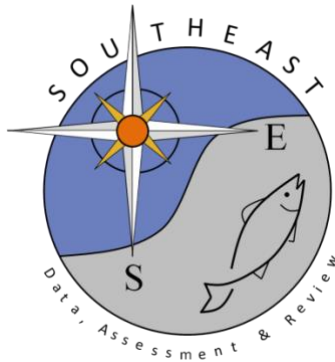


Indices of abundance for Vermilion Snapper (*Rhomboplites aurorubens*)
from the Florida Fish and Wildlife Research Institute (FWRI) vertical
long line survey in the eastern Gulf of Mexico

Heather M. Christiansen, Theodore S. Switzer, and Brent L. Winner

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Indices of abundance for Vermilion Snapper (*Rhomboplites aurorubens*) from the Florida Fish and Wildlife Research Institute (FWRI) vertical long line survey in the eastern Gulf of Mexico

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Introduction:

Reef fishes, including **Vermilion Snapper (*Rhomboplites aurorubens*)**, are targeted commercially and recreationally along the shelf of the eastern Gulf of Mexico off the Florida coastline. Historically, the assessment and management of reef fishes in the Gulf of Mexico has relied heavily on data from fisheries-dependent sources, although limitations and biases inherent to these data are admittedly a major source of uncertainty in current stock assessments. Additionally, commercial, headboat, and recreational landings data are restricted to harvestable-sized fish, and thus are highly influenced by regulatory changes (i.e., size limits, recreational bag limits, and seasonal closures). These limitations render it difficult to forecast potential stock recovery associated with strong year classes entering the fishery. There has been a renewed emphasis in recent years to increase the availability of fisheries-independent data on reef fish populations in the Gulf of Mexico because these data reflect the status of fish populations as a whole, rather than just the portion of the population taken in the fishery. To meet this need for fisheries-independent reef fish data, the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) has been working collaboratively with scientists from the National Marine Fisheries Service (NMFS) to expand regional monitoring capabilities and provide timely fisheries-independent data for a variety of state- and federally-managed reef fishes. Results for Vermilion Snapper are summarized from fisheries-independent reef fish surveys conducted by FWRI throughout the eastern GOM using time-series that vary in space, time, and habitats sampled.

Survey Design and Sampling Methods:

In 2014 and 2015 sampling occurred in the NFMS statistical reporting zones 4, 5, 9, and 10 as part of fisheries-independent surveys conducted by FWRI in the eastern Gulf of Mexico. In 2016 and 2017, the survey area was expanded to include the entire Florida coastline including statistical zones 2-10 (Figure 1). Each year, sampling locations were selected using a stratified-random sampling design with sampling effort proportional to available habitat within each statistical zone and depth stratum (9- 37 m, 38-110 m). An annual summary of sampling effort by year is illustrated in Table 1.

Very little is known regarding the fine-scale distribution of reef habitat throughout much of the eastern GOM, and due to anticipated cost and time requirements, mapping the entire west Florida shelf (WFS) survey area was not feasible prior to initiating the WFS reef fish survey. An adaptive strategy where a three-pass acoustic survey was conducted covering an area of 1 nm to the east and west of the pre-selected sampling unit prior to sampling. Acoustic surveys were conducted using an L3- Klein 3900 side scan sonar. If these acoustic surveys produced evidence of reef habitat in a nearby sampling unit, but not in the pre-selected sampling unit, sampling effort was randomly relocated to the nearby sampling unit. Habitats observed via side-scan sonar were classified as geofoms following the NOAA Coastal and

Marine Ecological Classification Standards (CMECS 2012) geoform and surface geological component classifications. Geoforms identified via side-scan sonar were coded as categorical variables and were included as a potential explanatory variable in the index model. Geoforms were grouped as Artificial or Natural, then Natural geoforms were further classified into potholes, fractures, having relief, or no relief (Table 2).

Protocols established by the Southeast Area Monitoring and Assessment Program (SEAMAP) were followed at stations fished with the vertical longline (VLL) method. Each VLL rig consisted of a 7.3-m monofilament (181 kg test) backbone equipped with 10 evenly spaced (every 0.61 m) crimped t-swivels. A gangion was attached to each t-swivel; consisting of a snap swivel with a length of 45-kg-test monofilament and a single Mustad circle hook attached to each end. A lead weight (4-7 kg), depending on current and sea conditions was attached at the base of the backbone. Two vertical longlines were fished simultaneously at each sampling site, each rigged with 10 hooks of the same size. Two hook sizes, 8/0, 11/0, or 15/0 (Mustad Ref 39960D), were randomly selected at the first station of the day and rotated by hook size throughout the day to ensure equal sampling effort. Hooks were baited with Atlantic Mackerel cut proportional to the hook size and the gear fished passively for five minutes before it was retrieved with a bandit reel. Standard, fork, and total lengths were measured for all captured Vermilion Snapper.

Data Treatment and Standardization:

Standardization of Response Variable:

To create the longest and most consistent possible time series for the VLL index of Vermilion Snapper, only data sampled from 2014-2017 in zones 4, 5, 9, and 10 from 2014-2017 were included. We modeled the total catch at each station as the total number of Vermilion Snapper captured on both hook sizes at a station combined.

Model Selection and Diagnostics:

To model abundance we used a suite of site-specific variables to fit a negative binomial GLM using proc GLIMMIX using SAS Enterprise Guide Software Suite version 7.13 (SAS Institute Inc., <https://www.sas.com>). We considered seven explanatory variables in the original model. Potential variables are listed below:

Year (*Y*) – Year was included since standardized catch rates by year are the objective of the analysis. We modeled data from 2014-2017.

Depth (*D*) – Water depth may be an important component affecting the distribution of reef fish. All depths sampled were included and treated as a categorical variable: Nearshore (9-37 m) or Offshore (38-110 m).

Region (*region*) – Region was included as a categorical variable where samples collected in National Marine Fisheries Service statistical zones 4 and 5 were categorized as Peninsula, while samples collected in zones 9 and 10 were categorized as Panhandle.

Geoform (*Geo*)- The observed geoform from side scan sonar used in site selection for vertical long line sampling. Geoforms were included as a categorical variable and grouped as shown in Table 2.

Small (*sm*)- The size of the hook used may be a limiting factor in whether a fish is captured. Recorded as a binary factor of the presence or absence of 8/0 hooks.

Medium (md)- The size of the hook used may be a limiting factor in whether a fish is captured. Recorded as a binary factor of the presence or absence of 11/0 hooks.

Large (lg)- The size of the hook used may be a limiting factor in whether a fish is captured. Recorded as a binary factor of the presence or absence of 15/0 hooks.

Backwards step-wise model selection and comparisons of AIC values were used to determine the optimal model. The final index model is given by the following equation:

$$Total = Y + sm$$

Results:

The distribution of Vermilion Snapper is presented in Figures A1-A4. In 2014 a total of 41 Vermilion Snapper were captured with 21 captured in 2015, 26 captured in 2016, and 31 captured in 2017. The sizes of Vermilion Snapper ranged from 187 mm to 483 mm fork length (Figure 2).

Annual standardized index values for Vermilion Snapper in the eastern Gulf of Mexico, including coefficients of variation, are presented in Table 3. The standardized index values indicating that there was a decrease from 2014 to 2015 and increasing trend from 2015 to 2017 (Table 3, Figure 3). All CVs indicated a good fit. Due to the relatively short temporal extent of the index, limited inferences can be discerned concerning patterns of overall Vermilion Snapper population abundance.

Literature Cited:

CMECS. 2012. Coastal and Marine Ecological Classification Standard. Marine and Coastal Data Subcommittee, Federal Geographic Data Committee, FGDC-STD-018-2012. url: <https://coast.noaa.gov/digitalcoast/training/cmecs-pub.html>

Table 1. Annual total number of vertical long line (VLL) samples included in the analysis and range of spatial and environmental variables included.

Year	# of VLL samples	Depth Range (m)	Latitude Range	Longitude Range
2014	125	13-97	26.076 – 30.243	-87.435 to -82.750
2015	90	9 - 84	26.021– 30.124	-87.389 to -82.588
2016	96	11-105	26.130 – 30.259	-87.473 to -82.879
2017	70	10-94	26.420 – 30.298	-87.495 to -82.533

Table 2. List of the geoforms used to describe potential reef fish habitats observed using side scan sonar and sampled using vertical long line.

Habitat Type	Geoforms	Habitat Type	Geoforms
<u>Relief</u>	Aggregate Coral Reef Boulder/Boulder Field Fragmented HB Ledge Mixed HB Pinnacle Reef Rubble	<u>Anthropogenic</u>	Artificial Reef Unknown Chicken Coop Construction Materials Large Vessel/Barge Military Tanks Reef Modules Small Vessel Tires
<u>Pothole</u>	Pothole	<u>No Relief</u>	
<u>Fracture</u>	Fracture		Flat HB Pavement

Table 3. Relative nominal total, number of stations sampled (N), proportion of positive sets, standardized index, and coefficient of variation (CV) for FWRI Vermilion Snapper vertical long line survey of the West Florida Shelf, 2014-2017.

Year	Nominal total	N	Proportion positive	Standardized Index	CV
2014	0.33	125	0.19	1.07	0.26
2015	0.23	90	0.17	0.67	0.33
2016	0.27	96	0.14	0.82	0.31
2017	0.44	70	0.20	1.43	0.31

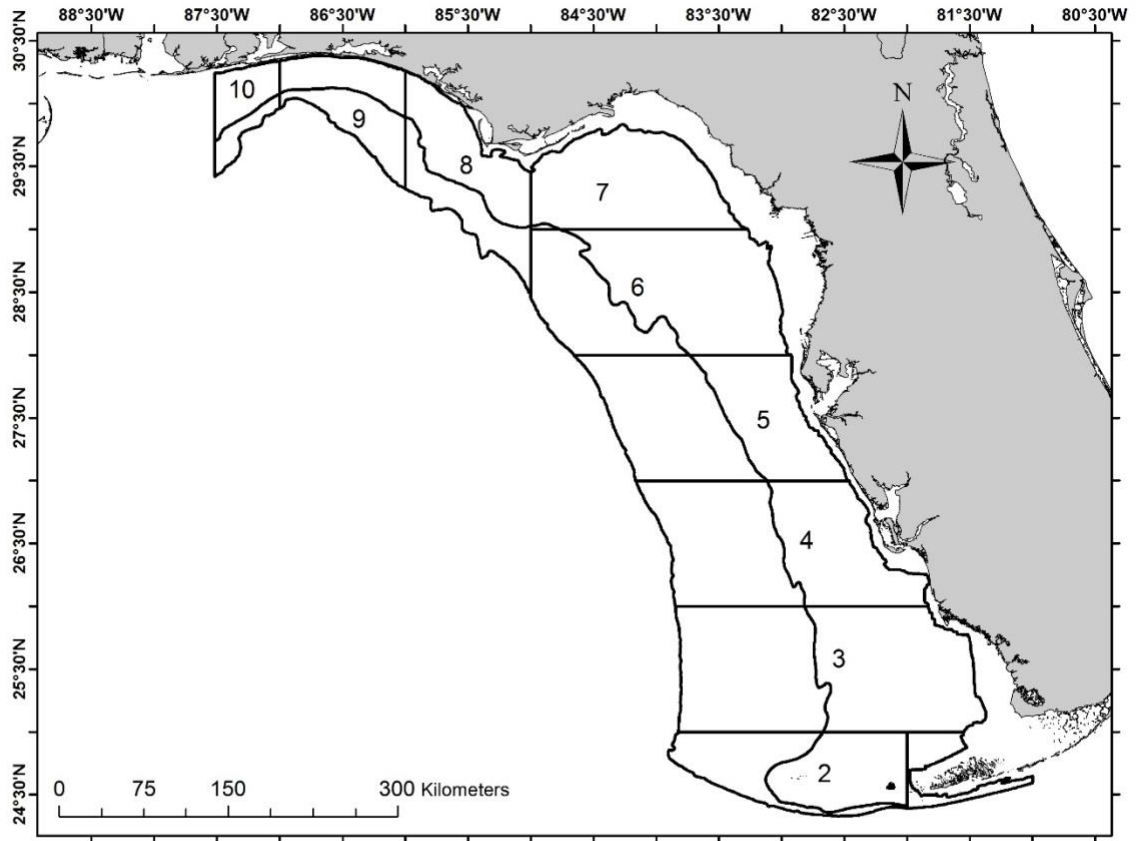


Figure 1. The eastern Gulf of Mexico vertical long line survey area. Sampling effort is allocated among NMFS statistical reporting zones (4, 5, 9, and 10) as well as nearshore (9 – 37 m) and offshore (37 – 110 m) depth strata.

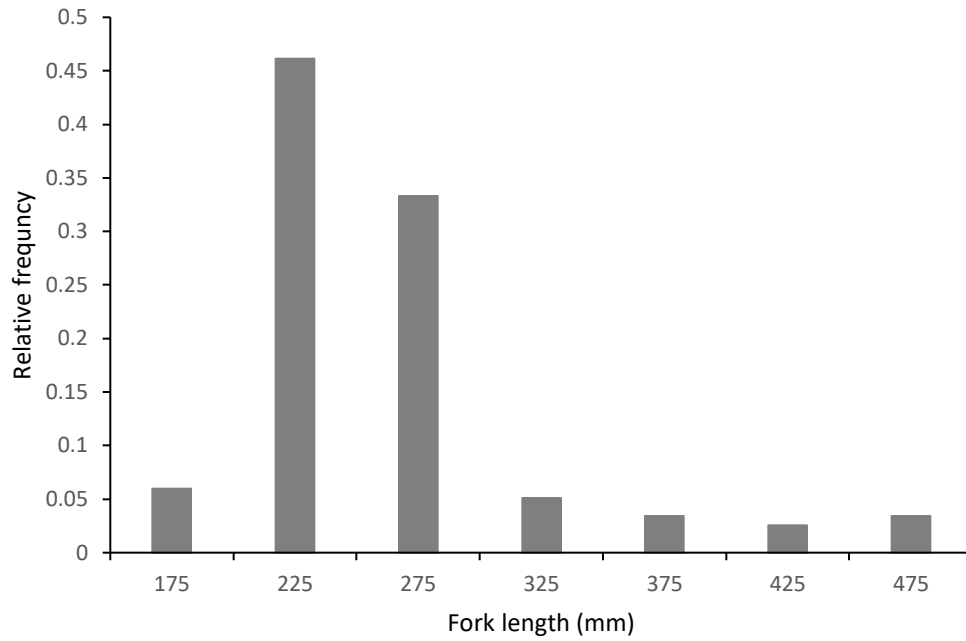


Figure 2. Size frequency distribution for Vermilion Snapper captured in the FWRI vertical long line survey from 2014-2017.

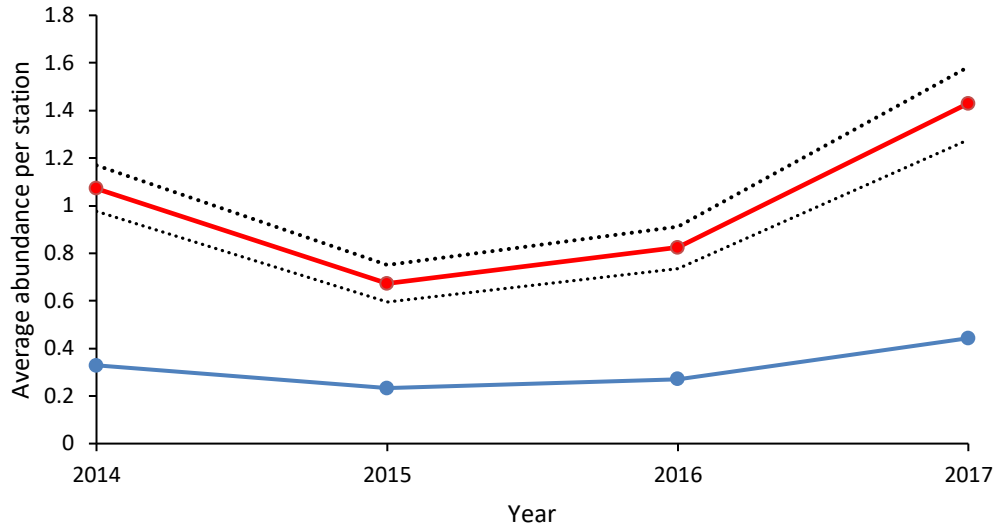


Figure 3. Relative standardized index (solid red line) with 2.5% and 97.5% confidence intervals (black dotted lines) and the nominal CPUE (blue hashed line) for Vermilion Snapper CPUE in the FWRI vertical long line survey.

Appendix A:

Figures A1-A4. Annual distribution of stations sampled (2014 – 2017) during the FWRI vertical long line sampling of reef fish along the West Florida Shelf.

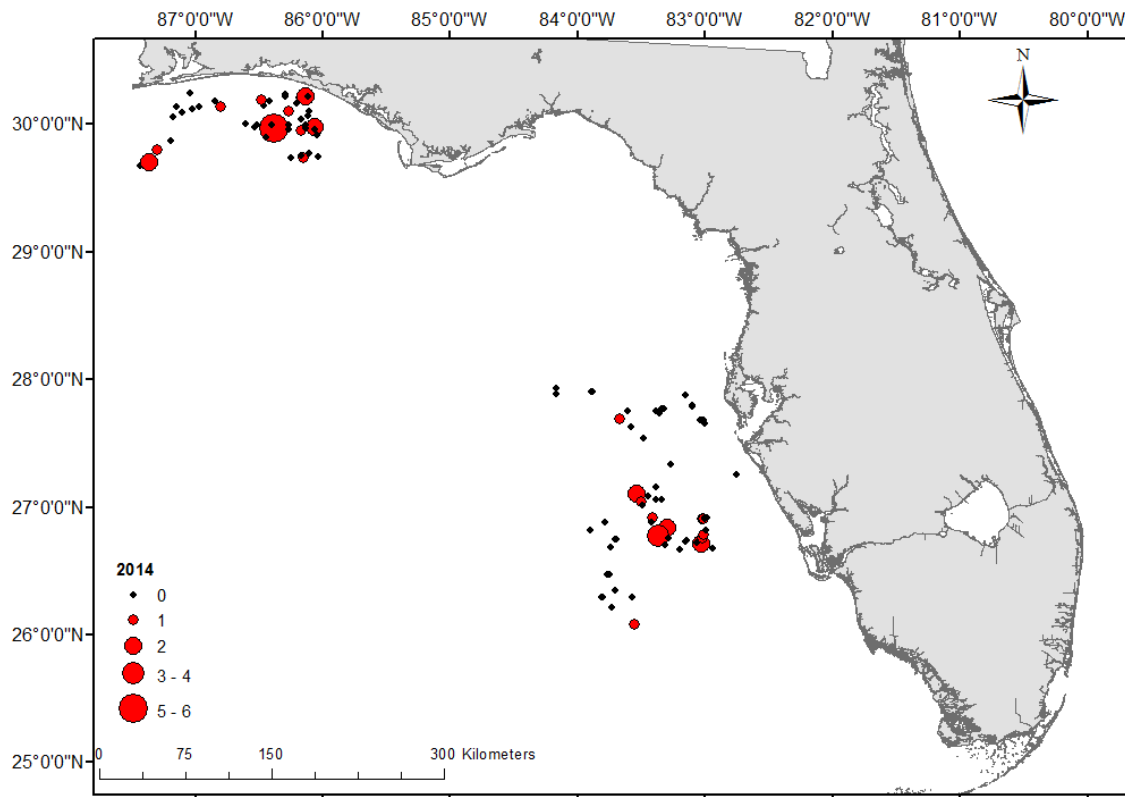


Figure A1. Stations sampled from 2014 during FWRI vertical long line sampling. Symbols represent total abundance of Vermilion Snapper captured at each station.

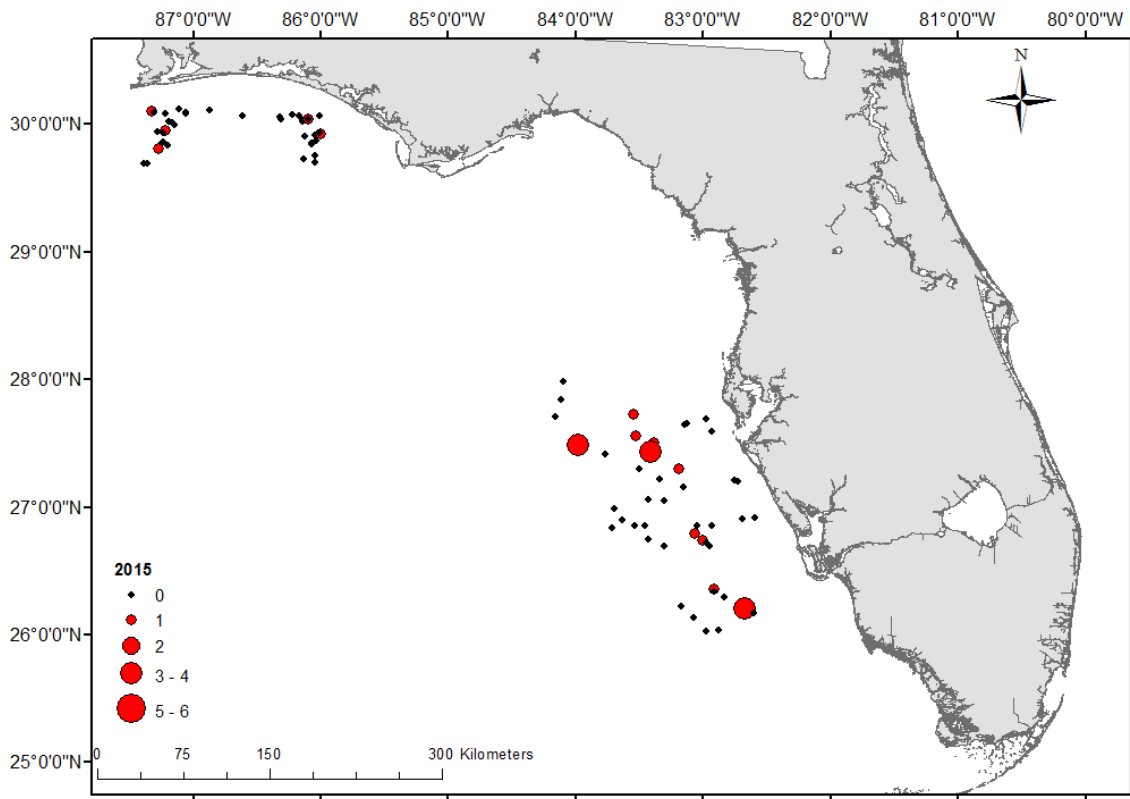


Figure A2. Stations sampled from 2015 during FWRI vertical long line sampling. Symbols represent total abundance of Vermilion Snapper captured at each station.

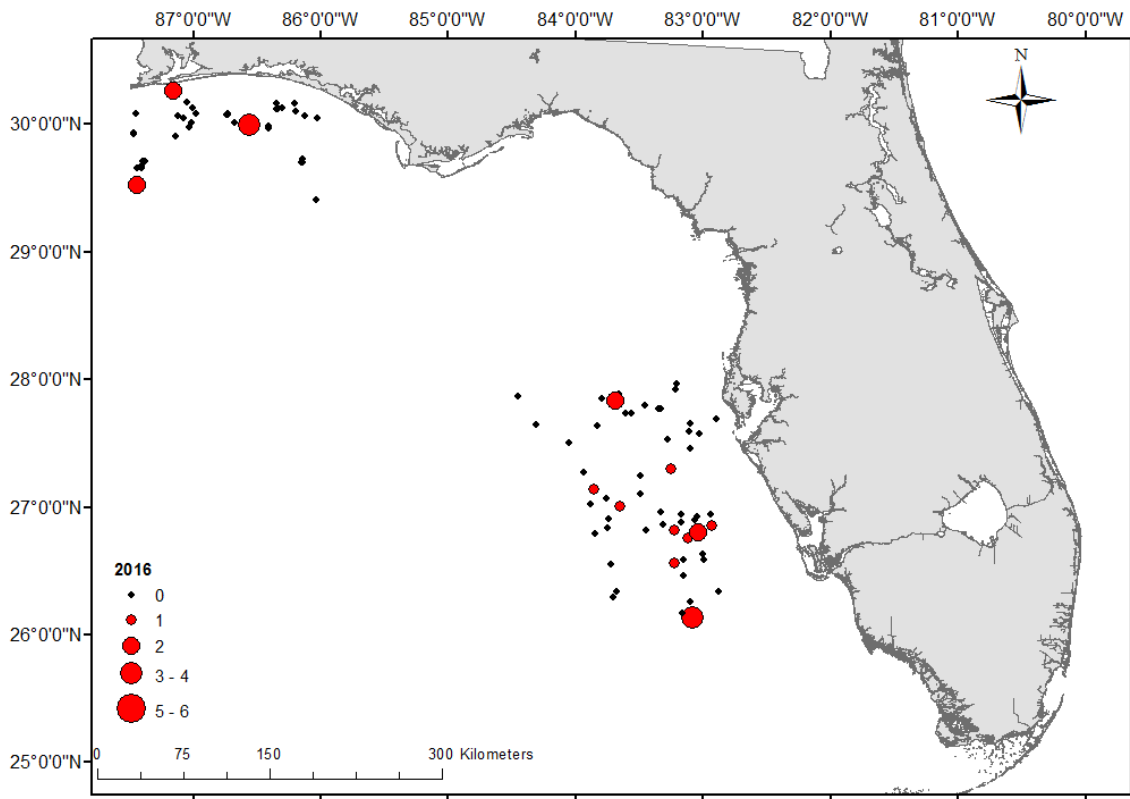


Figure A3. Stations sampled from 2016 during FWRI vertical long line sampling. Symbols represent total abundance of Vermilion Snapper captured at each station.

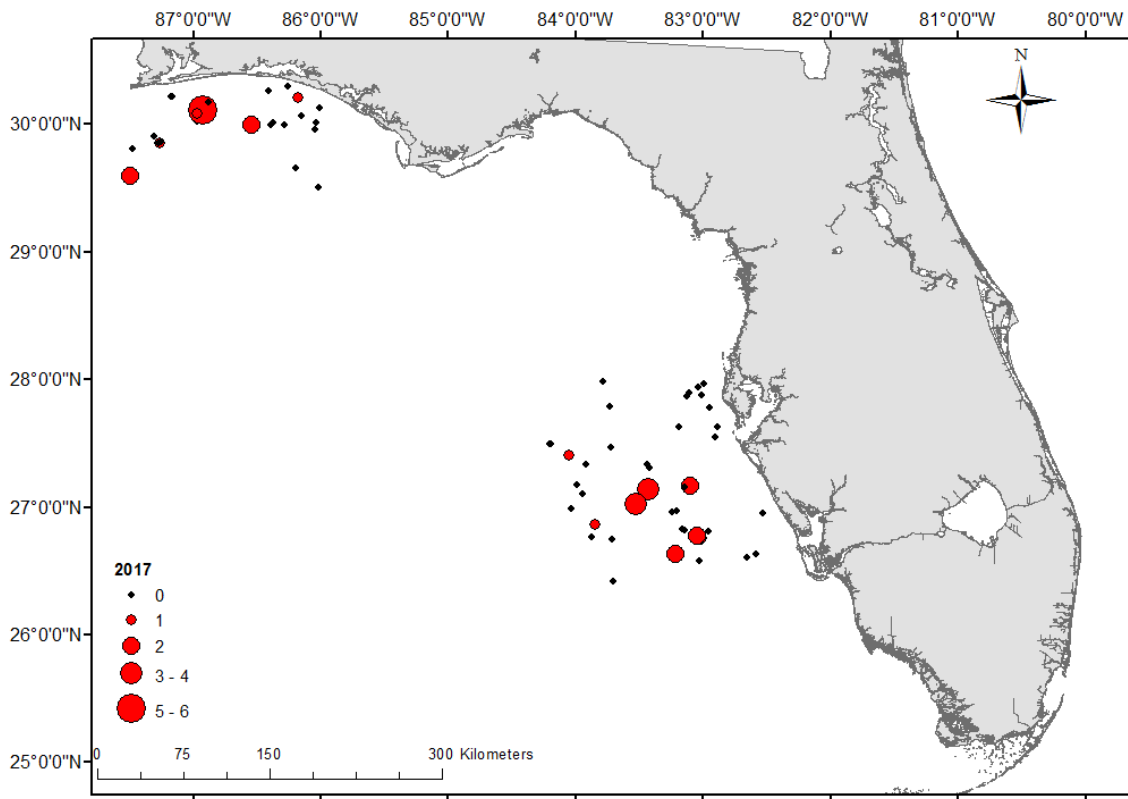


Figure A4. Stations sampled from 2017 during FWRI vertical long line sampling. Symbols represent total abundance of Vermilion Snapper captured at each station.