detector (FID) (Hewlett-Packard Co., Palo Alto, California), using a 60-m J&W DB-23 column (Agilent Technologies, Inc., Santa Clara, California) with a 0.25-mm inside diameter and 0.25-um cyanopropyl polysiloxane film. Signal data were collected and analyzed with Agilent GC Chemstation software.

Supelco 37-Component FAME Mix (Catalog No. 47885-U; Sigma-Aldrich Co., St. Louis, Missouri) was used as a continuing calibration verification (CCV) to verify both the retention times and recovery values. This CCV also contained 25 ug/mL of a C21:0 internal standard, which is required to meet a tolerance of no greater than +/- 20% of actual value. Analyte identity was verified further by mass spectrometry through the use of a Varian CP3800 GC (Agilent Technologies, Inc.) with a Varian Saturn 2200 ion trap mass spectrometer with a scan range of 50–400 mass-to-charge ratios (m/z). Additionally, a National Institute of Standards and Technology 1946 international standard was used to externally verify the method and the quality of recoveries.

(See ASET's Fatty Acid Methyl Ester(FAME) Analysis SOP, also available on the ASET website for more on their methodologies.)

Data Processing Description

Quality Control: Rather than normalize each sample's peak data to C18:0, ASET adds an internal standard to all samples, method blanks, and CCVs. This protocol is beneficial because it provides a data point of known quantity to each resulting set, including blanks, allowing the significance of low-recovery peak data to be verified. In addition, because normalization to a recovered compound incorrectly assumes that all compounds

respond equally in the FID, use of an internal standard avoids errors that might otherwise result from that assumption (Dodds et al., 2005). ASET also verifies each peak's identity by GC mass spectrometer (GC-MS), which is necessary to eliminate misclassification of non-fatty acid byproducts from the derivatization process. ASET also performs periodic standard calibrations at varying levels of concentration to determine the instrument's limit-of-detection for each compound.

Determination of Limit of Detection (LOD): The LOD is determined for each compound prior to analysis of the unknown samples. The LOD is calculated from the calibration curves. Refer to the calculated limits of detection (PDF) for these data. See ASET's Fatty Acid Methyl Ester(FAME) Analysis SOP for more on how LODs are calculated.

Processing Notes: A correction factor of 0.3529 has been applied to compounds C22.5w3, C22.5w6 and C21.5w3. A correction factor of 0.5779 has been applied to compounds C22.4w6 and C22.4w3.

BCO-DMO made the following modifications to the dataset:
- Replaced blanks and 'n/a' with 'nd' to indicate 'no data';
- Modified parameter names to conform with BCO-DMO conventions;
- Replaced spaces with underscores;
- Merged data from separate spreadsheets (1 for each species) into a single master dataset;
- Transposed fatty acids from columns to rows.

[table of contents | back to top]

Data Files

File
seal_and_prey_fatty_acids.csv (Comma Separated Values (.csv), 3.00 MB) MD5:74e4e7df8d8652cec30c8947a158a810 Primary data file for dataset ID 3799

[table of contents | back to top]

Parameters

Parameter	Description	Units
taxon	Name of the species, and its size/age in some cases.	text
sample	Consecutive sample ID number.	unitless
lab_id	Sample ID number used by the lab.	unitless
date	Date the sample was obtained.	mm/dd/yy
day	2-digit day of month.	dd (01 to 31)
month	2-digit month of year.	mm (01 to 12)
year	4-digit year.	YYYY
weight	Weight of partially thawed fish specimen.	grams
weight_kg	Weight of seal.	kilograms
len_std	Standard length of partially thawed fish specimen.	millimeters
len_fork	Fork length of partially thawed fish specimen.	millimeters
len_total	Total length of partially thawed fish specimen.	millimeters
site	Name of the site/source where the specimen was obtained.	text
sex	Sex of the specimen (M = male; F = female).	M or F
prep_method	Method used to homogenize the sample; either a small, medium, or large mechanical blender or a mortar and pestle (m/p).	text
fatty_acid	Designator of the fatty acid compound. For common and scientific names, see Table I in ASET's Fatty Acid Methyl Ester(FAME) Analysis SOP.	unitless
concentration	Concentration in ug per mL hexane. See 'Processing Description' for correction factors that have been applied.	micrograms per liter of hexane

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Gas Chromatograph
Generic Instrument Name	Gas Chromatograph
Dataset-specific Description	Samples were separated on a Hewlett-Packard 5890 gas chromatograph with flame ionization detector (Hewlett-Packard Co., Palo Alto, CA).
Generic Instrument Description	Instrument separating gases, volatile substances, or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay. (from SeaDataNet, BODC)

[table of contents | back to top]

Deployments

ASET_seals_and_prey

Website	https://www.bco-dmo.org/deployment/58898
Platform	Applied Science, Engineering, and Technology Lab
Start Date	2010-02-05
End Date	2010-02-05
Description	Samples from harbor seals and their prey were collected from 2007 to 2008 and analyzed at the Applied Sciences, Engineering, and Technology (ASET) Laboratory at the University of Alaska, Anchorage using flame ionization detection (FID) to produce fatty acid signatures. Part of the project titled "Responses of Seals and Sea Lions to Increased Rockfish Density" (NSF OCE-0550443); Lead PI: Alejandro Acevedo-Gutierrez. ASET Address: Conoco Phillips Integrated Science Building Room 321, 3101 Science Circle, Anchorage Alaska 99508

[table of contents | back to top]

Project Information

Responses of Seals and Sea Lions to Increased Rockfish Density (Seal_response_to_prey)

Website: http://biol.wwu.edu/mbel/?page=research

Coverage: Salish Sea, USA and Canada

From NSF proposal:
This project is a collaborative study of the responses of harbor seals and other mammalian predators to changes in prey density in Puget Sound. The general study approach will involve multi-year field estimates to observe the responses of predators to rockfish density in protected areas, candidate marine reserves, and unprotected sites.

The collaborating investigators will estimate 1) rockfish density using visual and mark and recapture techniques; 2) predator abundance using aerials surveys and dedicated land observations; and 3) predator food consumption using scat to describe diet, tagging of harbor seals to describe individual foraging sites, and population-based and individual bioenergetics models to describe consumption of rockfish. The investigators

will also take into account confounding factors that might explain predator behavior, such as environmental variables and alternative prey, by creating a GIS database from available information from the area. The different field observations and database estimates are explicitly linked through a common hypothesis and coordinated methodologies, and their results will be integrated into a model describing the impact of predation on rockfish populations. The responses of top predators to changes in prey density and their impact on fish populations of interest are unknown. This study will evaluate the effectiveness of MPAs as fish refugia, offer a framework for the management and conservation of marine resources, and provide an exciting opportunity for students to participate in ecological and conservation research.

Hypotheses:
1) Harbor seals and other pinniped species show aggregative responses to changes in prey density. Hence, their abundance will increase with fish density.
2) Harbor seals and other pinniped species show Type 2 or 3 functional responses to changes in prey density. Thus, their consumption rate of a particular prey type follows an asymptotic or sigmoidal curve relative to the prey's density, respectively.
3) Predation by harbor seals and other pinniped species is sufficiently intense that it impedes recovery of depleted fish populations.

Objectives:
1) Quantify the number of harbor seals and other pinniped species in relation to rockfish density and other environmental (confounding) factors.
2) Estimate the consumption rate of harbor seals and other pinniped species in relation to rockfish density and other prey species.
3) Correlatively estimate the influence of predation by harbor seals and other pinniped species on survivorship and population size of rockfish.

Publications resulting from this NSF award:
Bjorland, R. H., Pearson, S. F, Jeffries, S. J, Lance, M. M., Acevedo- Gutiérrez, A. & Ward, E. J. 2015. Stable isotope mixing models elucidate sex and size effects on the diet of a generalist marine predator. Marine Ecology Progress Series 526: 213-225. DOI: 10.3354/meps11230
Bromaghin, J. F., Lance, M. M., Elliott, E. W., Jeffries, S. J., Acevedo-Gutierrez, A. & Kennish, J. M. 2013. New insights into the diets of harbor seals in the Salish Sea of western North America revealed by quantitative fatty acid signature analysis. Fishery Bulletin 111: 13-26. DOI: 10.7755/FB.111.1.2
Buzzell, B.1, Lance, M. & Acevedo-Gutiérrez, A. 2014. Spatial and temporal variation in river otter (Lontra canadensis) diet and predation on rockfish (Genus Sebastes) in the San Juan Islands, Washington. Aquatic Mammals 40: 150- 161. DOI: 10.1578/AM.40.2.2014.150
Howard, S., Lance, M., Jeffries, S. & Acevedo-Gutierrez, A. 2013. Fish consumption by harbor seals (Phoca vitulina) in the San Juan Islands, WA. Fishery Bulletin 111: 27-41. DOI: 10.7755/FB.111.1.3
Lance, M. M., Chang, W.-Y., Jeffries, S. J., Pearson, S. F. & Acevedo-Gutierrez, A. 2012. Harbor seal diet in northern Puget Sound: implications for the recovery of depressed fish stocks. Marine Ecology Progress Series 464:257-271. DOI:10.3354/meps09880
Luxa, K. & Acevedo-Gutierrez, A. 2013. Food habits of harbor seals (*Phoca vitulina*) in two estuaries in the central Salish Sea. Aquatic Mammals 39: 10- 22. DOI: 10.1578/AM.39.1.2013.10
Peterson, S., Lance, M. M., Jeffries, S. J. & Acevedo-Gutierrez, A. 2012. Long distance movements and disjunct spatial use of harbor seals (*Phoca vitulina*) in the inland waters of the Pacific Northwest. PLoS ONE 7: e39046. DOI: 10.1371/journal.pone.0039046
Thomas, AC; Lance, MM; Jeffries, SJ; Miner, BG; Acevedo-Gutierrez, A. 2011. Harbor seal foraging response to a seasonal resource pulse, spawning Pacific herring. Marine Ecology-Progress Series, v.441. p. 225. DOI: 10.3354/meps09370
Ward, EJ; Levin, PS; Lance, MM; Jeffries, SJ; Acevedo-Gutierrez, A. 2012. Integrating diet and movement data to identify hot spots of predation risk and areas of conservation concern for endangered species. Conservation Letters, v.5, p. 37. DOI: 10.1111/j.1755-263X.2011.00210.x
Wilson, K.2, Lance, M., Jeffries, S. & Acevedo-Gutiérrez, A. 2014. Fine-scale variability in harbor seal foraging behavior. PLoS ONE 9: e92838. DOI: 10.1371/journal.pone.0092838.

[table of contents | back to top]

Funding

Funding Source	Award
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[table of contents | back to top]