1. PROJECT INFORMATION

GOA IERP Project Number:	4181-00
Title:	UTL – Surviving the Gauntlet
Overall project duration	1 October 2010 – 30 Sept 2014
Overall project funding	$3,765,811
Report period	1 December 2011 to 1 April 2012
Report submission date	13 April 2012
Lead Author of Report*	Jamal Moss

**Although there may be only one lead author of the report, all PIs and co-PIs of the project, as identified in the approved statement of work and listed below, are responsible for the content of the Semiannual Progress report in terms of completeness and accuracy.*

Principal Investigator(s), Co-Principal Investigators and Recipient Organization(s):

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2. PROJECT OVERVIEW

a. Briefly (4-5 sentences) describe the core purpose of your project, and the underlying need for this research.

The overall goal of our research is identifying and quantifying the major ecosystem processes that regulate recruitment strength of key groundfish species in the Gulf of Alaska (GOA). We concentrate on a functional group of five predatory fish species that are commercially important and account for most of the predatory fish biomass in the GOA. We focus on recruitment success because large swings in the abundance of these species have occurred despite precautionary fishing levels. Their early life begins with an offshore pelagic phase followed by a nearshore settlement phase. Spatial distribution, food preference, and habitat suitability of these two life history phases are poorly known. Fieldwork will define a critical environmental window for these five focal species by examining the gauntlet they endure while crossing from offshore spawning to nearshore settlement areas. We will contrast two regions: the central GOA with a broad shelf dominated by high oceanographic variability and large demersal fish biomass and the

eastern GOA (SEAK) with a narrower shelf, lower demersal biomass, and higher species diversity. Retrospective analysis of biological and environmental variability combined with multispecies stock assessment models will determine the relative influence of environmental parameters and identify processes influencing recruitment. Regional differences will be linked to dietary preference of top level predators to infer causal mechanisms for population trends and influence of climate change on ecosystem structure and diversity.

b. State the specific GOAIERP hypothesis or hypotheses that your project is addressing.

The Gauntlet: The primary determinant of year-class strength for marine groundfishes in the GOA is early life survival. This is regulated in space and time by climate-driven variability in a biophysical gauntlet comprising offshore and nearshore habitat quality, larval and juvenile transport, and settlement into suitable demersal habitat.

GOAIERP hypotheses are posted in SharePoint at: https://agora.afsc.noaa.gov/sites/gisr

c. List the specific objective(s) of your research project.

1.) Quantify, by region, the temporal variability in potential climatic, oceanographic, or biological drivers influencing the early life survival of key groundfish species. Differences between the eastern and central GOA will be examined through retrospective analyses of available spatial datasets. Please refer to the retrospective component progress report for more details.

2.) Determine by region the abundance, distribution, and condition of key groundfish species during their offshore to nearshore pelagic phase through at-sea sampling with concurrent observations of the biophysical environment (i.e. oceanography, prey, competitor, and predator fields). Please refer to the lower trophic level (LTL) and the middle trophic level (MTL) component progress reports for more details on nearshore sampling and the concurrent offshore observations of oceanography, competitor, and prey fields.

3.) Create benthic habitat suitability maps by region through analysis of available bathymetry and substrate data (e.g. slope, grain-size) to characterize the nearshore demersal habitat.

4.) Develop growth curves and consumption rates through laboratory work, which will parameterize simple bioenergetics models that will estimate potential fish growth for rockfish.

5.) Analyze dietary preference and foraging behavior of seabirds and relate diet to prey availability. Please refer to the MTL component progress report for more details on the estimation of total biomass removals by seabirds.

3. PROGRESS SUMMARY

a. Provide a table showing the timeline and milestones for the current reporting period only.

What	*Who*	*Start and end dates*	*Status*
2011 predator diet processing	**Fournier**	December 1 2011 – April 1 2012	In progress

2011 juvenile rockfish diet processing	**Fournier**	December 2011 – March 2012	Complete
Collect ADF&G and NMFS bottom trawl survey samples	**Moss**	December 2011 – February 2012	Complete
Georegistering and digitizing of central GOA bathymetry and sediment data and begin process for southeast Alaska region	**Shotwell, Zimmermann**	December 2011 – April 2012	In progress
Create SOW for habitat post doc position	**Shotwell, Zimmermann, Moss**	December 2011 – April 2012	In progress
2012 UTL survey planning	**Moss**	December 2011 – April 2012	In progress
2012 UTL survey coordination	**Fournier**	December 2011 – April 2012	In progress
Initiate proximate analysis for age-0 target species collected in 2011	**Heintz**	December 2011 – August 2012	In progress
Initiate rockfish physiology lab study	**Heintz**	December 2011 – March 2012	Complete
Initiate rockfish RNA/DNA lab study	**Heintz**	April – June 2012; September – December 2012	In progress
Prepare rockfish samples for genetics analyses	**Fournier**	December 2011 – March 2012	Complete
Analyze 2011 seabird diet data	**Slater**	December 2011– June 2012	In progress
Provide ship-board marine mammal and seabird observations from 2011 fisheries oceanographic surveys	**Slater**	December 2011– June 2012	In progress
Provide 2011 seabird reproductive success data	**Slater**	December 2011– June 2012	In progress

b. Describe report period progress.

Retrospective Analysis (1):
Please refer to retrospective component progress report.

Fisheries Oceanographic Surveys (2):
UTL fisheries oceanographic survey data (fish sampling and cruise activity logs) were checked, proofed, and posted to the GOA Program FTP site. These data are ready to be 'pushed' to the GOA Project *Workspace*. Catch data and age-1 and age-2 focal species specimens from the 2011 NMFS bi-annual bottom trawl survey (GOA) and ADF&G's annual large and small mesh bottom trawl surveys (Central GOA) were received and are being prepared for diet and proximate analysis. These samples will comprise the first year's worth of data in a time series linking energetic condition and body size of age-0 fish to subsequent year classes through energy content and body size, which will eventually be related to interannual patterns of recruitment.

Few age-0 marine fish were captured during summer and fall UTL surveys in 2011, but rockfish and arrowtooth flounder (ATF) comprised the majority of the catch. Age-0 rockfish diets have been processed. Larval rockfish collected in bongo nets were received from NOAA's ECO-FOCI group and combined with their age-0 counterparts collected in surface trawls. These specimens were delivered to UAF for genetic analysis. Age-0 rockfish collected during the GLOBEC Program (2001-2004) and preserved at -80°F are being prepared for diet and proximate analysis. Age-0 ATF diet samples are scheduled for diet processing and proximate analysis during May and June. Salmon were the most abundant predator in surface waters during summer and fall, and diet samples for Chinook, pink, and coho have been processed.

Habitat Suitability (3):
We have completed preliminary bathymetric surfaces of the CGOA and EGOA area. These grids were constructed from historical smooth sheet data sets, which are single-beam or lead-line soundings available from the National Geophysical Data Center (NGDC). While most of these smooth sheets data sets are available as digital files from NGDC, there is a lot of proofing and editing required ensuring that each smooth sheet data set is complete and correct. We used the following six steps to create the grids for both regions:

1.) Georegister each smooth sheet (color digital image of the original paper map) in ArcMap.
2.) Custom datum shift the image from the original datum, such as Valdez or Port Hobron, into proper alignment with NAD83.
3.) Compare the digital soundings file to the NAD83-aligned smooth sheet and shift, if necessary, to also align the digital soundings with NAD83.
4.) Compare the digital soundings to the smooth sheet image for correctness and completeness - in some instances entire smooth sheets were digitized, while others required little or no digitization.
5.) Resolve overlaps of contradictory data sets and combine the depth soundings from each region (94 in the CGOA, 54 in EGOA) into a large file.
6.) Using ArcMap, convert the bathymetric points into a Triangulated Irregular Network (TIN), which is a continuous surface of triangles constructed by using the bathymetric points as vertices for the triangles. This preliminary surface helped identify additional errors and data gaps which we are working towards fixing.

There are additional useful data sets which can be extracted from the smooth sheets. Features such as rocky reefs, kelp, rocks and islets are represented as symbols on the smooth sheets and we are working on digitizing these. Sediments such as gravel, sand and mud are also available on the smooth sheets as verbal notations. We are about 2/3rd complete digitizing these for the CGOA and just started in the EGOA. Eventually we should be able to create sediment surfaces such as percent sand or mean grain size which can be draped over the bathymetric surface.

Seabirds and Marine Mammals (4):
Seabird and marine mammal abundance and distribution data from 2011 fisheries oceanographic surveys was checked and proofed, and is ready to be moved into the *Workspace*.

Seabird Colony (5):
Long-term monitoring work based at St. Lazaria and East Amatuli islands was carried out in 2011 as in previous years by Alaska Maritime National Wildlife Refuge staff. Monitoring data collected during 2011 is currently available and roughly half of the seabird diet samples collected as part of that effort have been processed. Samples for energetic analysis will be processed before the next interim report is due. We anticipate that the remaining diet data will be available by winter 2012. Data produced from telemetry work carried out on rhinoceros auklet adults to determine foraging range and patterns in 2011 is ready for analysis.

Physiology (6):
Numerous attempts were made to collect live age-0 rockfish specimens for wetlab experiments in summer and fall 2011, however, these attempts were successful. Forty rockfish collected as age-0 fish three years ago and reared at the Auke Bay Lab were made available for respirometry experiments. Oxygen consumption over a range of temperatures and swimming speeds is being measured to calculate metabolic rate and swimming activity costs. Parameters obtained from these experiments will be combined with measurements for age-0 fish to create a more comprehensive model for juvenile rockfish.

The larger rockfish utilized for respirometry experiments are also going to be used in a feeding and growth rate experiment over a range of temperatures this spring. This effort will provide data that can be used to develop growth curves and consumption rates across temperatures and will help in estimating potential rockfish growth through bioenergetic models. RNA/DNA measurements will also be made on rockfish to determine instantaneous growth rates. The growth and consumption data from this experiment will be combined with data generated from age-0 rockfish feeding and growth experiments scheduled for fall.

c. Describe preliminary results.

Fisheries Oceanographic Surveys (2):
Age-0 rockfish were not abundant in 2011, which was confirmed by being rarely observed in adult Chinook, coho, or pink salmon diets. Adult salmon diet information from SEAK in 2010 demonstrated that adult salmon readily feed on age-0 rockfish, a year when rockfish catch rates were much higher. Adult salmon sampled in 2011primarily fed upon zooplankton prey. The most abundant prey items by weight were decapods, gammarid amphipods, and limacina helicina. The major prey item in age-0 rockfish diets were calanoid copepods with *Calanus marshallae* comprising the largest percentage by weight relative to other species in the eastern, central and western study regions (Figure 1).

Habitat Suitability (3):
The preliminary bathymetric maps reveal numerous seafloor features in greater detail than previously seen. In the CGOA, the bathymetry clearly defines the boundaries of Portlock Bank and the three sections of Albatross Bank, which dominate the western half of the CGOA. The shape and the continuity of the canyons which divide the banks are greatly clarified. The canyons are sometimes obstructed by curvilinear deposits, some of which are small and diffuse, while others are large and pronounced. We hope to identify these deposits as possible moraines, which are piles of glacially accumulated rock, or as ebb tidal deltas, which are gradual accumulations of finer grain sediments. A notable curvilinear deposit divides Marmot Bay from the Gulf of Alaska and has a curved length of about 55 km, a width of about 3 km, and a height of about 50 m. The Albatross Canyons and Banks are crossed by nearly linear, NE-SW trending features which are probably earthquake faults. In the eastern half of the CGOA are some broad, diffuse curvilinear deposits which extend in a fairly continuous arc of about 150 km and are as far as 75 km offshore. In the EGOA, the bathymetry greatly clarifies Spencer gully and the Cape Ommaney region. A potential earthquake fault is now noticeable running from Yakobi Strat to Lituya Bay. Features in the Fairweather area are also more distinguishable such as the Fairweather Grounds, Toivo Pinnacle, and Alsek Canyon. Additionally, the best (most accurate and detailed) bathymetry is typically from the nearshore area, which is fortunate for our project's focus on successful larval settlement in shallow waters. This high resolution has also aided other projects such as the lower trophic level decisions on mooring placement in Cross Sound.

We have just begun experimenting with developing metrics from the smooth sheet bathymetry, features and sediment data so that we can quantify the nearshore larval settlement areas. This will be important not

only for producing maps of preferred larval settlement, but also for making comparisons between MTL bay study sites. For example, the shoreline can be digitized within a bay and converted into bathymetry data points (on the smooth sheets the shore is defined in terms of location and tidal depth). This process is time-consuming but produces a very valuable product: shoreline length might prove to be a valuable measure of a bay's productivity. Once the shore bathymetry is added to the bay bathymetry, horizontal slices of the bay can be made such that the surface area and volume of the bay's water can be made at any depth. Vertical slices of the bay can also be made such that constrictions within the bay, or the openness of the bay to the Gulf of Alaska, can be made. The area of islands, islets, rocks, kelp patches, rocky reefs, and sediment types can be estimated. The bathymetric representation of the bay can also be linked to the land (USGS topographic maps) so that freshwater inflow points of rivers and streams can be located along with an estimated amount of annual precipitation, which might be an important factor for larval fish.

Seabirds and Marine Mammals (4):
Slightly more tubenoses (albatrosses and fulmars) were observed in the eastern study region than in the western, which are associated with areas of upwelling and convergence. The majority of cormorants were observed in western region, which is likely an artifact of higher proportion of transects over relatively shallow waters as cormorants are not deep divers. Seaducks, a species that has a high fidelity with bays and relatively shallow habitats, were observed on western study region transects. Twice as many gulls and terns were observed in western study region than in the eastern which may be due to a greater availability of nesting habitat in close proximity to foraging areas. Twice as many alcids (murrelets) were seen in eastern study region than is the western which is likely due to more glacial/post-glacial habitat.

Seabird Colony (5):
Seabird diets were slightly more diverse in the eastern study region (St. Lazaria) relative to the western (E Amatuli), with proportionately greater contributions from *Thysanoessa* & *Lysianassidae* in eastern region. Myctophids were equally abundant in diets at both colonies, but jellyfish and squid were only observed in bird diets in the western region. Approximately 70% of puffin bill-loads from East Amatuli contained capelin, lumpsucker, squid, and amphipods; 30% of St. Lazaria auklet bill-loads contained capelin and sandlance, and 50% contained Pacific herring.

Physiology (6):
Activity costs for rockfish are relatively low compared to other marine species due to their sedentary nature. A preliminary analysis on a limited number of specimens showed no difference in energy content between two species of rockfish. Energy did not appear to vary between study region, nearshore locations, or offshore locations. However, age-0 rockfish may have slightly higher energy content than larval counterparts in a given year. Instantaneous growth rate as measured by RNA/DNA ratio showed differences across rockfish species, location, and region. However, most of these differences were related to collections of fish made with the livebox and fasted for 1-3 days.

d. Describe integration activity.

Fisheries Oceanographic Surveys (2):
UTL investigators put forth considerable effort toward preparing topic session talks for the GOA Project PI meeting. Priorities for sample processing and preliminary data analysis were developed through that effort and will be carried out accordingly this spring and summer. UTL investigators will continue to work collaboratively through the topic session group model over the coming months to ensure cross cutting themes are addressed and integration is preserved. The UTL field sampling team has also worked with other trophic-level groups on planning and scheduling 2012 field sampling efforts.

Habitat Suitability (3):

We provided information to Phyllis Stabeno and her group on the bathymetry in Cross Sound area. The bathymetry identified a small hill slightly upstream of their mooring. This hill explained anomalous sideways current measurements that seemed to flow from Cross Sound.

We have also worked closely with Kim Rand, Olav Ormseth, and Alex DeRobertis in the MTL so that we can provide any possible bathymetry, feature and/or sediment information for MTL site selection and field work activities. We have provided geo-referenced and datum shifted smooth sheets, corrected bathymetry and digitized sediment data for MTL research sites, along with instruction in GIS so that the information can be used properly.

Finally, during the PI meeting in March, we discussed the parameters of our final habitat suitability indices and maps with the modeling component. Spatial resolution, nearshore cutoff location (e.g. particular isobaths), and static measurements were key topics of that discussion.

We will continue to coordinate with all the components to inform surveys, sampling, and modeling as the habitat products develop.

Seabirds and Marine Mammals (4):
Density estimates of marine wildlife observed on transects (i.e., between sampling stations) are being derived (using an R-based script) for incorporation within the GOA Project *Workspace*. Also, through this integrative process, distribution and abundance of all species can be temporo-spatially linked with chemical and physical properties of the marine environment recorded during UTL cruises.

Seabird Colony (5):
Standardized protocols were followed at both east and west colonies, and results of this work were prepared by leads to be as consistent as possible. Reproductive success of the three focal seabird species, as well as diet sampling from the same areas was evaluated. A subsample of rhinoceros auklet diets was sent to the Auke Bay lab for lipid content analysis and sex determination. Otherwise, most of the integration occurred between project leads at the two colonies in addition to submitting data to the modeling team during the “push”.

Physiology (6):
After meeting with the modeling group we have identified priorities for physiological analyses in our wetlab studies. We will continue as planned, developing functional responses for growth under different temperatures and rations for rockfish and sablefish. In addition, we will try to develop similar data for Pacific cod, as time and resources allow. For all the target species we will identify critical condition values for fish that have starved to death. These will include length, weight, energy, RNA/DNA and lipid.

e. Describe any concerns you may have about your project’s progress.

We have three primary concerns. The first concern is the lack of age-0 target species captured in 2011 summer and fall surveys. Catches were so low that we may not have enough samples to generate statistically significant results if 2013 proves to be an anomalously low abundance year as well. However, we will conduct a summer surveys in both the eastern and western study regions in 2012. The first priority will be to extend trawling operations further offshore to increase survey coverage and maximize opportunities for age-0 fish collection.

Our second concern is the delay in feeding and growth rate experiments resulting from unsuccessful attempts to capture live specimens in the field and transport them to the laboratory. Assuming that live specimens are collected early next summer, resulting experimental data and model parameterization

would be delayed by 10 or more months. Two survey days on leg 1 (July) are dedicated to live fish capture in 2012 and weekly efforts to collect age-0 rockfish in Sitka Sound during July and August are scheduled to ensure that live specimens will be available for the experiments.

The third concern is centered on telemetry-based work on rhinoceros auklets to identify foraging locations. Less information was obtained than anticipated in this first year of study as retrieval of deployed units proved to be more difficult than expected.

f. Poster and oral presentations at scientific conferences or seminars

1. Oral presentation: (AMSS Keynote, January 2012) The Gulf of Alaska Project: an Integrated Ecosystem Research Program by Jamal Moss, Sarah Hinckley, Russell Hopcroft, and Olav Ormseth

2. Oral presentation: (AMSS GOA, January 2012) Spatio-temporal Analysis of Chlorophyll-Concentrations in the Coastal Gulf of Alaska by Jason Waite and Franz Mueter

3. Oral presentation(s): (GOA Project Annual PI Meeting, March 2012) Topic session presentations
    a. Topic Session 1: Retrospective analyses overview (UTL speakers: Mueter, Waite, Shotwell)
    b. Topic Session 3: Fish distribution and abundance (UTL speakers: Fournier, Moss)
    c. Topic Session 4: Habitat research (UTL speakers: Shotwell)
    d. Topic Session 5: Trophic relationships (UTL speakers: Fournier)
    e. Topic Session 6: Physiological ecology (UTL speakers: Heintz)

4. Poster presentation: (AMSS, January 2012) Gulf of Alaska IERP retrospective Data Project by Franz J. Mueter, Miriam J. Doyle, Jason N. Waite, S. Kalei Shotwell, Kimberly M. Rand, Sarah Hinckley

5. Poster presentation: (AMSS, January 2012) Regional and Seasonal Food habits of Adult Salmon in the Gulf of Alaska and Implications for Mortality of Age-0 Marine Fish by Wyatt Fournier and Jamal Moss

6. Poster presentation: (AMSS, January 2012) The Gulf of Alaska Project Upper Trophic Level: Preliminary Findings from the First Field Season by Jamal Moss, Wyatt Fournier, and Kalei Shotwell

7. Poster presentation: (AMSS, January 2012) The Gulf of Alaska Upper Trophic Level Benthic Habitat Research by S. Kalei Shotwell, Mark Zimmermann, Jane A. Reid, and Nadine Golden

8. Poster presentation: (Western Groundfish Conference, February 2012) "Describing Alaskan Groundfish Habitat Using Smooth Sheets" by Mark Zimmermann, Jane A. Reid and Nadine Golden

g. Education and outreach

Bonita Nelson (UTL education and outreach coordinator) organized tours of the Northwest Explorer for at-risk high school students from the Choice Program in the Juneau Douglas High School.

Bonita Nelson mentored a student in the Southeast Alaska Regional Science Fair titled “Respiration Rate of Swimming Rockfish”.

Bonita Nelson organized a SEAK Regional Science Fair Poster Judging Session held at the Annual PI Meeting.

UTL field survey blog: http://gulfofalaska.nprb.org/program/field.html (UTL cruises are not able to accommodate teachers at sea).

4. PROGRESS STATUS

We have made satisfactory progress in completing all tasks scheduled for the current reporting period with the exception of conducting live age-0 rockfish feeding and growth rate experiments in the laboratory. Survey data from 2011 is ready to be shared with the group and sample processing is proceeding as planned. Preparations for a 2012 summer survey are underway and 2011 and 2010 genetic data for larval and age-0 rockfish should available by fall 2012.

5. FUTURE WORKPLAN and DATA DELIVERY

Workplan

What	*Who*	*Start and end dates*	*Other key dates*
NOAA/UTL summer field survey	**Moss, Fournier**	July 1 – August 23	
Age-0 ATF diet and proximate analysis	**Moss**	May 1 – June 30	
Adult diet salmon processing	**Fournier**	September 1 – November 30	
Complete georegistering and digitizing of central GOA bathymetry and sediment data and begin process for southeast Alaska region	**Zimmermann, Shotwell**	April 1 – completion of product	
Complete SOW for habitat post doc position	**Zimmermann, Shotwell, Moss, Heifetz**	April 1 – June 1	
Begin age-0 rockfish lab experiments	**Heintz**	September 1 – November 30	
'Push' UTL field data into *Workspace*	**Moss**	April 17	
Rockfish genetics processing	**Heifetz**	April 1 – August 30	
Acquire field samples	**Heintz**	September 1 – October 1	
Continue RNA/DNA analysis	**Sreenivasan**	June – July 2012; November – December 2012	

Data delivery

GOAIERP Data Delivery Table		
Data type for delivery	Delivery Month & Year	Person sending data, with email address
2011 field survey data	April 2012	Jamal Moss jamal.moss@noaa.gov

Adult salmon diet data	November 2012	Wyatt Fournier wyatt.fournier@noaa.gov
Age-0 focal species diet data	June 2012	Wyatt Fournier wyatt.fournier@noaa.gov
Tufted puffin diet data	April 2012	Arthur Kettle arthur_kettle@fws.gov
Fork-tailed storm-petrel diet data	September 2012	Leslie Slater leslie_slater@fws.gov
Seabird/marine mammal observational data	May 2012	Leslie Slater leslie_slater@fws.gov
Species Specific Habitat Suitability (SSHA) maps	January 2014	Kalei.Shotwell@noaa.gov

1) 2011 field survey data was posted to the SharePoint FTP site in December 2011. This database will be made available on the *Workspace* on April 17th. Specific survey data to be delivered are:

    - Haul location, timing, weather, and net mensuration
    - Fish species abundance by haul (counts and total weight)
    - Individual lengths and weights for all fish sampled
    - Event log with time and location (GPS) of all sample activities

2) Wyatt Fournier will disseminate fish diet data.
    - Prey composition by prey group weight for adult salmon
    - Prey composition by prey group weight for age-0 marine fish

3) Leslie Slater will disseminate shipboard seabird and marine mammal observational data and seabird colony diet and tag data.
    - Transect line counts (with locations) of seabirds and marine mammals
    - Diet and tag data from colonies

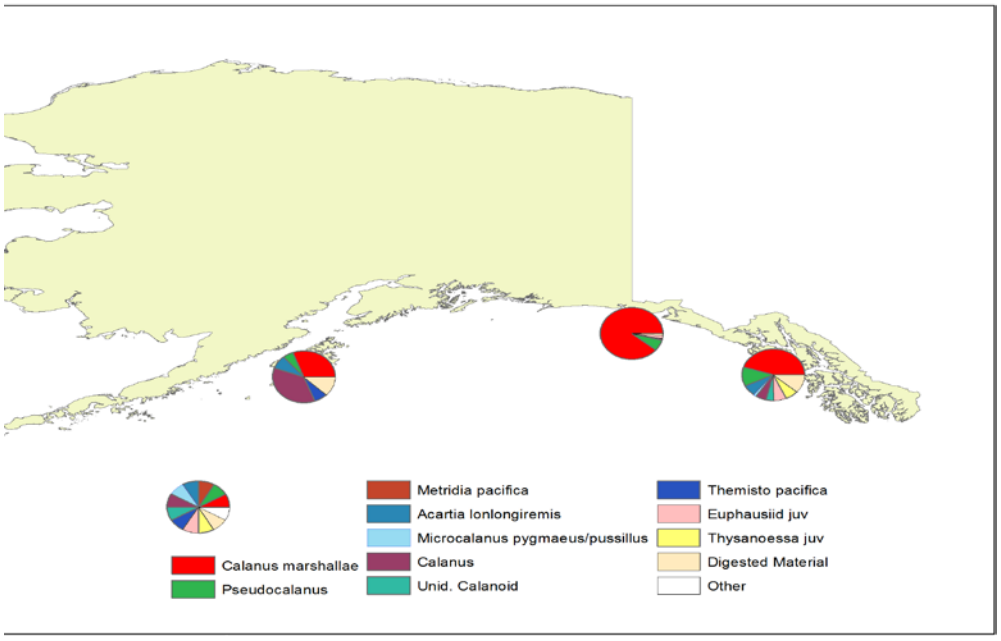

Figure 1. Percent prey composition by weight in age-0 rockfish diets.