Indices of abundance for Red Snapper (*Lutjanus campechanus*) on artificial reefs on the West Florida Shelf from stationary video surveys

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Indices of abundance for Red Snapper (*Lutjanus campechanus*) on artificial reefs on the West Florida Shelf from stationary video surveys

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Introduction

The Fish and Wildlife Research Institute (FWRI) began using stereo-baited remote underwater video survey (S-BRUV) to assess trends in reef fish species in 2008 on the West Florida Shelf (WFS) to supplement ongoing NOAA surveys that focused on different habitats or were limited in geographic scope. These initial efforts were focused on natural reefs offshore of Tampa Bay and Charlotte Harbor but funding through the National Fish and Wildlife Fund (NFWF) expanded the survey to cover the entirety of the WFS region from zones 2-10. Part of this expansion was the inclusion of artificial reef habitats as a stratum within the mapping and sampling protocol. Efforts on these habitats began in 2014 in the Panhandle and in 2016 for the remainder of the state. These efforts have continued through funding from the NOAA Restore Science program starting in 2020. Given the time series of these surveys (seven years in the Central region, and five years in the South region), as well as ongoing interest in incorporation information from artificial reef habitats into the Red Snapper assessment, we developed an index for these habitats for the two regions identified in the stock ID process (Central=zones 7-10, South=zones 2-6; SEDAR 2021).

Methods

Survey design

FWRI efforts on artificial reefs and other man-made habitats (e.g., wrecks, construction materials, etc.) begin in 2014 for the Panhandle (zones 9 and 10) and in 2016 expanded to include the remainder of the state (zones 3-10) (Fig. 1, Fig. 2; FWRI/NFWF). In 2020 video survey efforts in the eastern Gulf of Mexico were unified among FWRI and federal partners as the Gulf Fisheries Independent Survey of Habitat and Ecosystem Resources (G-FISHER) and will remain as such in subsequent years (Fig. 1, Fig. 2). As part of these efforts, overall sampling effort on artificial reef habitats was redistributed to provide better sampling coverage throughout the full survey domain. Sites are randomly selected and subsequently mapped using standardized survey methods, utilizing a side scan sonar to cover an area of 2.1 km^2 prior to sampling (Keenan et al. 2018; Switzer et al. 2020). Artificial reef sites are initially selected from a geodatabase of available, known artificial reefs and wrecks occurring with the survey frame. Mapping protocols vary slightly around artificial habitats where the selected reef site is centered within the 2.1 km2 area and the survey covers 1.3 km East-West and 1.6 km North-South. Video

deployment sites are then randomly assigned based on the distribution of presumed artificial reef habitats.

Video reads

The FWRI video survey uses paired stereo-imaging cameras at each site. All videos are read to identify the maximum number of individuals of each species viewed in a single frame within a 20-minute time frame (i.e. MaxN, MinCount). Habitat characteristics on video are also noted with the percentage or presence/absence of abiotic and biotic habitat types that may contribute to fish biomass (e.g. sponge, algae, and corals, and side-scan geoform is paired to the site as a landscape level variable (Thompson et al. 2022).

Fish length measurement

SeaGIS software (SeaGIS Pty. Ltd.) was used to estimate fish total mid-line length (fork-length) for fish close enough of target species using the paired-cameras; lengths are obtained at the time where the maximum number of fish can be measured. Length compositions by region are shown in Fig. 3.

Data reduction

Video reads were excluded if they were unreadable due to turbidity or deployment errors. If Geoform was not recorded it was excluded as well as it is considered a potentially important habitat covariate. Final sample sizes by year for both stock regions can be found in Table 1.

Index development

Due to the general zero-inflated nature of these data, as with other indices using the video data, a negative binomial GLM was fit to predict annual MaxN. All potential habitat variables were initially used in the model which included spatial data such as latitude, longitude, depth as well as the landscape level habitat as side-scan geoform, and finally site-specific variables which were the amount of relief seen at a site on video and percent coverage and the presence/absence of sponge, rock, algae, hard corals, soft corals, unknown sessile organisms, and seagrass. Models for each region were backwards selected by sequentially removing non-significant variables to find the most parsimonious model using AIC as criteria. Final models for the two regions were (where per=percent cover, and pa=presence/absence):

Central: *Lcamp_maxn ~ year + latitude + longitude + arti_pa + rock_per + algae_pa*

South: *Lcamp_maxn = year + depth + latitude + longitude + algae_per + scoral_per +sponge_per+ rock_per + arti_per*

Results and Discussion:

Annual standardized index values for Red Snapper in the eGOM on artificial reefs, for Central and South regions including coefficients of variation, are presented in Table 2. Artificial reefs in the Central region had significantly higher proportion positive sites with Red Snapper in the range of 60-70% whereas the South region was only in the range of 0-17% of sites (Table 1). As such, index CVs indicated a good fit for the Central region, in the 11% to 37% range, however CVs are high in the South with CVs from 65% to 150% depending on year. Index trends from the GLM showed similar patterns to the nominal in the Central, however they diverge in the South index. These results indicate a limited dataset potentially in the southern region driven by generally low sampling intensity prior to 2020 and the low occurrence of Red Snapper on artificial reefs in this region. Furthermore, the South has fewer years available to index with lower sample sizes overall. Patterns in the trends for the Central remain relatively stable over time with a slight increase from 2015 and after (Fig. 4). Index trends in the South show variable relative MaxNs with a peak in 2018 followed by a drop in subsequent years (Fig. 5).

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Table 1. Summary of sample sizes by region of Red Snapper on artificial reefs sampled by stationary cameras. Proportion positives illustrate the sites with at least one Red Snapper.

Central Region			
year	N	N present	Prop Positive
2014	60	46	0.767
2015	20	14	0.700
2016	69	41	0.594
2017	93	72	0.774
2018	173	124	0.717
2019	110	75	0.682
2020	67	46	0.687
total	592	418	0.706

South Region			
year	N	N present	Prop Positive
2015	19	0	0.000
2016	19	1	0.053
2017	26	1	0.038
2018	17	3	0.176
2019	36	0	0.000
2020	100	7	0.070
total	217	12	0.055

Table 2. Number of stations sampled (N) by survey and year, , standardized index, and CV for the annual Red Snapper index of artificial reefs in both the Central and South region of the WFS.

Central Region						
year	N	Std Nominal	Std Index	lcl	ucl	CV
2014	60	0.6229	0.6029	-0.4126	1.6184	0.2046
2015	20	0.3098	0.2719	-0.5597	1.1036	0.3715
2016	69	0.9655	1.0421	-0.5277	2.6119	0.1830
2017	93	1.1619	1.5323	-0.4766	3.5411	0.1593
2018	173	1.1205	1.2548	0.0553	2.4542	0.1161
2019	110	1.0193	1.1098	-0.2168	2.4364	0.1452
2020	67	1.0116	1.1863	-0.6156	2.9881	0.1845

South Region						
year	N	Std Nominal	Std Index	lcl	ucl	CV
2015	19	0.0000	0.4251	0.3325	0.5178	1.4869
2016	19	0.1146	0.9664	0.7975	1.1352	1.1921
2017	26	4.1855	1.4549	1.2814	1.6284	0.8134
2018	17	2.0484	2.5065	2.2703	2.7427	0.6428
2019	36	0.0000	0.3812	0.3127	0.4497	1.2259
2020	100	0.7618	0.2659	0.2428	0.2891	0.5939

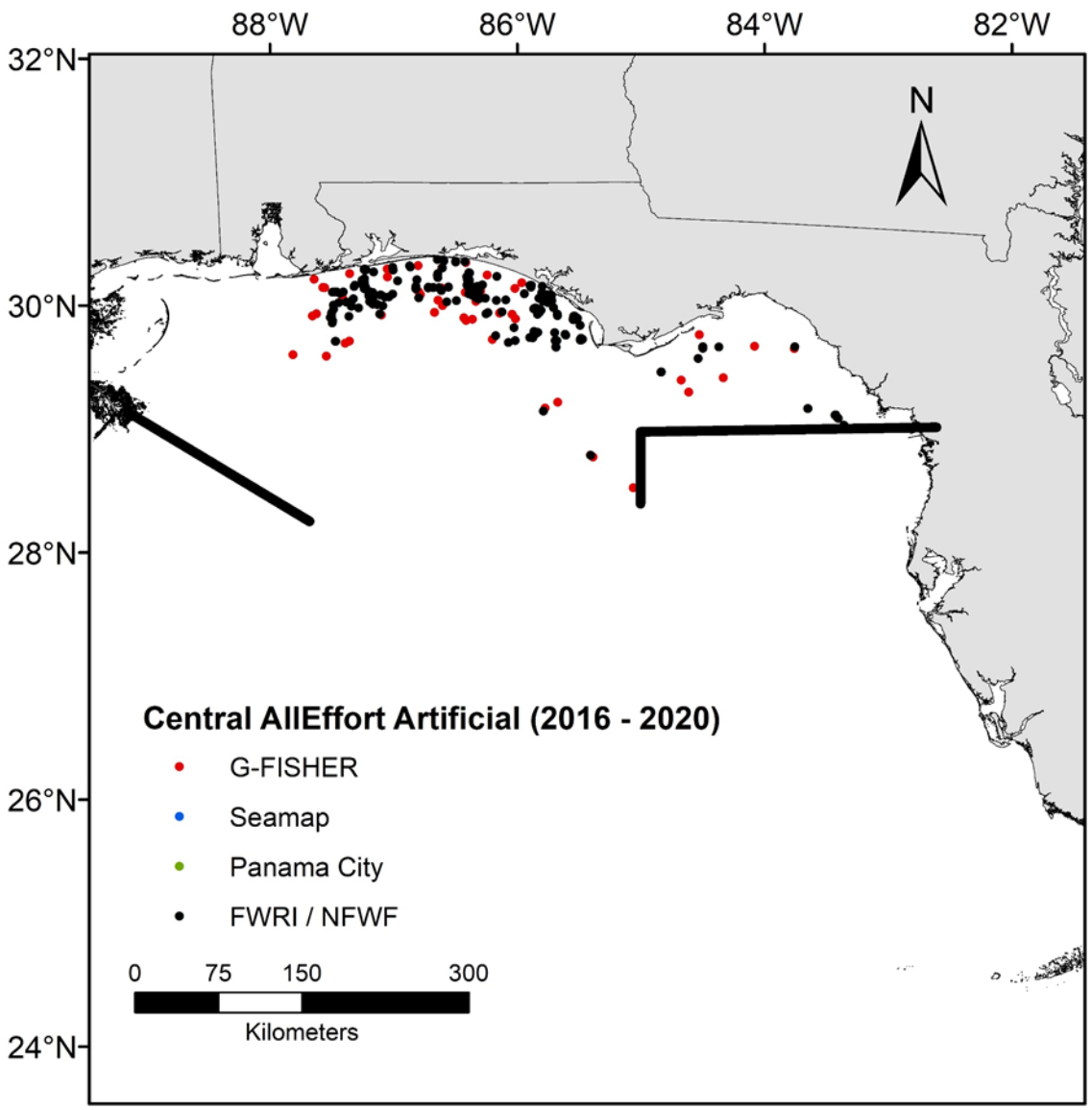

Figure 1. Sample sites for Artificial Reefs used in the index for Red Snapper for the Central Region.

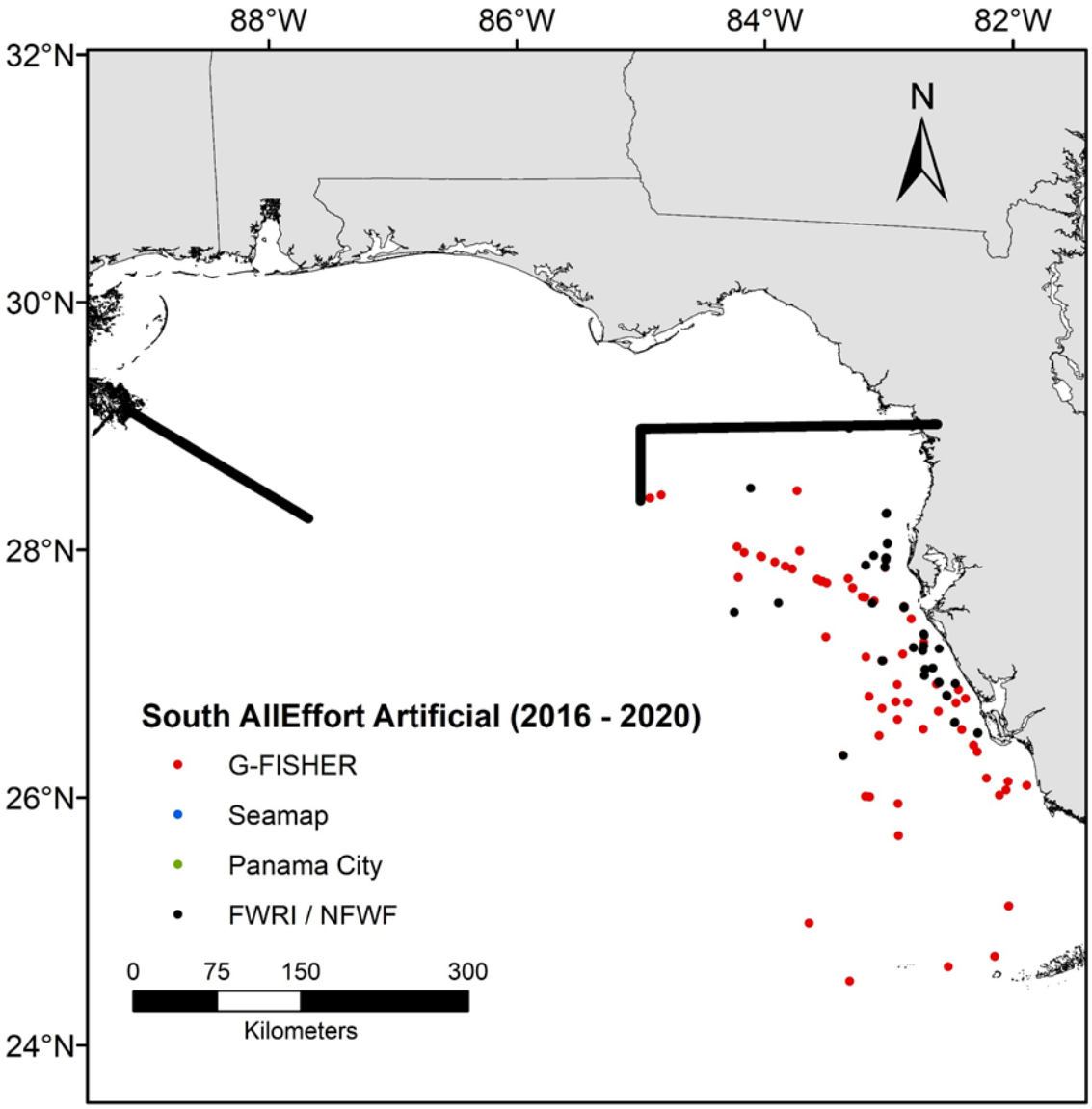

Figure 2. Sample sites for Artificial Reefs used in the index for Red Snapper for the South Region.

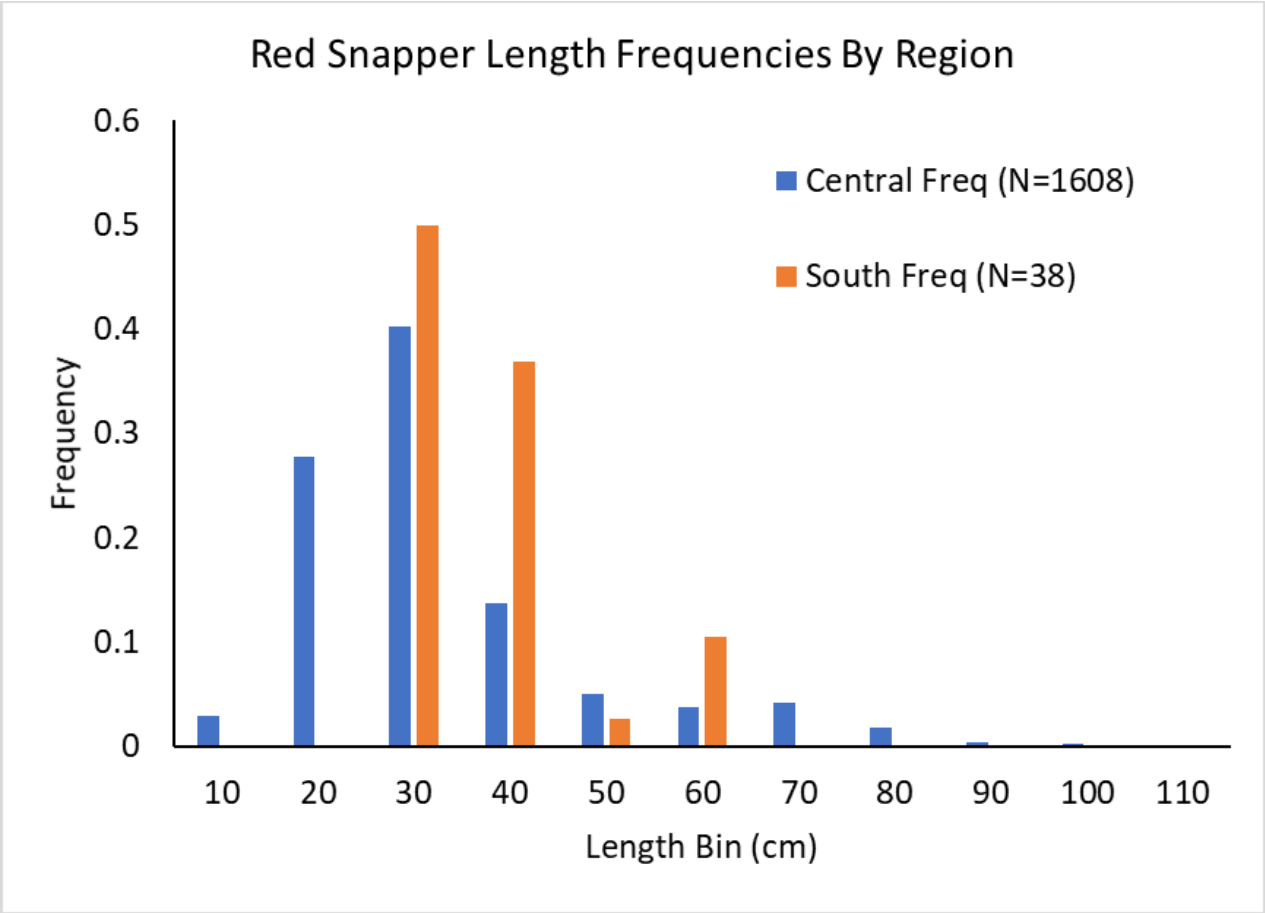

Figure 3. Length frequencies of Red Snapper fork length as observed in the Central and South regions in the WFS on stationary camera.

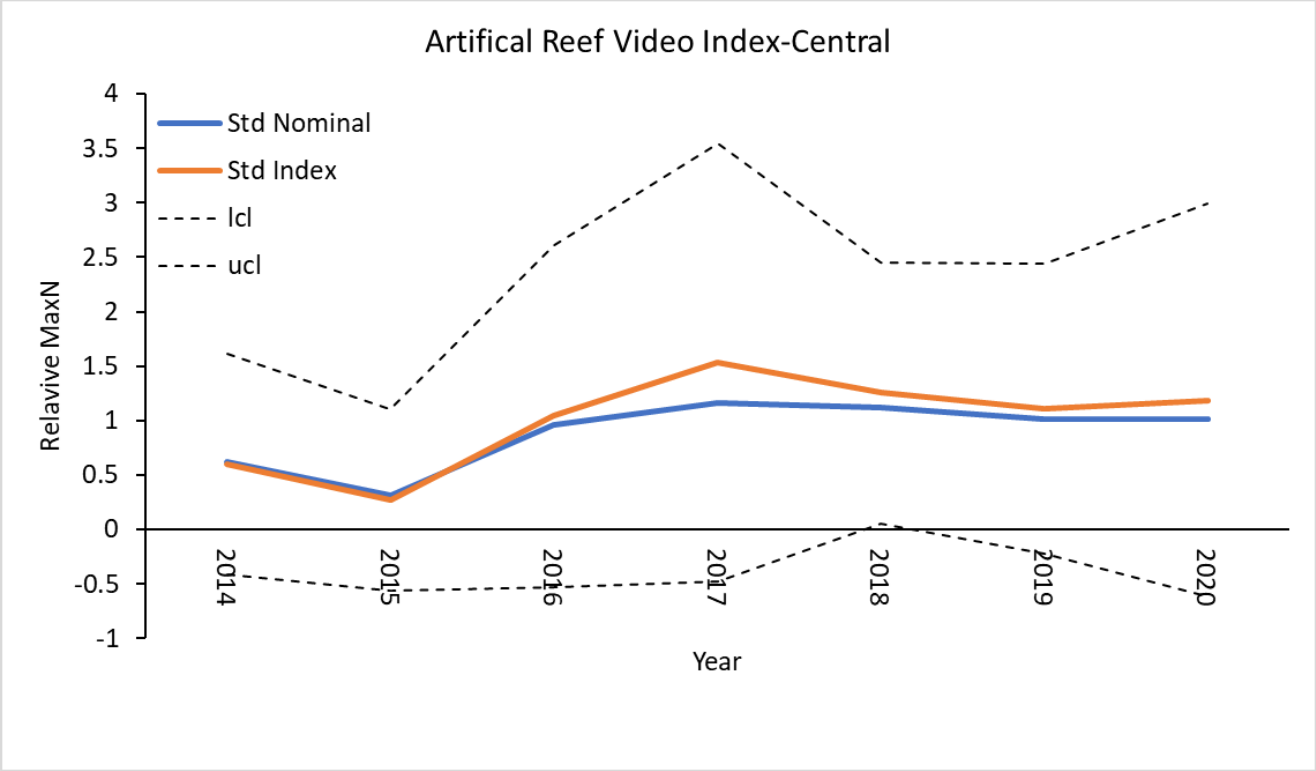

Figure 4. Standardized index with 2.5% and 97.5% confidence intervals and nominal index for relative Red Snapper CPUE (MaxN) using artificial reef video data for the Central Region.

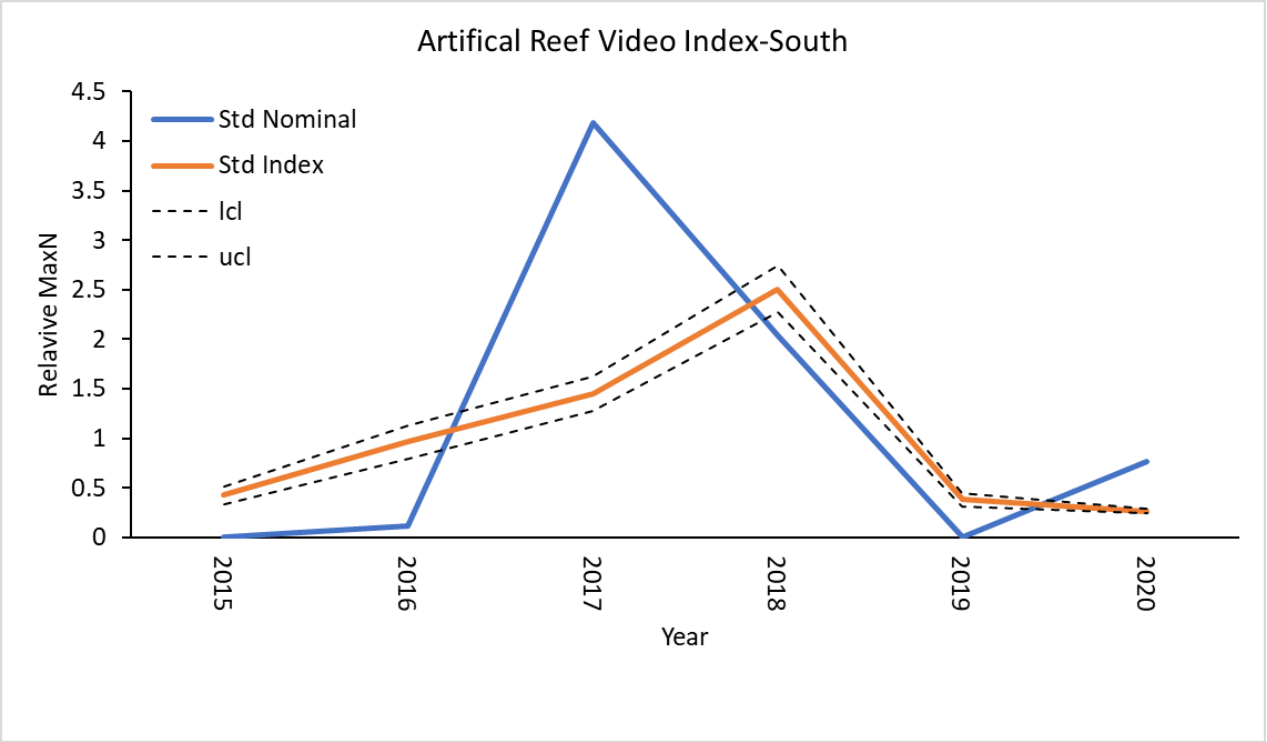

Figure 5. Standardized index with 2.5% and 97.5% confidence intervals and nominal index for relative Red Snapper CPUE (MaxN) using artificial reef video data for the South Region.