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

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Revised 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 (ten years in the Central region, and nine 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, East=zones 2-6; SEDAR 2021). Following the SEDAR 98 in-person data workshop, we identified discrepancies in 2023 data, therefore updated indices of abundance were developed with revised data using identical analytical methodologies initially approved at the workshop.

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 enhanced and redistributed following an optimal stratified random survey design (Switzer et al. 2023) 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 G-FISHER 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. In the East region samples prior to 2020 were excluded due to low sampling effort. Final sample sizes by year for both stock regions can be found in Table 1. The total number of measurements and sites from which measurements were obtained can be found in Table 3 and Table 4.

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 strata, and finally site-specific variables which were the amount of relief seen at a site on video, if artificial structure was visible on the video 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 pa=presence/absence):

Central: *Lcamp_maxn ~ Year + Longitude + Depth + Algae_pa + Artificial_pa*

East: *Lcamp_maxn ~ Year + Longitude + Relief_pa*

Results and Discussion:

Annual values for Red Snapper in the eGOM on artificial reefs, for Central and East 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 56-85% whereas the East region was only in the range of 8-20% of sites (Table 1). As such, index CVs indicated a good fit for the Central region, in the 13% to 26% range, however CVs are high in the South with CVs from 34% to 38% depending on year. Original results, along with results from updated analyses using corrected 2023 data, are presented in Figures 3 and 4. Patterns in the trends for the Central remain relatively stable over time with a slight peak in 2021 (Fig. 3). Index trends in the East have been relatively stable since 2020 (Fig. 4). Length frequency distributions were slightly different among regions (Fig. 5), which is possibly an artifact of lower sample sizes in the East to the Central. Overall, there was no discernable difference in the length frequencies between natural and artificial reefs (Fig. 6).

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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		East Region	
Year	N	Proportion positive	N	Proportion positive
2014	34	0.85		
2015	14	0.64		
2016	50	0.56		
2017	78	0.79		
2018	146	0.72		
2019	110	0.68		
2020	65	0.68	96	0.08
2021	89	0.75	97	0.2
2022	121	0.70	90	0.16
2023	117	0.72	92	0.12

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

Central Region					
year	N	LS means	LB	UB	CV
2014	34	2.740	1.345	4.136	0.260
2015	14	0.975	0.108	1.843	0.454
2016	50	4.833	2.794	6.871	0.215
2017	78	5.755	3.804	7.706	0.173
2018	146	5.243	3.959	6.526	0.125
2019	110	4.733	3.418	6.047	0.142
2020	65	4.631	2.938	6.324	0.187
2021	89	7.175	4.978	9.373	0.156
2022	121	4.000	2.918	5.077	0.138
2023	117	3.945	2.846	5.044	0.142
East Region					
year	N	LS means	LB	UB	CV
2020	96	0.110	0.027	0.192	0.382
2021	97	0.218	0.072	0.363	0.341
2022	90	0.208	0.059	0.357	0.365
2023	92	0.174	0.055	0.294	0.348

Table 3. Total number of measurements (N) and sites from which measurements were obtained for the Central region.

Central		
YEAR	**N**	**Sites**
2014	68	27
2015	12	8
2016	105	25
2017	260	56
2018	461	87
2019	300	69
2020	154	37
2021	135	47
2022	164	66
2023	191	65

Table 4. Total number of measurements (N) and sites from which measurements were obtained for the East region.

East		
YEAR	**N**	**Sites**
2014	0	0
2015	0	0
2016	1	1
2017	10	1
2018	15	3
2019	0	0
2020	12	5
2021	35	12
2022	27	9
2023	18	7

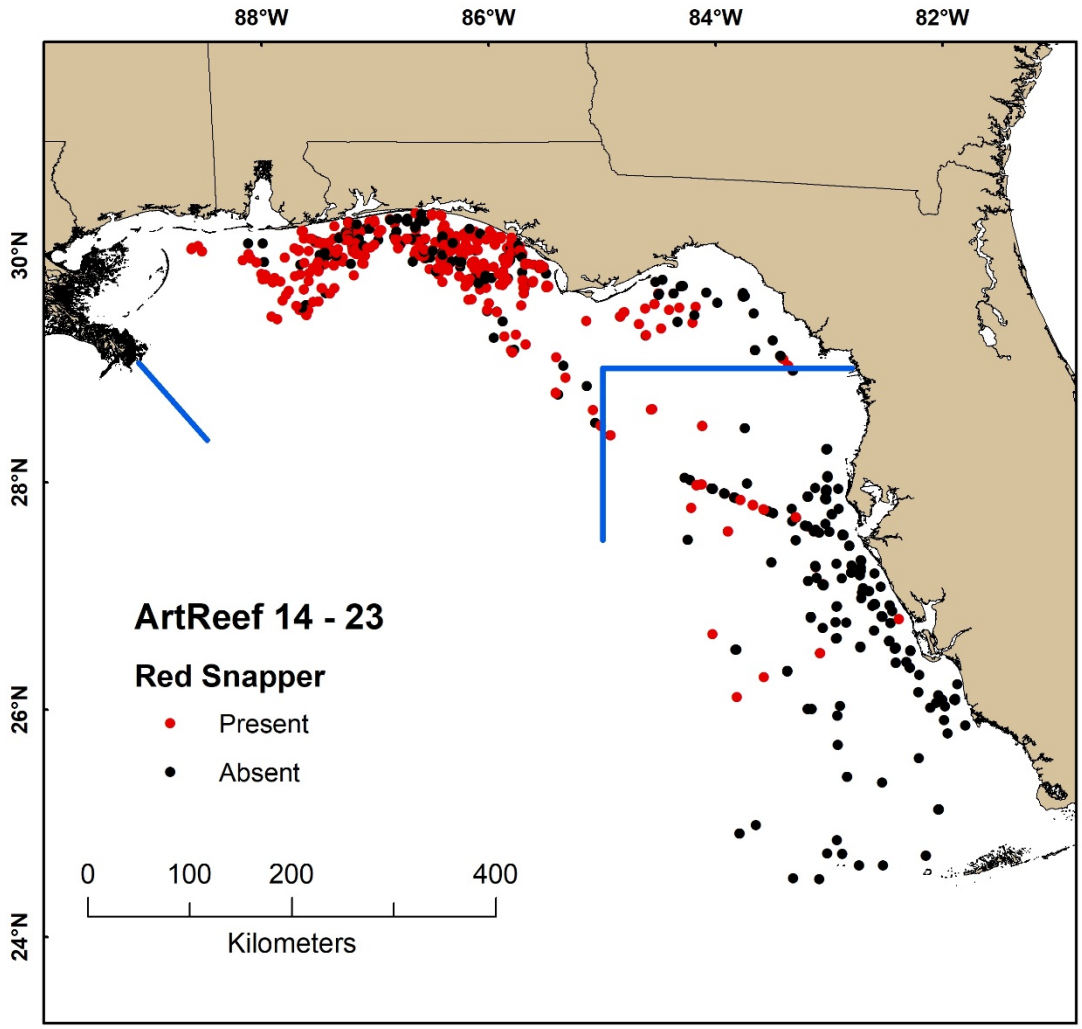
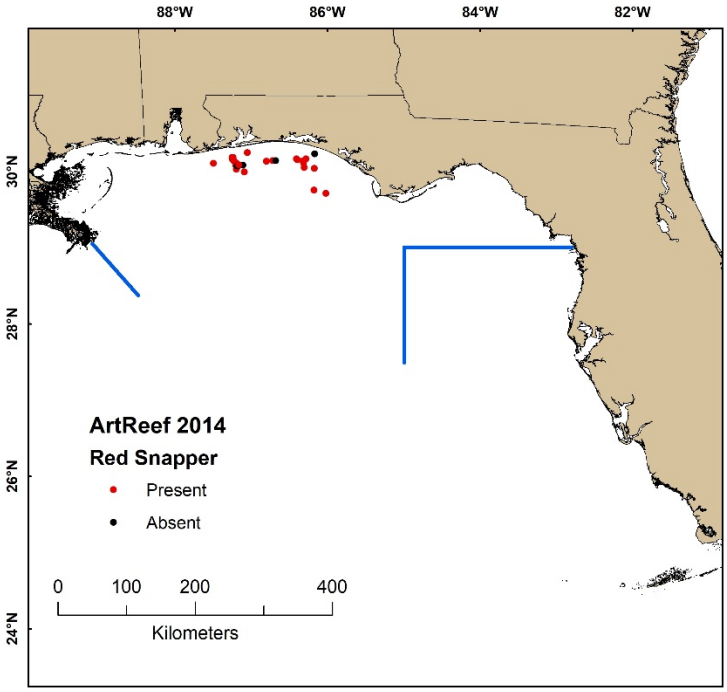
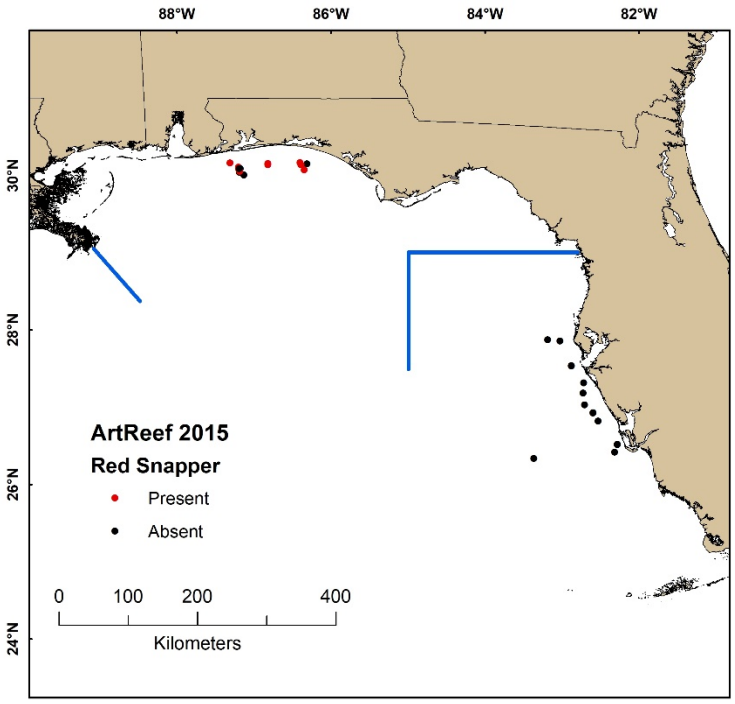


Figure 1. Sample sites for Artificial Reefs used in the index for Red Snapper for the Central and East Regions.

Figure 2. Annual maps of sampling effort on artificial reef habitats by the G-FISHER video survey. Blue lines designate boundaries of Central and East Red Snapper stocks.

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26°N
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ArtReef 2015
Red Snapper
Present
Absent
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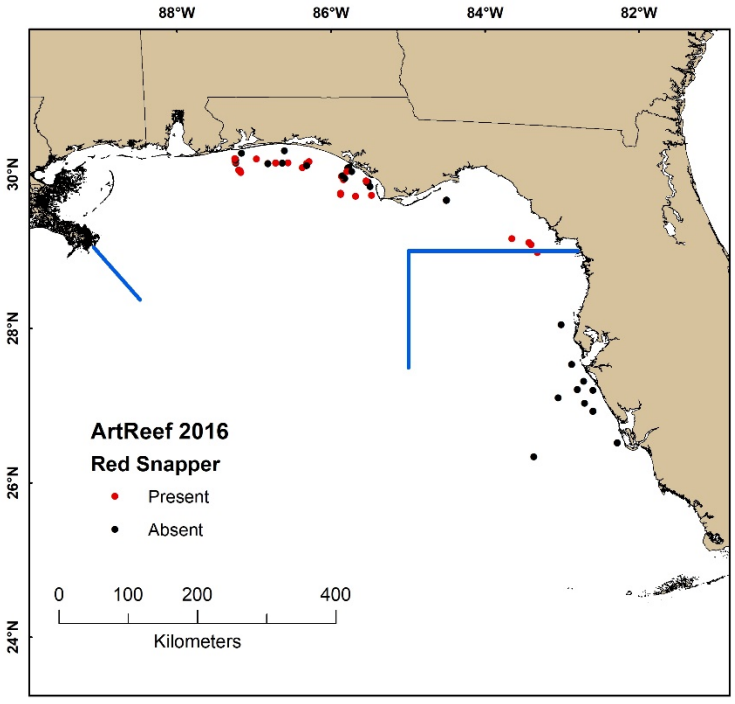
Kilometers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ArtReef 2016
Red Snapper
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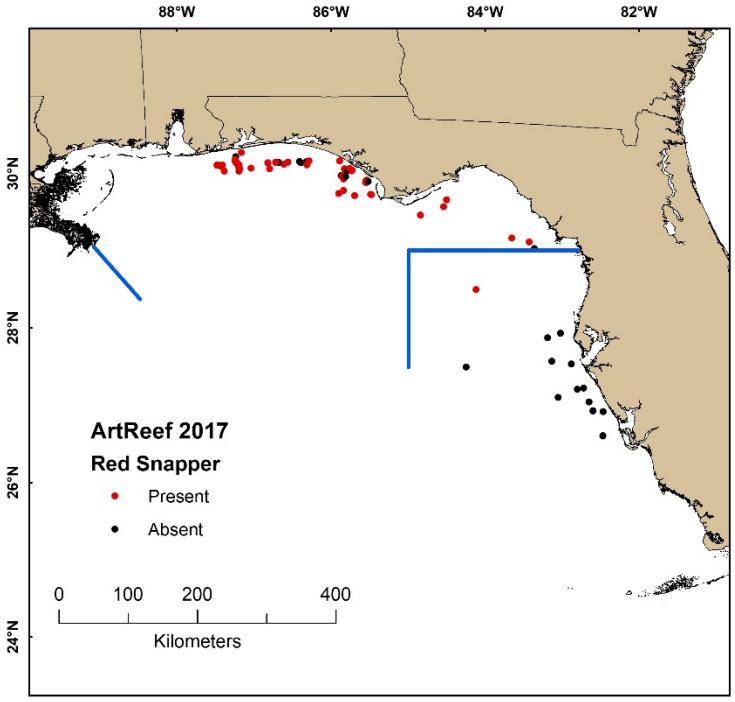
Kilometers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ArtReef 2017
Red Snapper
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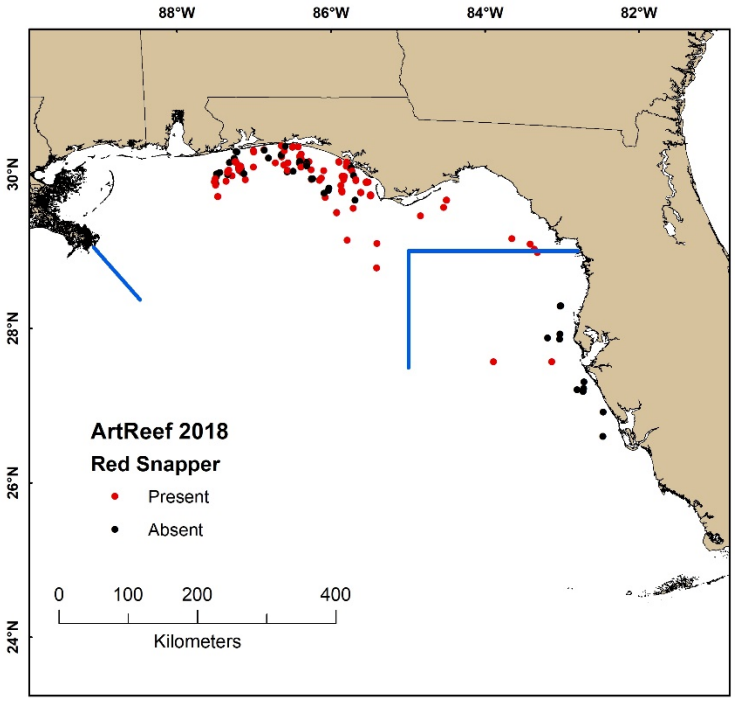
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Red Snapper
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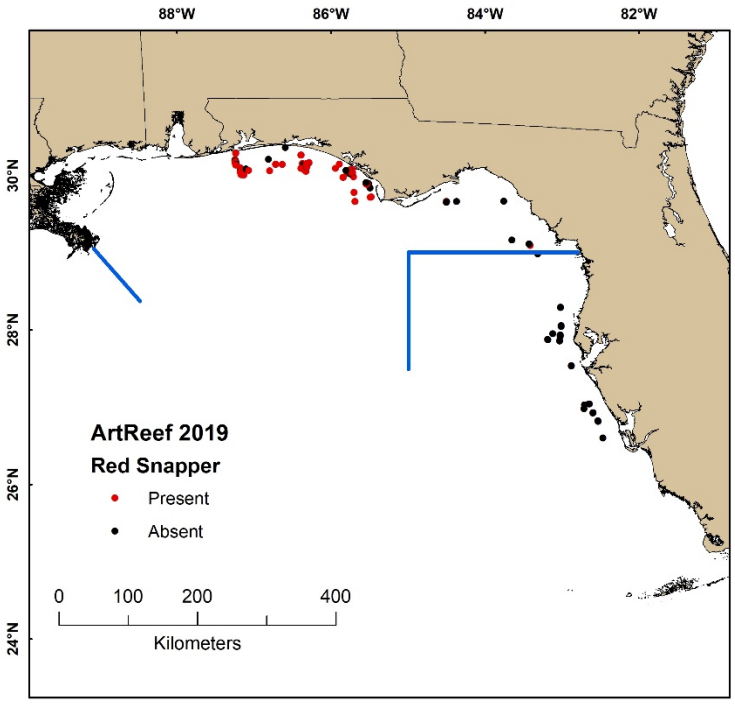
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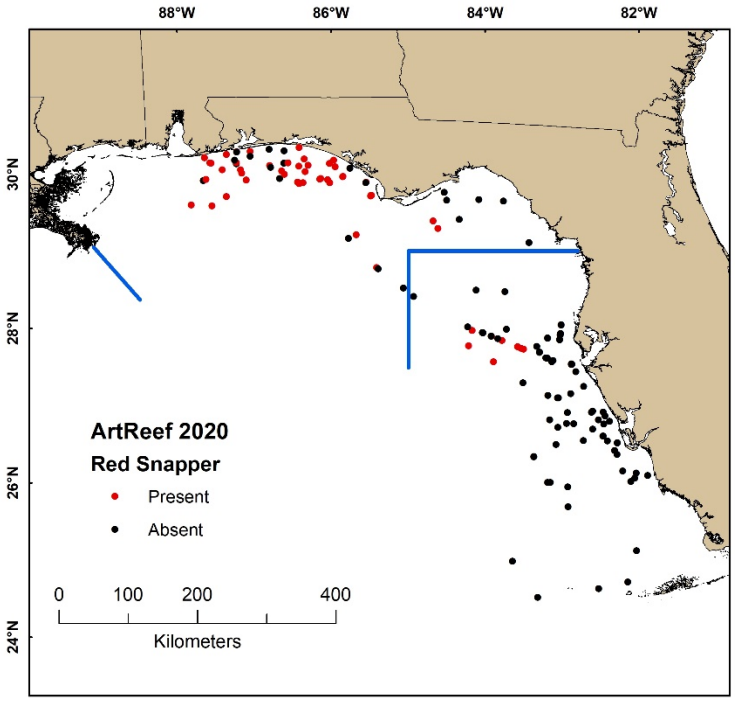
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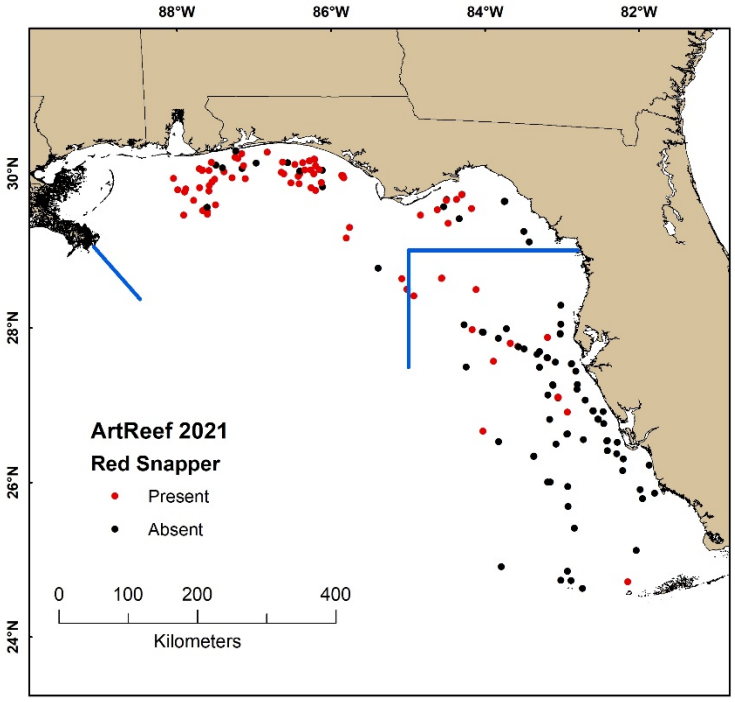
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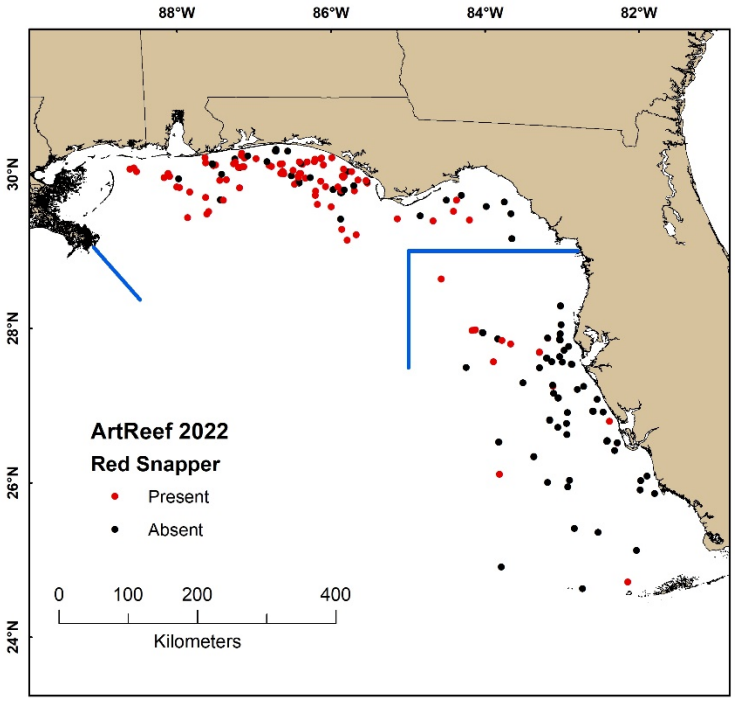
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ArtReef 2022
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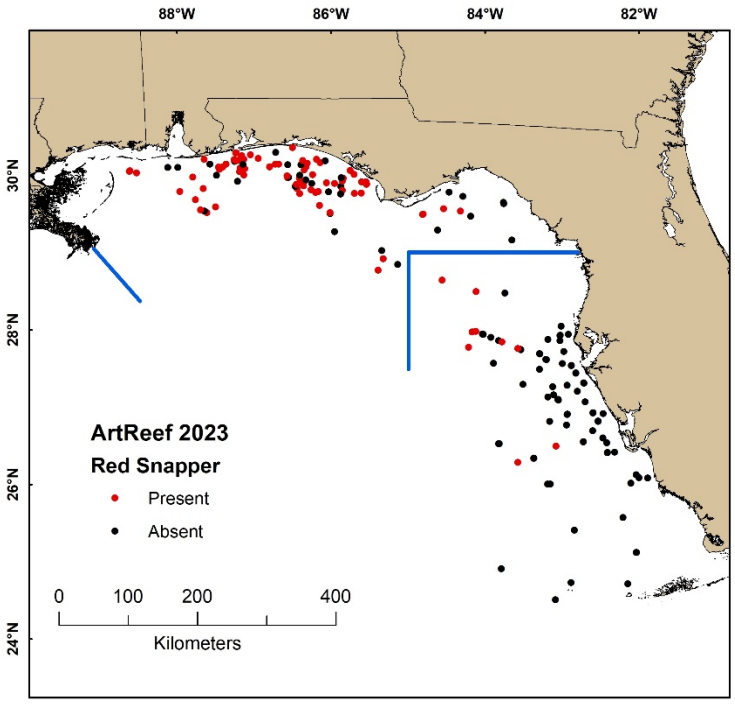
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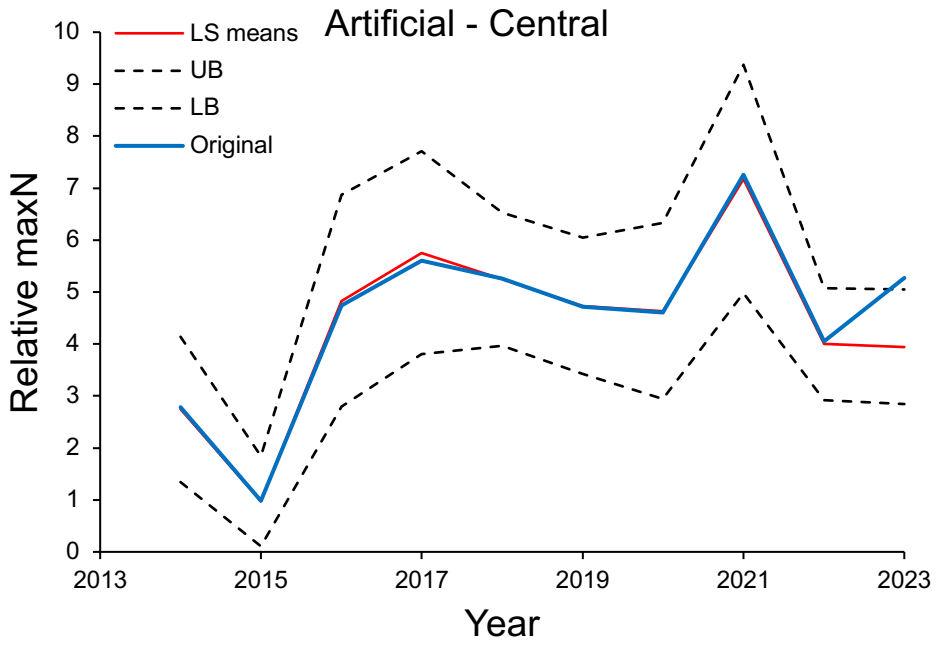

Figure 3. Index with 2.5% and 97.5% confidence intervals for relative Red Snapper CPUE (MaxN) using artificial reef video data for the Central Region.

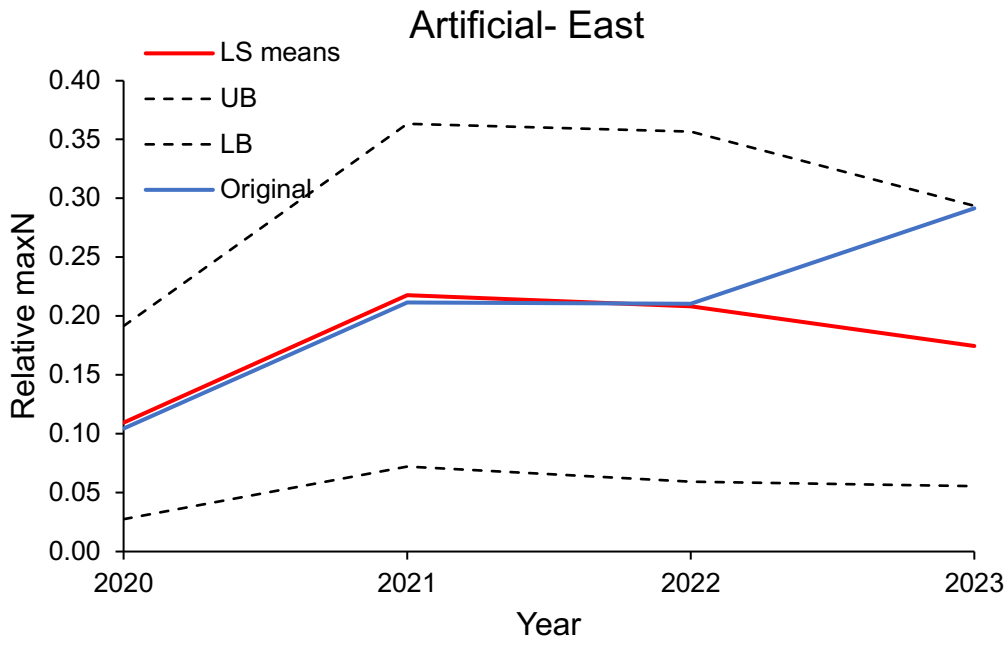

Figure 4. Index with 2.5% and 97.5% confidence intervals and nominal index for relative Red Snapper CPUE (MaxN) using artificial reef video data for the East Region.

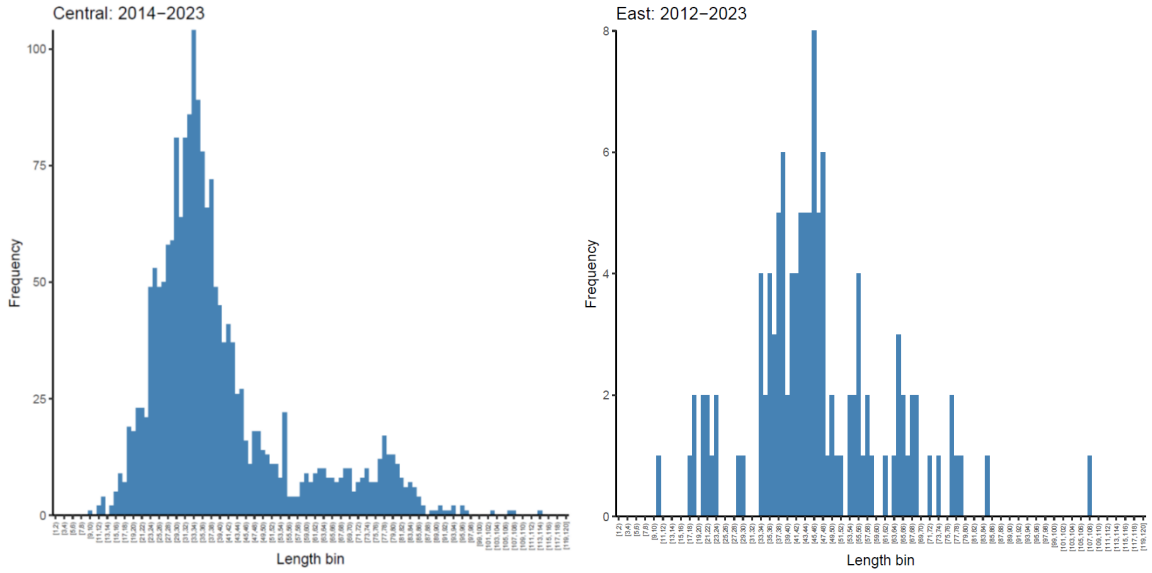

Figure 5. Length frequencies of Red Snapper fork length as observed in the Central and East regions.

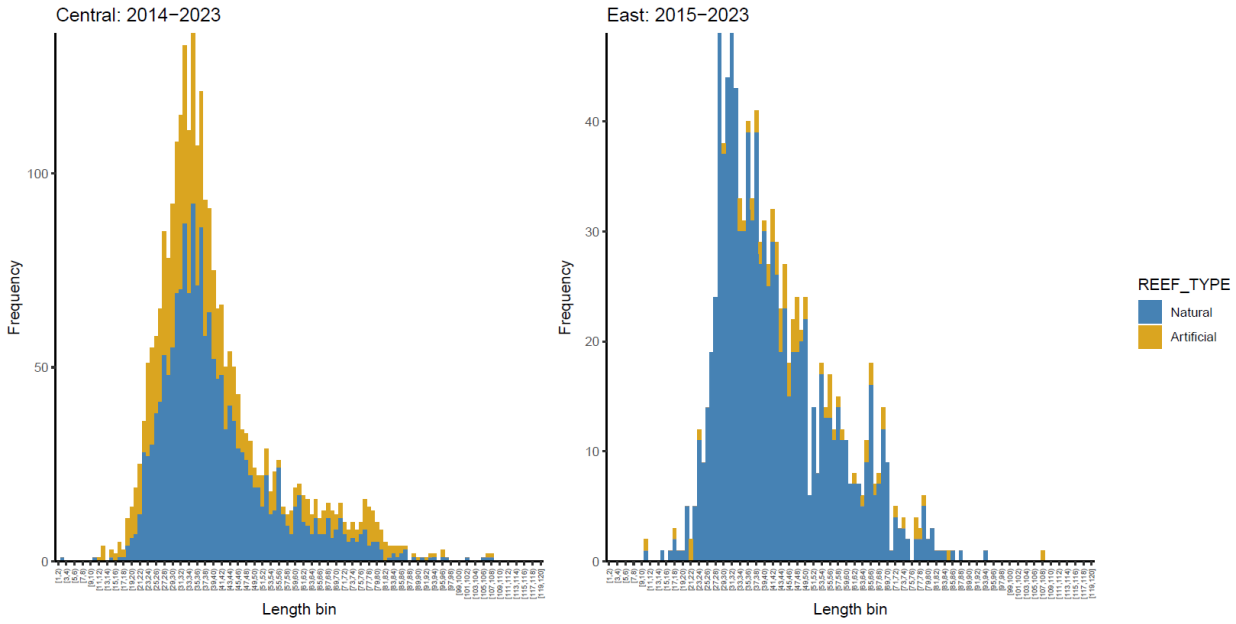

Figure 6. Length frequencies from natural and artificial reefs for the Central and East index regions.