Gray triggerfish *Balistes capriscus* Findings from the NMFS Panama City Laboratory Trap & Camera Fishery-Independent Survey – 2004-2014

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Survey history and overview

In 2002 the Panama City NMFS lab began development of a fishery-independent trap survey (PC survey) of natural reefs on the inner shelf of the eastern Gulf of Mexico off Panama City, FL, with the primary objective of establishing an age-based annual index of abundance for young (age 0-3), pre-recruit gag, scamp, and red grouper. Secondary objectives included examining regional catch, recruitment, demographic, and distribution patterns of other exploited reef fish species. The chevron trap is efficient at capturing a broad size range of several species of reef fish (Nelson et. al.1982, Collins 1990), and has been used by the South Atlantic MARMAP program for over 20 yr (McGovern et. al. 1998). Initially the PC survey used the same trap configuration and soak time used by MARMAP (McGovern et. al. 1998), but an in-house study in 2003 indicated that traps with a throat entrance area 50% smaller than that in the MARMAP traps were much more effective at meeting our objective of capturing sufficient numbers of all three species of grouper. Video data from our study and consultations with fishermen suggested that the presence of larger red grouper in a trap tended to deter other species from entering. Beginning in 2004, the 50% trap throat size became the standard. That same year the survey was expanded east of Panama City to Apalachee Bay off the Big Bend region of Florida (Figure 1), an area separated from the shelf off Panama City by Cape San Blas - an established hydrographic and likely zoogeographic boundary (Zieman and Zieman 1989).

Beginning in 2005, the collection of visual (stationary video) data was added to the survey to provide insight on trap selectivity, more complete information on community structure, relative abundance estimates on species rarely or never caught in the trap, and additional, independent estimates of abundance on species typically caught in the traps. Video sampling was only done in Apalachee Bay that first year, but was expanded to the entire survey in 2006. Also in 2005 the target species list was expanded to include the other exploited reef fishes common in the survey area , i.e., red, vermilion, gray, and lane snapper; gray triggerfish, red porgy, white grunt, black seabass, and hogfish. From 2005 through 2008 each site was sampled with the camera array followed immediately by a single trap. Beginning in 2009 trap effort was reduced ~50%, with one deployed at about every other video site, starting with the first site of the day. This was done to increase the number of video samples, and thereby the accuracy and precision of the video abundance estimates. Camera arrays are much less selective and provide abundance estimates for many more species than traps, and those estimates are usually much less biased (DeVries et al. 2009). At each site, a CTD cast was made to collect temperature, salinity, oxygen, and turbidity profiles.

Through 2009 sampling was systematic because of a very limited sampling universe. In 2010 the design was changed to 2 stage random after side scan sonar surveys that year yielded an order of magnitude increase in that universe (Figure 1). Five by five minute blocks known to contain reef sites, and proportionally allocated by region, sub-region, and depth (10-20, 20-30, 30+ m) to ensure uniform geographic and bathymetric coverage, are randomly chosen first. Then 2 known reef sites a minimum of 250 m apart within each selected block are randomly selected (Figure 2). Alternates are also selected for use when another boat is found to be fishing the site or no hard bottom can be found with sonar at that site.

Depth coverage was ~8-30 m during 2004-07, and then subsequently steadily expanded to ~8 – 52 m (Figure 3). Sampling effort has also increased since 2004. Sample sizes were 59 in 2004 (33 West: 26 East), 101 in '05 (24 W: 77 E), 114 in '06 (25 W: 89 E), 86 in '07 (29 W: 57 E), 97 in '08 (31 W: 66 E), 143 in '09 (47 W: 96 E), 162 in '10 (53 W: 109 E), 180 in '11 (65 W: 115 E), 178 in '12 (61 W: 117 E), 112 in 2013 (71 W: 41 E), and 184 in 2014 (113E: 71 W). Nine sites in 2004 and 23 in 2005 were sampled twice; thereafter each site was only sampled once in a given year. All sampling has occurred between May and October (with the exception of four sites in November, 2013), but primarily during June through August (Figure 4) Sampling east of Cape San Blas in 2013 was greatly reduced (down ~66%) and done later than normal (Oct. and Nov.) because of late receipt of funding, ship mechanical issues, and weather problems.

Methods

Sampling was conducted during daytime from 1 hr after sunrise until 1 hr before sunset. Chevron traps were baited each set with 3 previously frozen Atlantic mackerel *Scomber scombrus,* and soaked for 1.5 hr. Traps were fished as close as possible to the exact location sampled by the camera array. All trap-caught fish were identified, counted and measured to maximum total and fork length (FL only for gray triggerfish and TL only for black seabass). Both sagittal otoliths were collected from 4-5 randomly subsampled specimens of all snappers (gray, lane, red, and vermilion), groupers (gag, red, and scamp), black seabass, red porgy, hogfish, white grunt, and gray triggerfish (first dorsal spine for the latter).

Visual data were collected using a stationary camera array composed of 4 Hi 8 video cameras (2005 only) or 4 high definition (HDEF) digital video cameras (2006-08) mounted orthogonally 30 cm above the bottom of an aluminum frame. From 2007 to 2009, parallel lasers (100 mm spacing) mounted above and below each camera were used to estimate the sizes of fish which crossed the field of view perpendicular to the camera. In 2009 and 2010, one of the HDEF cameras was replaced with a stereo imaging system (SIS) consisting of two high resolution black and white still cameras mounted 8 cm apart, one digital video (mpeg) color camera, and a computer to automatically control these cameras as well as store the data. The SIS provides images from which fish measurements can be obtained with the Vision Measurement System (VMS) software. Beginning in 2011, a second SIS facing 180º from the other was added, reducing the number of HDEFs to two; and both SIS's were also upgraded with HDEF, color mpeg cameras. In 2012 the two HDEFs were replaced with hi-def GoPro cameras. The camera array was unbaited 2005-2008, but since 2009 has been freshly baited each drop with one previously frozen Atlantic mackerel placed in a mesh bag near the center.

Before stereo camera systems were used (prior to 2009), soak time for the array was 30 min to allow sediment stirred up during camera deployment to dissipate and ensure tapes with an unoccluded view of at least 20 min duration (Gledhill and David 2003). With the addition of stereo cameras in 2009, soak time was increased to 45 min to allow sufficient time for the SIS to be settled on the bottom before starting its hard drive, and to insure the hard drive had time to shut down before retrieval. In mid-2013, stereo cameras were upgraded with solid state hard drives, enabling soak time to be reduced back to 30 min. Prior to 2009, tapes of the 4 HDEF cameras were scanned, and the one with the best view of the habitat was analyzed in detail. If none was obviously better, one was randomly chosen. In 2009 only the 3 HDEF video cameras were scanned and the one with the best view of the reef was analyzed. Starting in 2010, all 4 cameras – the HDEFs and the SIS MPEGs, which have virtually the same fields of view (64 vs 65º) – were scanned, and again, the one with the best view of the habitat was analyzed. Beginning in 2012, when a video from a GoPro camera was selected to be read, because they have a much larger field of view than the SIS MPEGs (122 vs 65º), predetermined, equal portions of each edge of the video monitor were covered so that only the central 65° of the field of view was visible. Twenty min of the tape were viewed, beginning when the cloud of sediment disturbed by the landing of the array has dissipated. All fish captured on videotape and identifiable to at least genus were counted. Data on habitat type and reef morphometrics were also recorded. If the quality of the MPEG video derived from the SIS was less than desirable (a common problem), fish identifications were confirmed on the much higher quality and concurrent stereo still frames. The estimator of abundance was the maximum number of a given species in the field of view at any time during the 20 min analyzed (= min count; Gledhill and Ingram 2004, or MaxN; Ellis and DeMartini 1995), and VMS measurements were taken from a still frame showing the min count of a given species (but not necessarily the same frame the actual min count came from) to eliminate the possibility of measuring the same fish more than once. Even for deployments where the SIS did not provide a good view of the reef habitat, the files were examined to obtain fish measurements using VMS, and again, those measurements were only taken from a still frame showing the min count of a given species. In contrast, when scaling lasers were used to obtain length data, there was no way to eliminate the possibility of double measuring a given fish, although this was probably not a serious problem, as usable laser hits were typically rare for any one sample.

Because of the significant differences we observed in both species composition and abundance of many reef fishes east and west of Cape San Blas, and because of the Cape's known status as a hydrographic and likely zoogeographic boundary (Zieman and Zieman 1989), many of the results presented herein are shown separately for the two areas.

Censored data sets were used in deriving the indices of relative abundance from video data. All video samples were screened, and those with no visible hard or live bottom and no visible species of fish strongly associated with hard bottom habitat, as well as samples where the view was obscured because of poor visibility, bad camera angle, video out of focus, etc., were censored (excluded) from calculations of relative abundance. In 2014, 10 video samples from an area with an ongoing serious red tide bloom, and which showed no or virtually no evidence of living fish, were also censored. As a result of this screening, of video samples east of the Cape, only 31 of 41 in 2005, 47 of 89 in 2006, 23 of 57 in 2007, 56 of 66 in 2008, 62 of 97 in 2009, 95 of 109 in 2010, 99 of 115, in 2011, and 100 of 115 in 2012, 38 of 39 in 2013, and 103 of 113 in 2014 met the reef and visibility criteria and were retained. In contrast, west of the Cape, 24 of 25 sites in 2006, 29 of 29 in 2007, 29 of 31 in 2008, 42 of 47 in 2009, 52 of 53 in 2010, 57 of 64 in 2011, 49 of 59 in 2012, 66 of 72 in 2013, and 71 of 71 in 2014 were retained for analyses.

No model based index was generated from trap data for gray triggerfish, although nominal cpue and proportion of positive samples were calculated and are presented herein. This decision was based on the same reasoning given for not recommending the Panama City and FWRI trap survey indices in SEDAR42 by the data workshop indices workgroup, i.e., they covered the same portion of the population as the recommended combined video index which had longer time series and more complete spatial coverage. The CPUE and proportion positive findings for the trap survey were based on all samples except those from sites which had already sampled in a given year and 8 sites in 2014 located in an ongoing red tide bloom. As a result of this screening, of trap samples east of the Cape, 16 of 17 in 2004, 44 of 68 in 2005, 68 of 68 in 2006, 44 of 44 in 2007, 50 of 50 in 2008, 53 of 53 in 2009, 52 of 52 in 2010, 50 of 50 in 2011, and 59 of 59 in 2012, and 14 of 14 in 2013, and 47 of 56 in 2014 were retained. West of the Cape, 18 of 24 in 2004, 18 of 18 in 2005, 23 of 23 sites in 2006, 20 of 20 in 2007, 31 of 31 in 2008, 29 of 30 in 2009, 17 of 17 in 2010, 30 of 30 in 2011, 30 of 30 in 2012, and 37 of 37 in 2013, and 33 of 33 in 2014 were retained for analyses.

Indices of relative abundance from video data

The delta-lognormal index of relative abundance (I_y) as described by Lo *et al*. (1992) was estimated as

(1) $I_y = c_y p_y$,

where c_y is the estimate of mean CPUE for positive observations only for year y; p_y is the estimate of mean probability of occurrence during year y. Both c_y and p_y were estimated using generalized linear models. Data used to estimate abundance for positive catches (c) and probability of occurrence (p) were assumed to have a lognormal distribution and a binomial distribution, respectively, and modeled using the following equations:

(2) $\ln(\mathbf{c}) = \mathbf{X\beta} + \boldsymbol{\varepsilon}$

and

(3) $\mathbf{p} = \dfrac{e^{\mathbf{X\beta}+\boldsymbol{\varepsilon}}}{1 + e^{\mathbf{X\beta}+\boldsymbol{\varepsilon}}}$, respectively,

where **c** is a vector of the positive catch data, **p** is a vector of the presence/absence data, **X** is the design matrix for main effects, **β** is the parameter vector for main effects, and **ε** is a vector of independent normally distributed errors with expectation zero and variance σ^2.

We used the GLIMMIX and MIXED procedures in SAS (v. 9.1, 2004) to develop the binomial and lognormal submodels, respectively. Similar covariates were tested for inclusion for both submodels: water depth, survey region [two regions in the northeastern GOM: East (east of Cape san Blas) and West (west of east of Cape san Blas)], month and year. A backward selection procedure was used to determine which variables were to be included into each submodel based on type 3 analyses with a level of significance for inclusion of $\alpha = 0.05$. If year was not significant then it was forced into each submodel in order to estimate least-squares means for each year, which are predicted annual population margins (i.e., they estimate the marginal annual means as if over a balanced population).

Therefore, c_y and p_y were estimated as least-squares means for each year along with their corresponding standard errors, SE(c_y) and SE(p_y), respectively. From these estimates, I_y was calculated, as in equation (5), and its variance calculated as

(4) $$V(I_y) \approx V(c_y)p_y^2 + c_y^2 V(p_y) + 2c_y p_y \mathrm{Cov}(c, p),$$

where

(5) $$\mathrm{Cov}(c, p) \approx \rho_{c,p}\left[\mathrm{SE}(c_y)\mathrm{SE}(p_y)\right],$$

and $\rho_{c,p}$ denotes correlation of *c* and *p* among years.

Results

Since the Panama City lab reef fish survey began in 2004/5, gray triggerfish (hereafter referred to as triggerfish) have consistently and commonly been observed with stationary video gear and captured in chevron traps across the inner and mid-West Florida shelf both east and west of Cape San Blas (Tables 1 and 2, Fig. 5) (DeVries et al. 2008, 2009, 2012). The annual percent of positive video samples ranged from 12.4 to 44.1 % east of Cape San Blas during 2005-2014, and 47.0 to 88.0 % west of the Cape during 2006-2014 (Table 1). The annual percent of positive triggerfish trap catches during 2004-2014 ranged from 6.3 to 54.5 % east of Cape San Blas and 29.7 to 69.6 % west of the Cape (Table 1). Triggerfish were noticeably more abundant west of Cape San Blas than east. The mean proportion of positive video samples was 0.64 west of the Cape vs 0.28 in the east, and respective mean min counts were 1.77±0.16 vs 0.45±0.04. This geographical difference in abundance is clearly visible in a kernel density plot of pooled min count data from all years (Figure 6), which shows a fairly large area between 85° 45' and 86° 30'W with much higher densities than any seen in the entire area east of Cape San Blas.

Triggerfish were encountered by both gears across virtually the entire depth range sampled, although encounter rates did increase noticeably with depth from 6 to ~22-26 m, then seemed to level off, although small sample sizes at deeper depths made it difficult to interpret results from >40 m (Fig. 7).

Triggerfish observed with stereo cameras during 2009-2014 averaged larger than those caught in traps — 334 mm vs 297 mm FL; had larger ranges: 145- 645 mm vs 157- 472 mm FL; and had larger modes: ~300-340 mm vs ~300 mm FL (Fig. 8). Not surprisingly, a comparison of size data from both gears from the same years (2009-14) clearly showed that the more selective traps do select against most triggerfish >380 mm FL, although fish that large are relatively uncommon in the survey area based on the few stereo measurements obtained (Fig. 8).

The video survey targeted both pre-recruit triggerfish (<356 mm FL, the legal size limit) and those recruited to fisheries. Of fish measured from stereo images, 69% (47 of 68) from east of Cape San Blas and 63% (69 of 109) from west of the Cape were <356 mm. The more selective trap survey strongly targeted pre-recruits — 94% from east of Cape San Blas and 92% from the west were < 356 mm FL. There appeared to be little difference in size structure east and west of Cape San Blas. Mean sizes in those respective areas were 333.7 and 333.4 mm FL in the video survey, and 294 and 298 mm in the trap survey; and within both surveys the distributions were very similar (Fig. 9). Similarly, there was very little relationship between size of triggerfish and depth.

Although regressions from both video and trap survey data were highly significant, primarily because of large sample sizes, respectively <1% and 3% of the variance in size was explained by changes in depth (Figure 10).

Annual mean sizes of triggerfish in the video survey were quite variable, showing particularly wide swings each year since 2011, possibly due to the typically low sample sizes of stereo measurements and the greatly reduced and seasonally late sampling east of Cape San Blas in 2013 (Figure 11). The very large decline in average size in 2014, if representative of the population, could suggest the entry of large numbers of small fish into the survey area which could represent the recruitment of a new strong year class. Evidence of an increased proportion of small individuals in 2014 is clearly visible in Figure 12. In contrast, mean sizes in the trap survey have been fairly stable since 2004, and from 2007 through 2013 hovered around 300 ± 10 mm FL before rising in 2014 almost 25 mm to 325 mm FL, opposite the trend seen in the stereo data (Figure 11). The annual size distribution data from the trap survey shows no evidence of increased proportions of small fish but does show a slightly higher mode than seen in any previous years (320-340 vs ~300 mm FL) (Figure 13).

Triggerfish caught in the trap survey ranged from ages 1 to 7 yr with a mean age of 3.6±0.05 yr and a strong mode of 3 yr (Fig. 14). They also averaged slightly older west of the Cape than east (3.8±0.07 vs 3.2±0.07 yr), although the range in ages was similar (1-7 vs 1-8 yr) and modal age was 3 in both regions (Figure 14). Annual age structure data of triggerfish from the trap catches showed no evidence of the periodic strong year classes that characterize population of co-occurring reef fish such as gag, red grouper, and red snapper on the northern West Florida Shelf (Fig. 15). Overall modal age was 3 yr every year from 2004 through 2012 except for 2011, when it was 5 yr, and in 2014 when ages 3-6 were all similarly represented (Figure 15). Fish ages 1 and >6 yr have been rare since the survey began in 2004. Between depths of 10 and 25 m, mean age increased slightly (from 3.0 to 3.8 yr), but from 25 to 40 m it was fairly constant at 3.7-3.9 yr (Figure 16).

Abundance trends

Annual GIS plots of video min counts and trap catch/hr of triggerfish showed very similar geographic patterns in relative abundance trends between 2005 and 2014 (Figure 17). Triggerfish were noticeably more abundant west of Cape San Blas than east. The annual proportion of positive video samples ranged from 58 to 348% higher in the west during 2006-2014 and averaged 139% higher (Figure 18). The proportion of positive trap samples was higher in the west every year through 2014 except 2004 and 2007, and averaged 194% higher (Figure 18). In most cases the trends in proportion positive were the same between video and trap surveys within regions but not between them except in 2009 when all showed an increase (Figure 18).

Like the proportion positive findings, min counts were always higher west of the Cape than east, ranging from 101 to 641 % higher, and averaging 331% (Figure 19). West of the Cape min counts began rising between 2007 and 2008, peaked in 2009, and then began a substantial decline that didn’t cease until 2013, when it finally began rising somewhat in 2014 (Figure 19). Trends in min count east of the Cape did not seem to follow those in the west, or only very marginally so. There were only minor fluctuations in abundance, with no obvious peak in 2009 and virtually no increase in 2014 as well

(Figure 19). Trends in trap cpue were much more variable than, and only very roughly followed, those in the video survey. Like the video trends west of the Cape, trap cpue in the west did decline from 2006 to 2007 followed by a rise to 2008, and a rise from 2013 to 2014 (Figure 19). Unlike in the video data, there was no peak in 2009, and there was a peak in 2011(Figure 19). East of the Cape, trap cpue declined steadily from its peak in 2004 to almost zero in 2011, where it has remained through 2014 (Figure 19). These noticeable differences in trends east and west of Cape San Blas are quite different from the very similar trends seen in red grouper in both video and trap surveys in the same years and region (Figure 20), and may be evidence of sub-populations with different dynamics.

Figure 21 and its adjoining table summarize indices of gray triggerfish developed from the Panama City video survey data, 2005-2014, using a delta-lognormal model. The index, scaled to a mean of one over the time series, peaked in 2009, then declined and continued to do so until 2012. It showed almost no change in 2013, then for the first time since 2008 increased slightly in 2014.

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Tables

Table 1. Annual video survey sample sizes, % positive occurrences, mean nominal video min counts, and standard errors of gray triggerfish east and west of Cape San Blas, 2005-2014. Estimates calculated using censored data sets (see Methods).

	Total sites sampled			% Positive occurrences			Mean nominal min count			Standard error		
Year	East	West	Total	East	West	Total	East	West	Total	East	West	Total
2005	41		41	14.6		14.6	0.171		0.170	0.069		0.069
2006	84	25	109	41.7	88.0	52.3	0.857	1.72	1.055	0.203	0.268	0.171
2007	48	25	73	35.4	56.0	42.5	0.708	1.48	0.972	0.174	0.327	0.164
2008	61	29	90	31.1	79.3	46.7	0.426	2.172	0.988	0.095	0.415	0.171
2009	68	43	111	44.1	81.4	58.6	0.764	3.674	1.891	0.165	1.114	0.460
2010	97	51	148	29.9	56.9	39.2	0.484	2.431	1.155	0.092	0.526	0.205
2011	100	59	159	21.0	49.2	31.4	0.250	1.355	0.660	0.052	0.310	0.126
2012	105	54	159	12.4	55.6	27.0	0.152	1.129	0.484	0.042	0.191	0.079
2013	38	66	104	23.7	47.0	38.5	0.342	1.030	0.778	0.109	0.184	0.127
2014	93	71	164	23.7	64.8	41.5	0.408	1.620	0.932	0.109	0.333	0.163

Table 2. Annual trap survey sample sizes, % positive catches, mean catch per trap hour, and standard errors of gray triggerfish east and west of Cape San Blas, 2004-2014. Estimates calculated using censored data sets (see Methods).

	Total sites sampled			% Positive catches			Mean nominal catch/trap hr			Standard error		
Year	East	West	Total	East	West	Total	East	West	Total	East	West	Total
2004	22	30	52	54.5	36.7	36.7	1.041	1.698	1.420	0.300	0.598	0.367
2005	68	23	91	17.6	65.2	65.2	0.318	1.679	0.662	0.096	0.565	0.170
2006	68	23	91	39.7	69.6	69.6	0.769	1.329	0.911	0.174	0.265	0.148
2007	44	20	64	40.9	30.0	30.0	0.747	0.563	0.690	0.198	0.249	0.156
2008	50	31	81	18.0	51.6	51.6	0.282	1.816	0.869	0.102	0.471	0.207
2009	51	28	79	47.1	57.1	57.1	0.630	1.755	1.028	0.138	0.451	0.191
2010	46	14	60	21.7	35.7	35.7	0.462	1.023	0.593	0.172	0.704	0.209
2011	48	31	79	6.3	64.5	64.5	0.065	2.107	0.866	0.043	0.536	0.238
2012	52	29	81	13.5	31.0	31.0	0.115	0.549	0.270	0.047	0.184	0.076
2013	14	37	51	14.3	29.7	29.7	0.095	0.558	0.431	0.065	0.204	0.151
2014	55	33	88	7.3	36.4	36.4	0.057	1.147	0.466	0.030	0.379	0.153

Figures

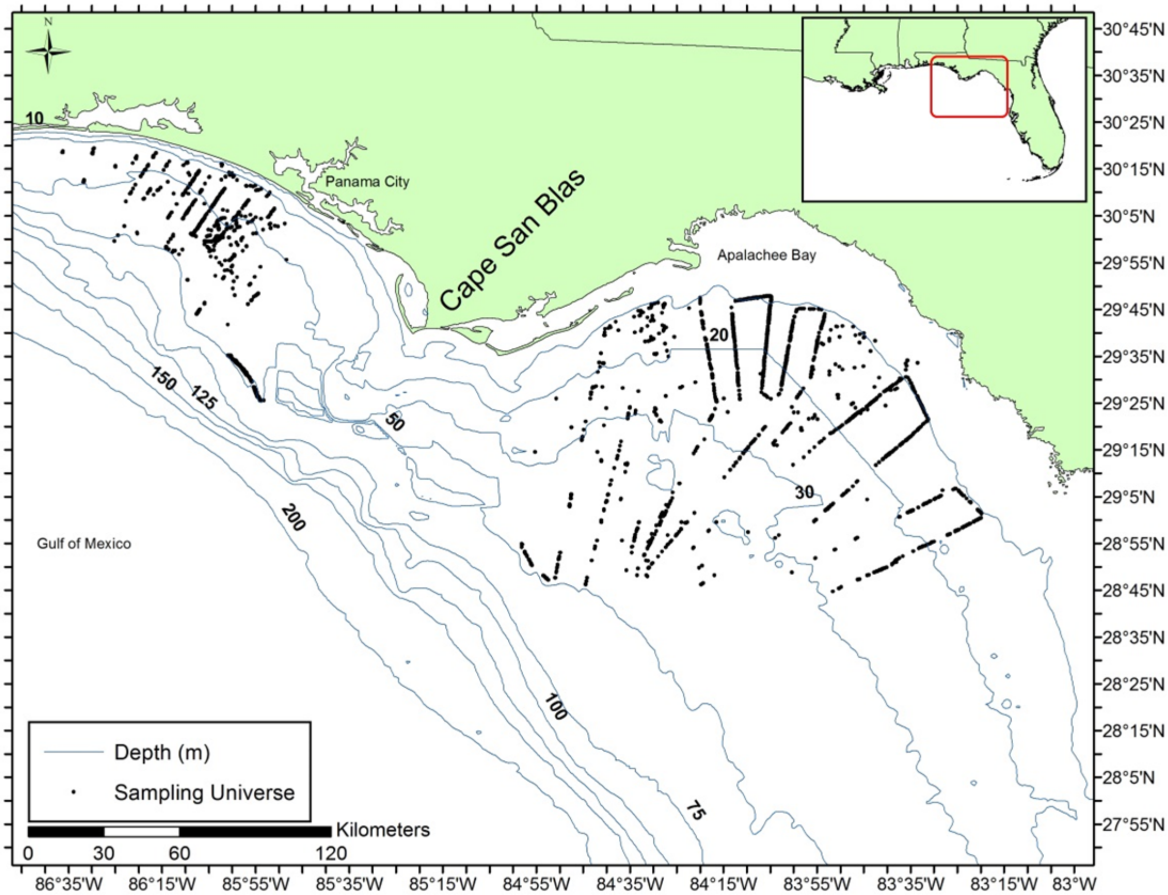


Figure 1. Locations of all natural reefs in the sampling universe of the Panama City NMFS reef fish video survey as of November 2014. Total sites: 2985 – 1105 west, and 1880 east, of Cape San Blas.

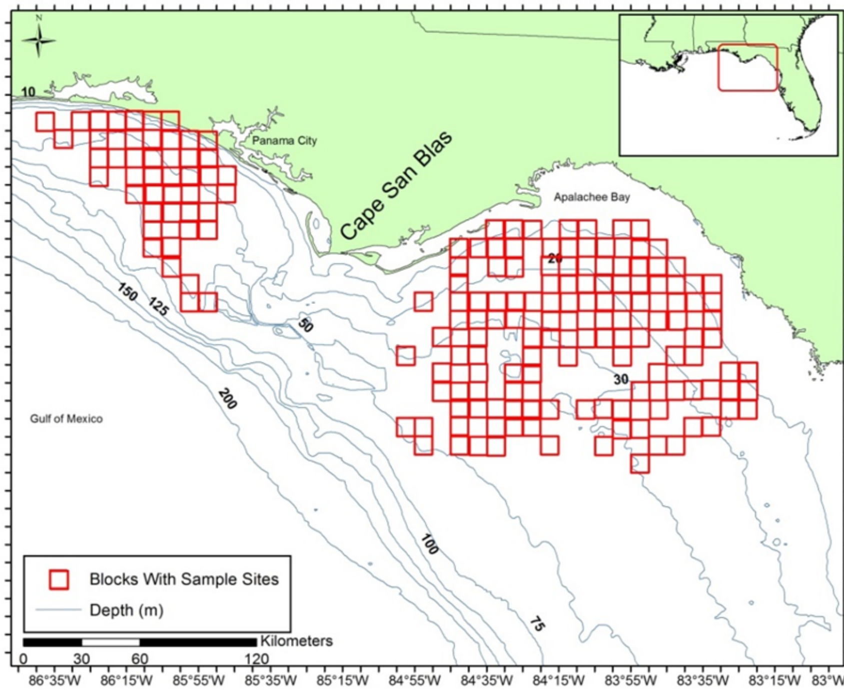


Figure 2. Sampling blocks (5' lat. X 5' long.) of the Panama City reef fish survey as of 2014.

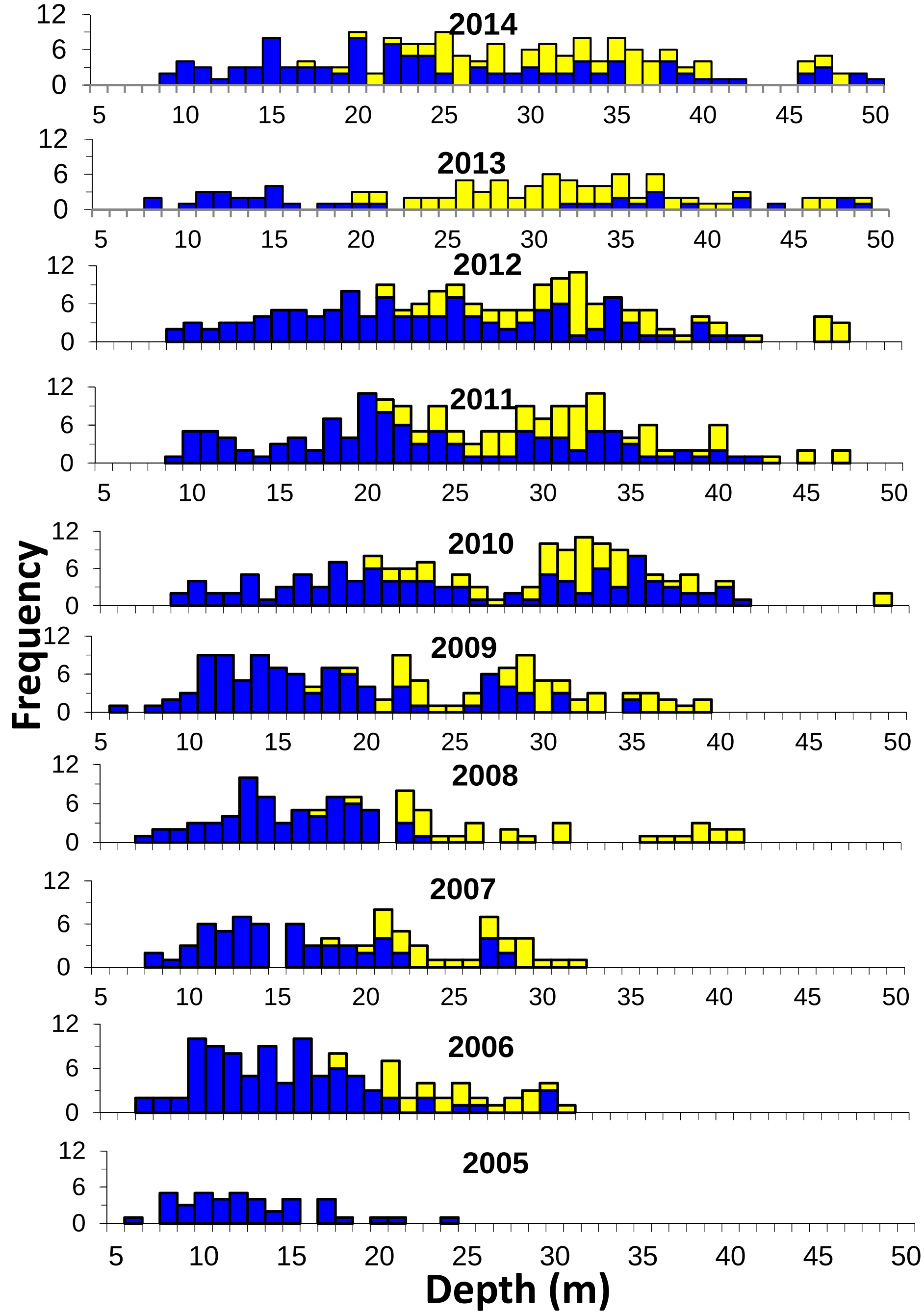


Figure 3. Annual depth distribution of Panama City reef fish survey video sample sites east and west of Cape San Blas, 2005-2014.

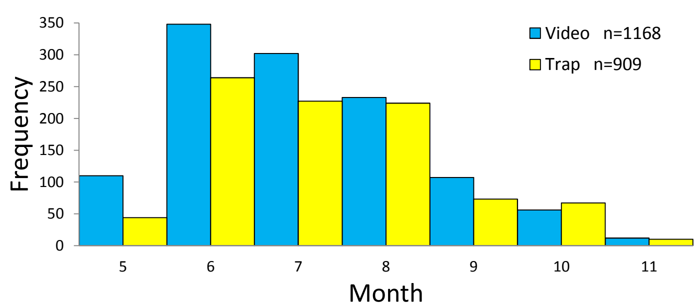


Figure 4. Overall monthly distribution of Panama City reef fish survey video and trap samples (censored data sets only), 2004-2014.

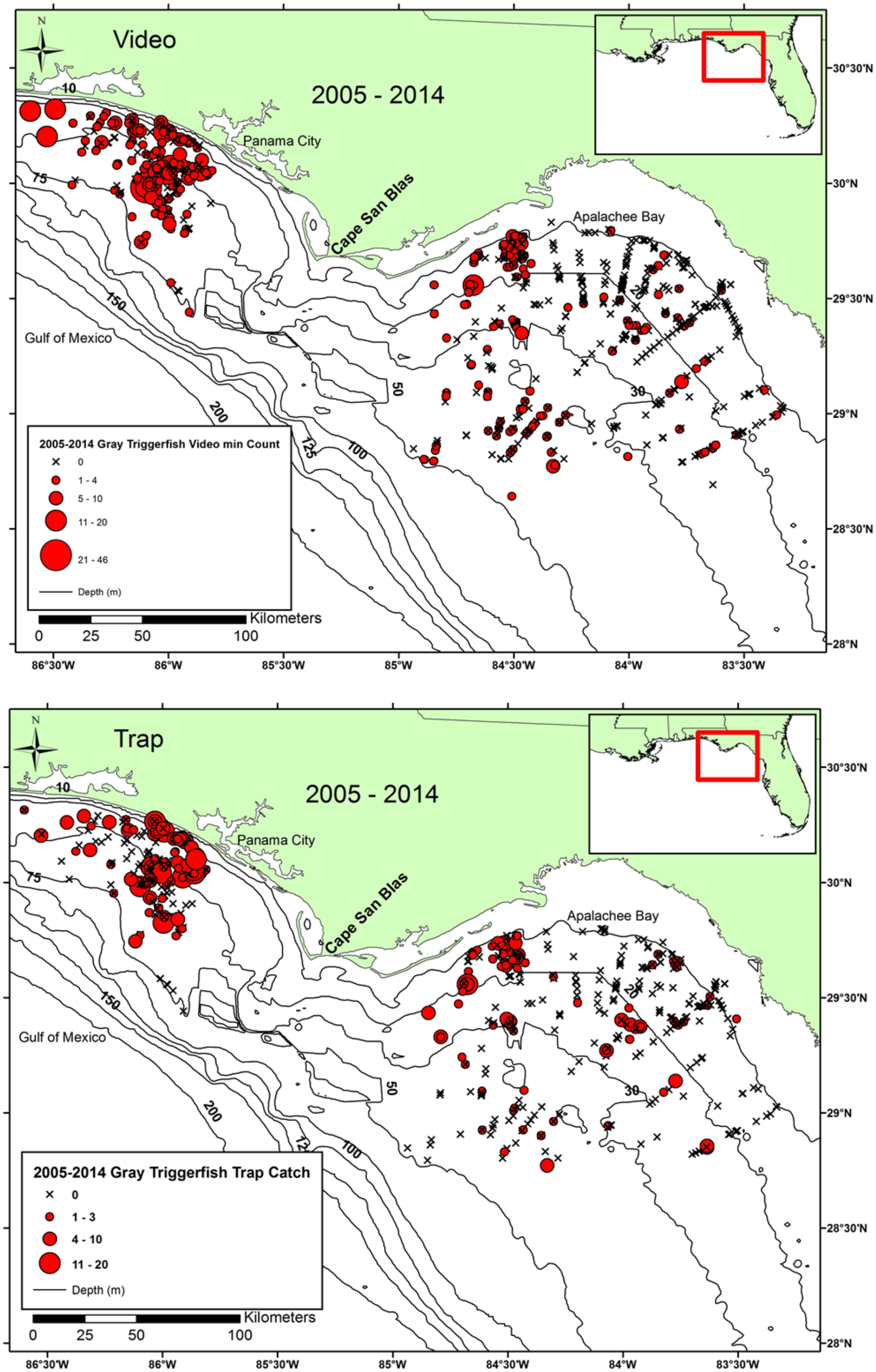


Figure 5. Distribution and relative abundance of gray triggerfish observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2004-2014. Sites sampled, but where no gray triggerfish were caught or observed, are indicated with an X.

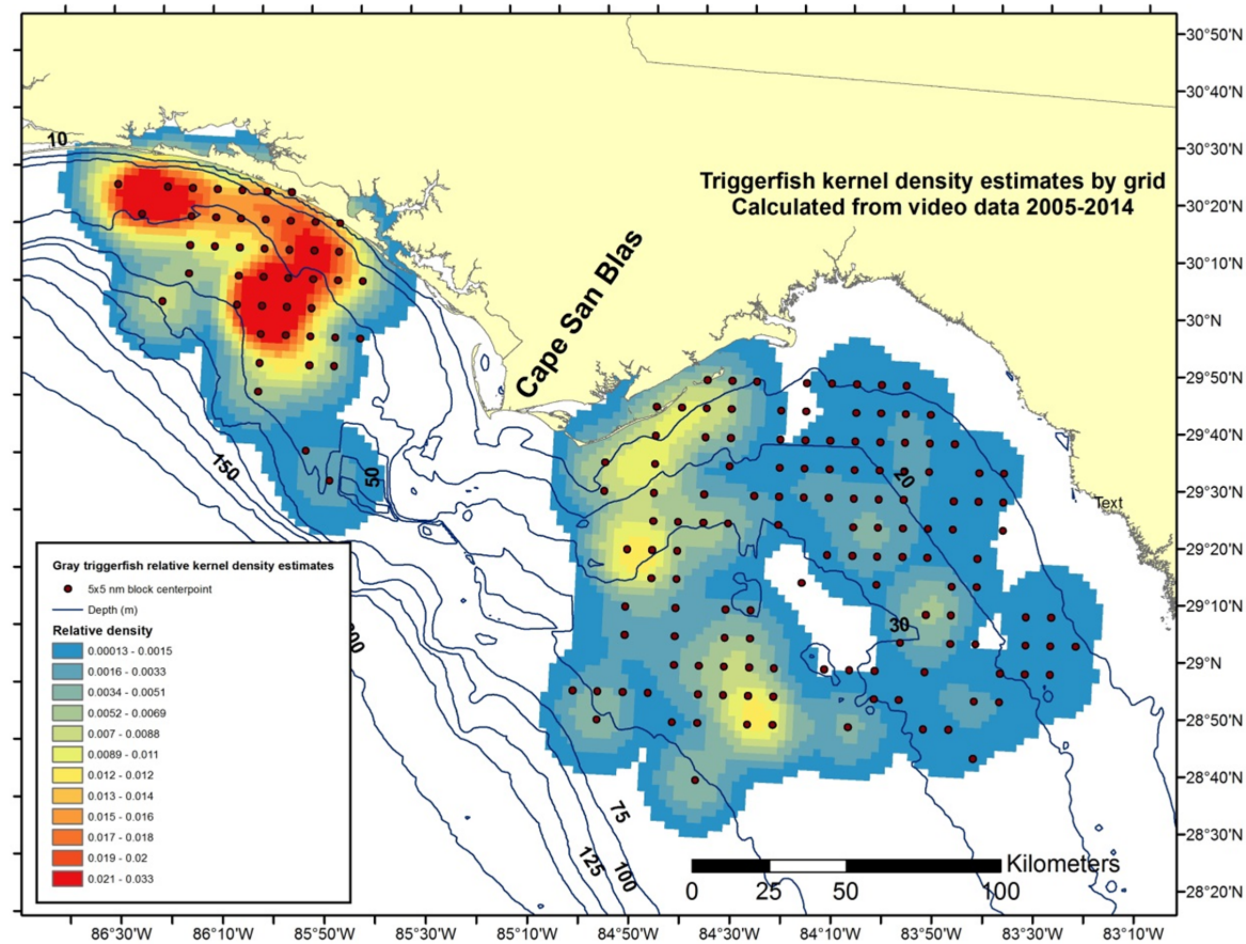


Figure 6. Overall relative density plot of gray triggerfish based on count data (min-counts, also called maxN) from video collected with stationary camera arrays in annual surveys, 2005-2014. Min counts were standardized by 5 min x 5 min sampling block, and kernel density estimates were calculated from the mid-point (black dots in the figure) of each block (See Fig. 2).

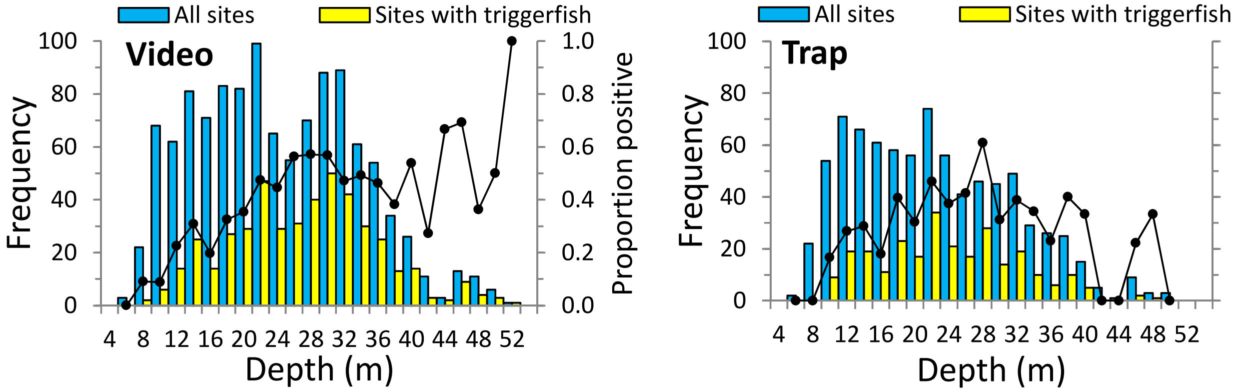


Figure 7. Depth distributions of all video and trap sample sites vs only sites positive for gray triggerfish, 2004-2014; and overall proportions of positive gray triggerfish video and trap samples, 2004-14, by depth.

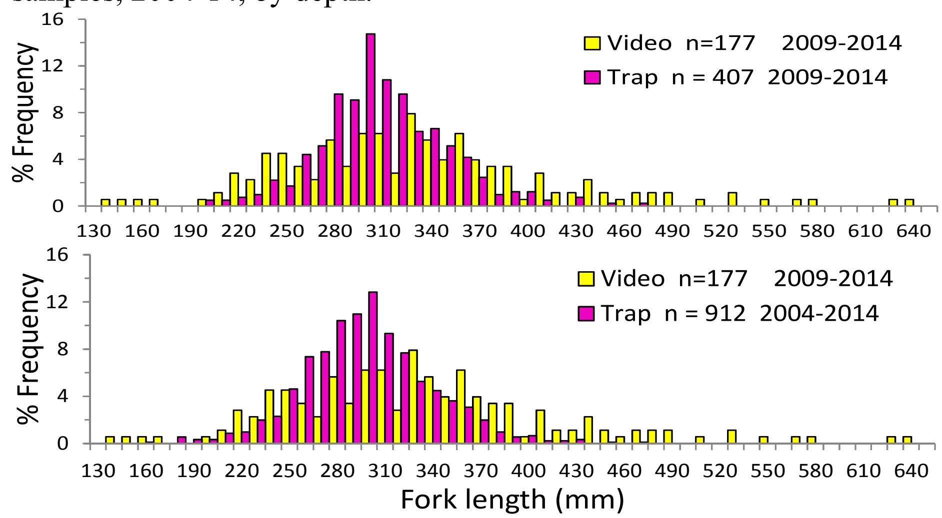


Figure 8. Overall size distributions of (top) all gray triggerfish collected in chevron traps and measured in stereo images, 2009-2014, and (bottom) all gray triggerfish collected in chevron traps, 2004-2014, and measured in stereo images, 2009-2014.

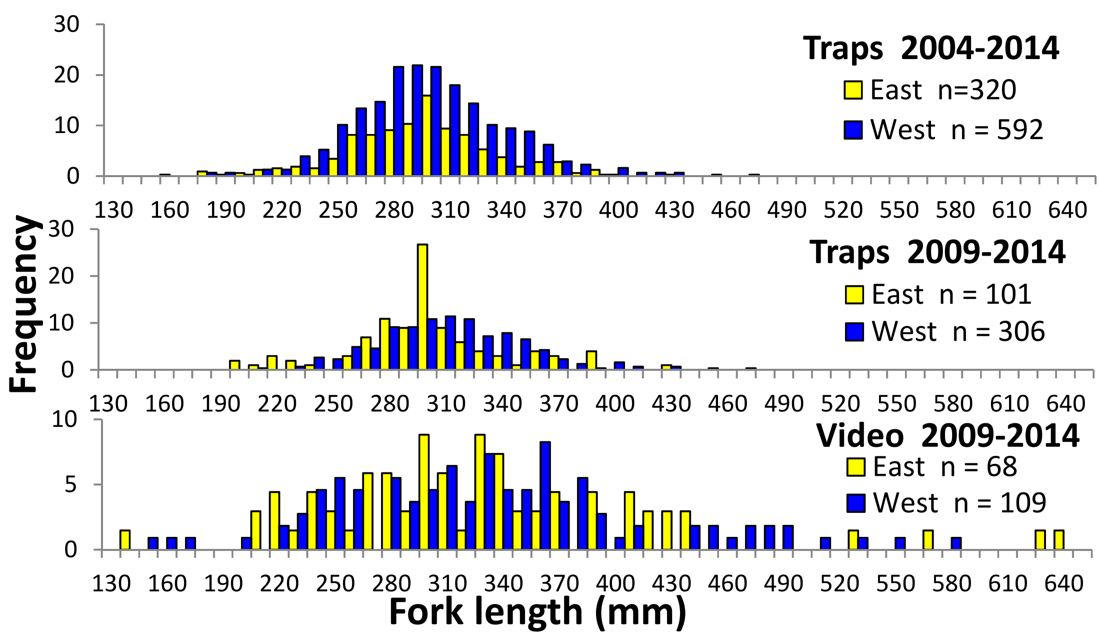


Figure 9. Overall size distributions east and west of Cape San Blas of trap-caught gray triggerfish, 2004-14 and 2009-14, and triggerfish measured from stereo images, 2009-14.

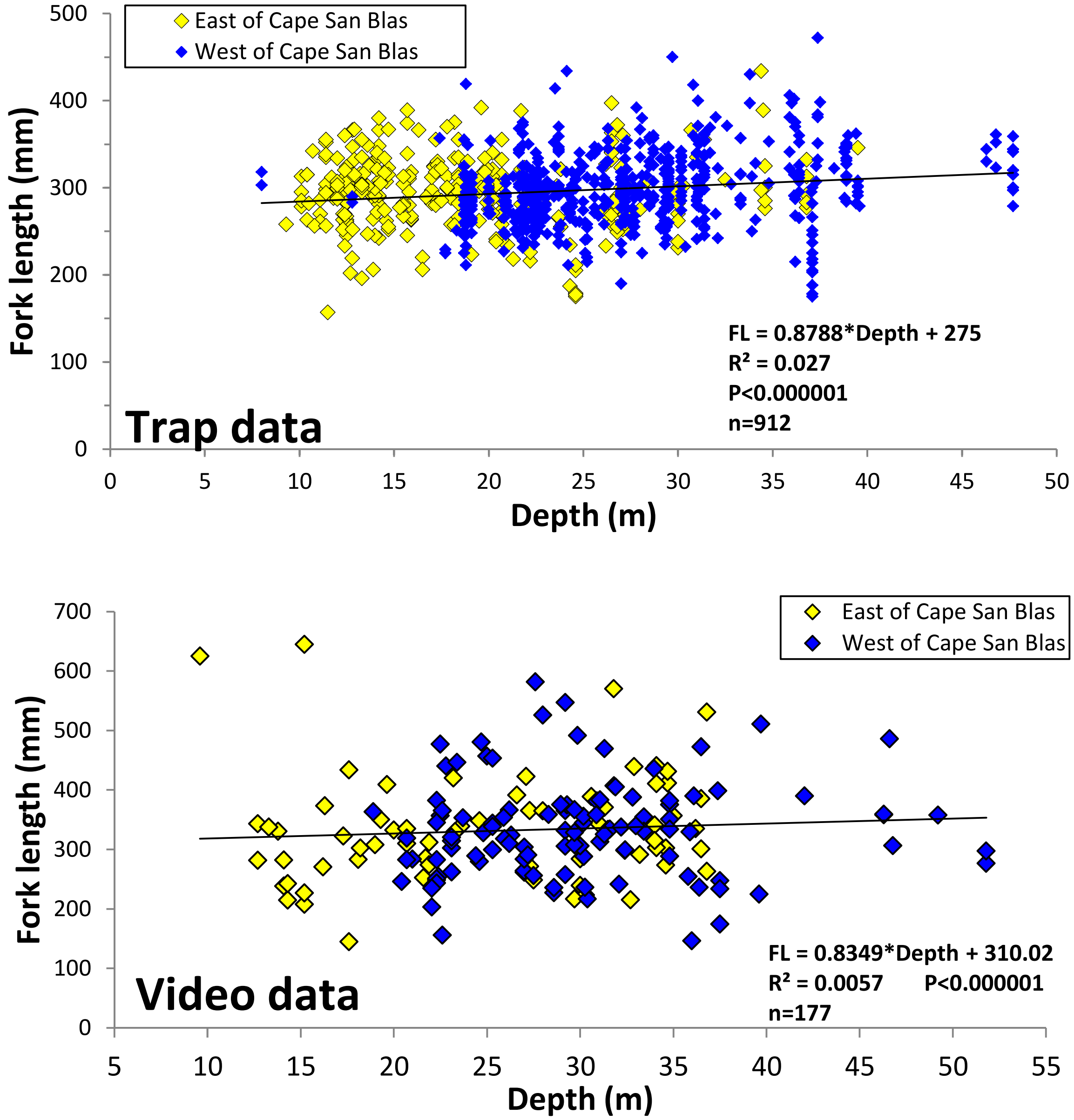


Figure 10. Fork length vs. depth relationship of gray triggerfish collected in traps and measured from stereo images in the video survey, 2004-2014.

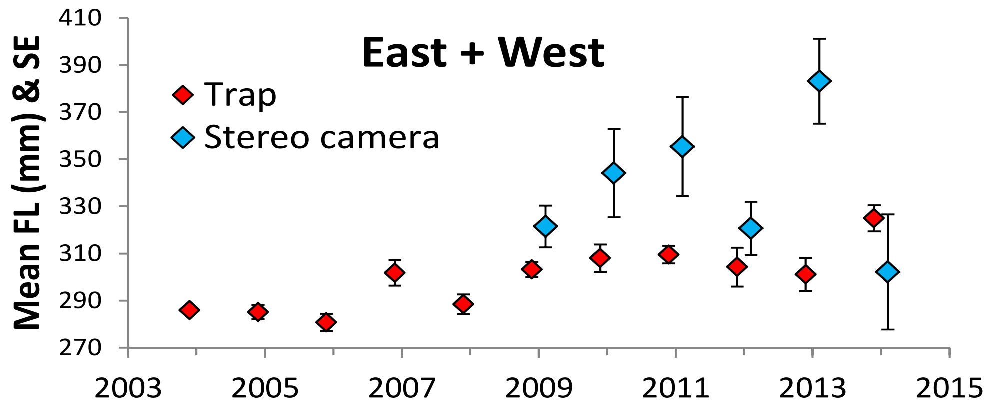


Figure 11. Mean annual size and standard error of triggerfish from traps, 2004-2014, and measured from stereo images, 2009-2014.

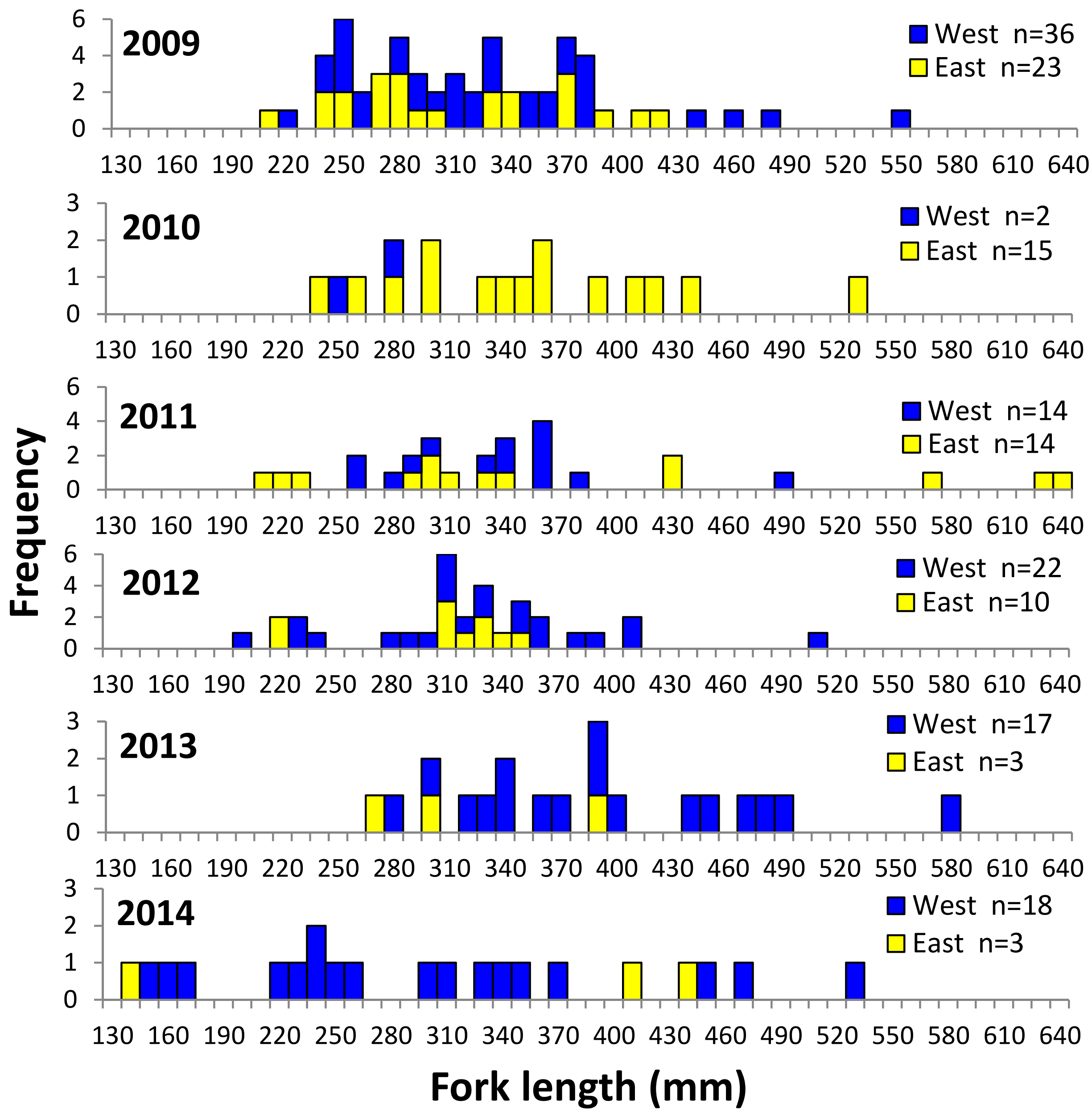


Figure 12. Annual size distributions of gray triggerfish derived from measurements from stereo images collected in the video survey, 2009-2014.

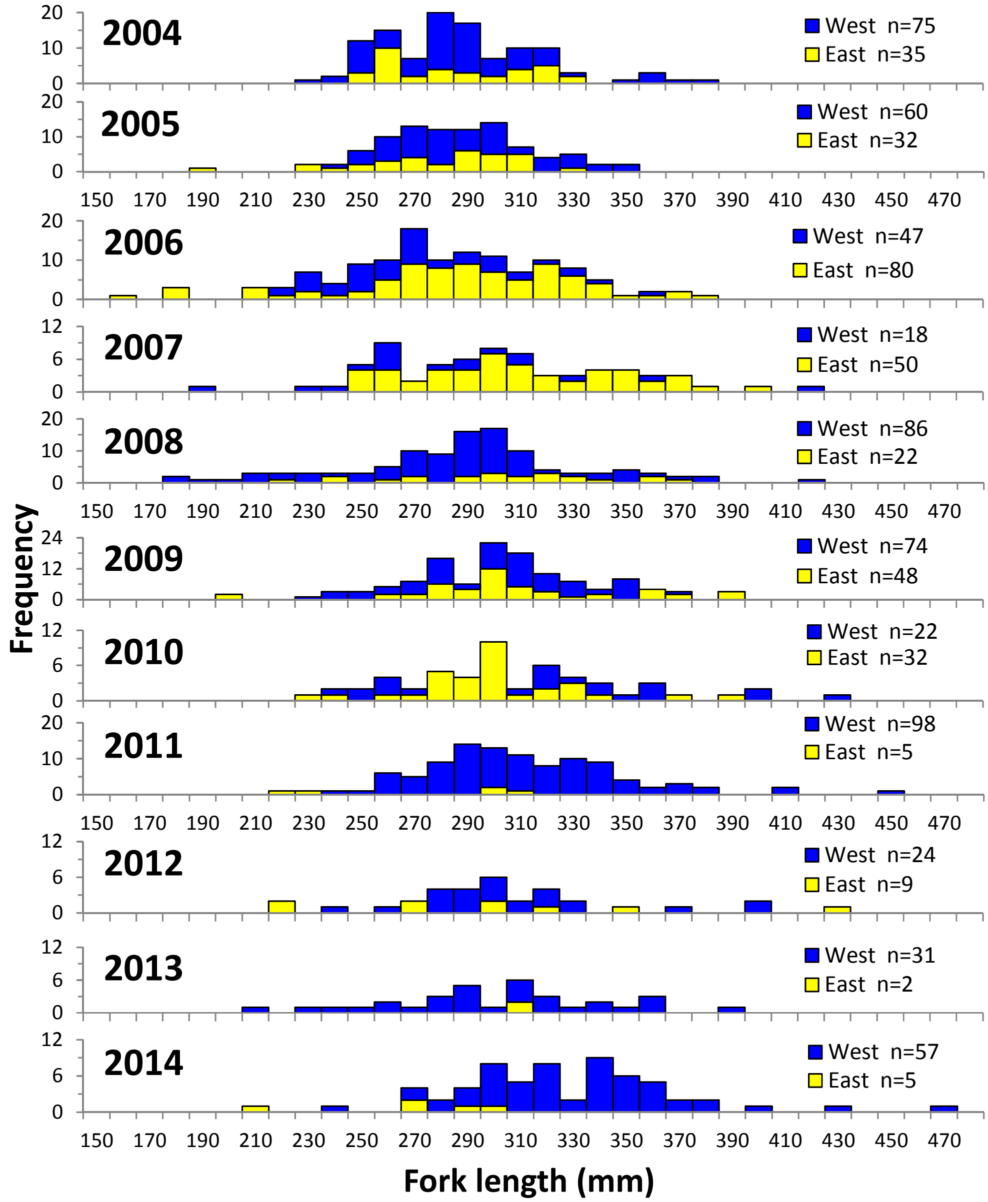


Figure 13. Annual size distributions of gray triggerfish collected in chevron traps, 2004-2014, east and west of Cape San Blas.

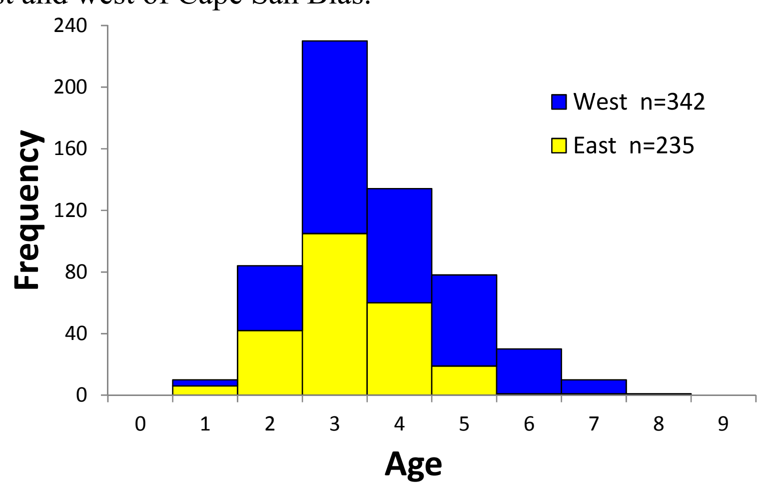


Figure 14. Overall age structure of trap-caught gray triggerfish, 2004-2013, east and west of Cape San Blas.

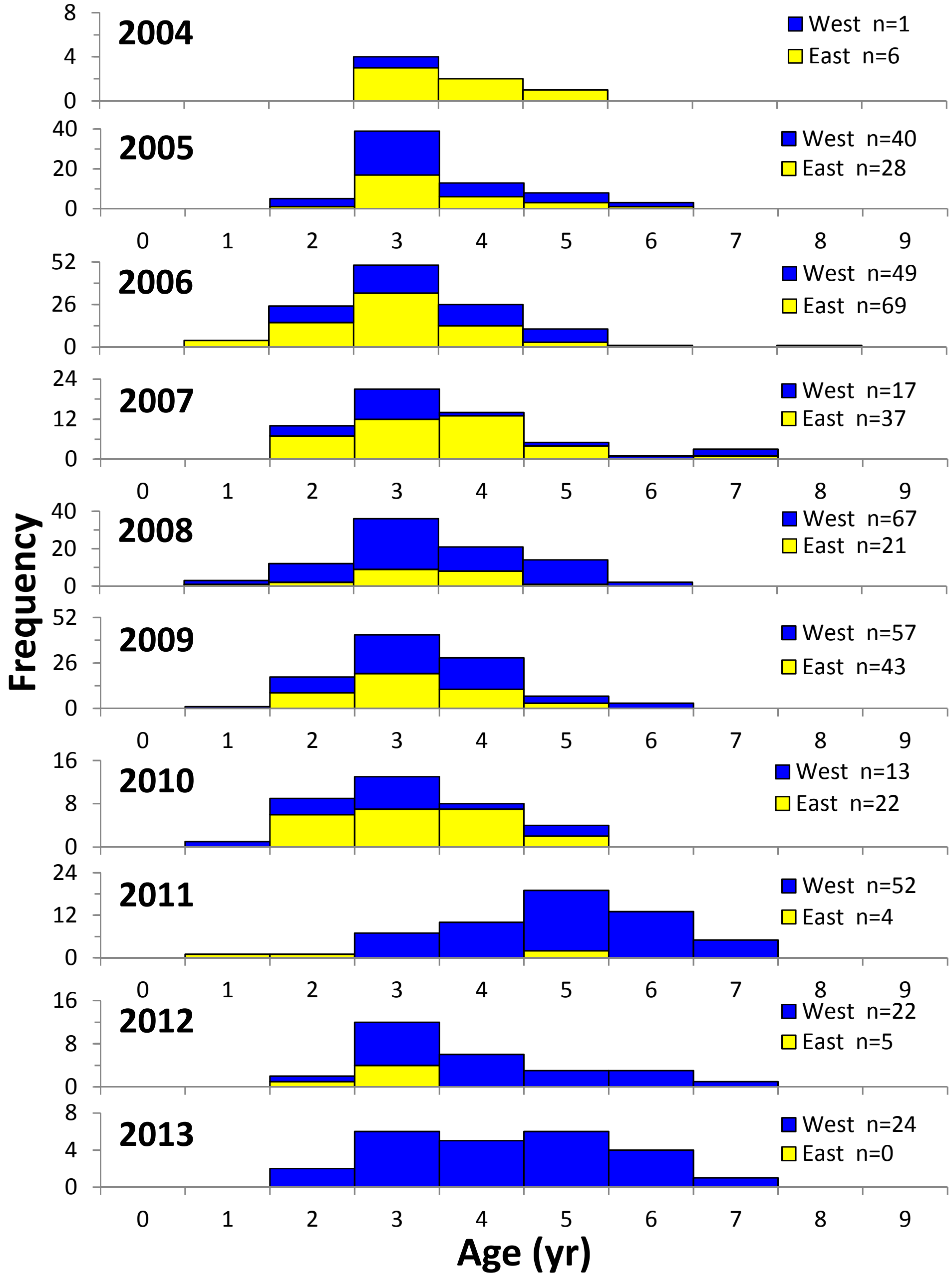


Figure 15. Annual age structure of gray triggerfish caught in chevron traps in the NOAA Panama City lab reef fish survey, 2004-2013, by region.

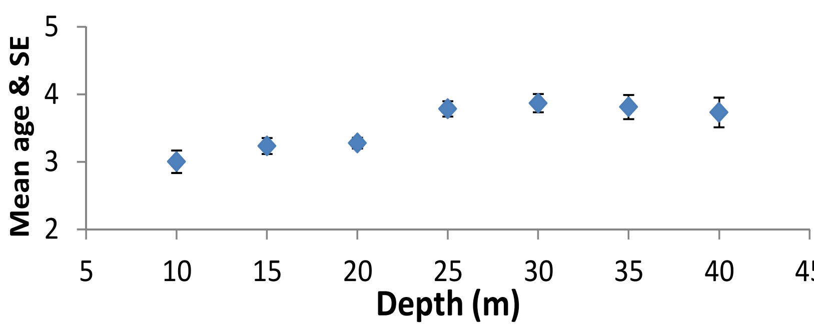


Figure 16. Age vs depth relationship of gray triggerfish caught in chevron traps, 2004-2013, in the Panama City reef fish survey.

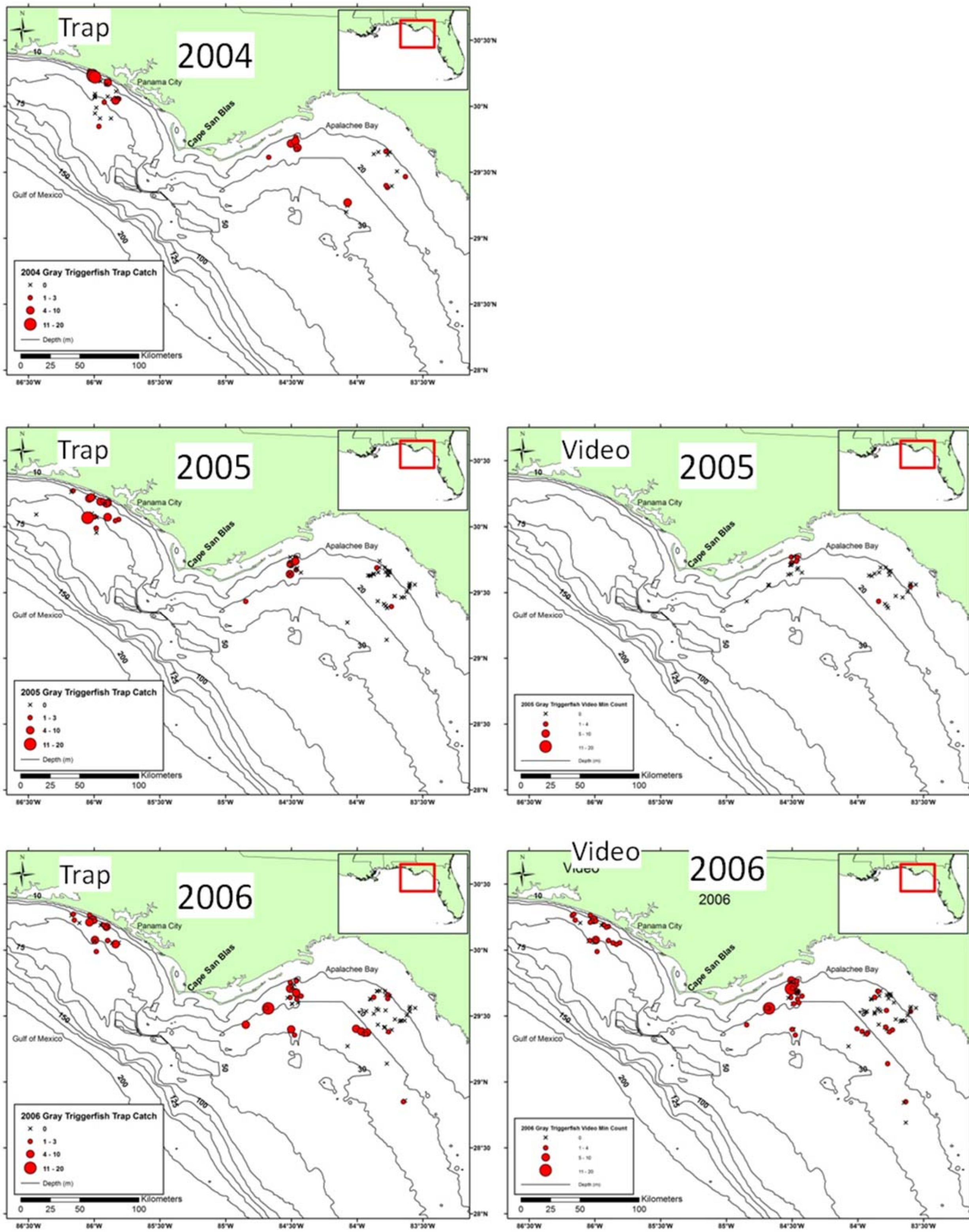


Figure 17. Annual distribution and relative abundance of gray triggerfish observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2004-2014. Sites sampled, but where no gray triggerfish were caught or observed, are indicated with an X.

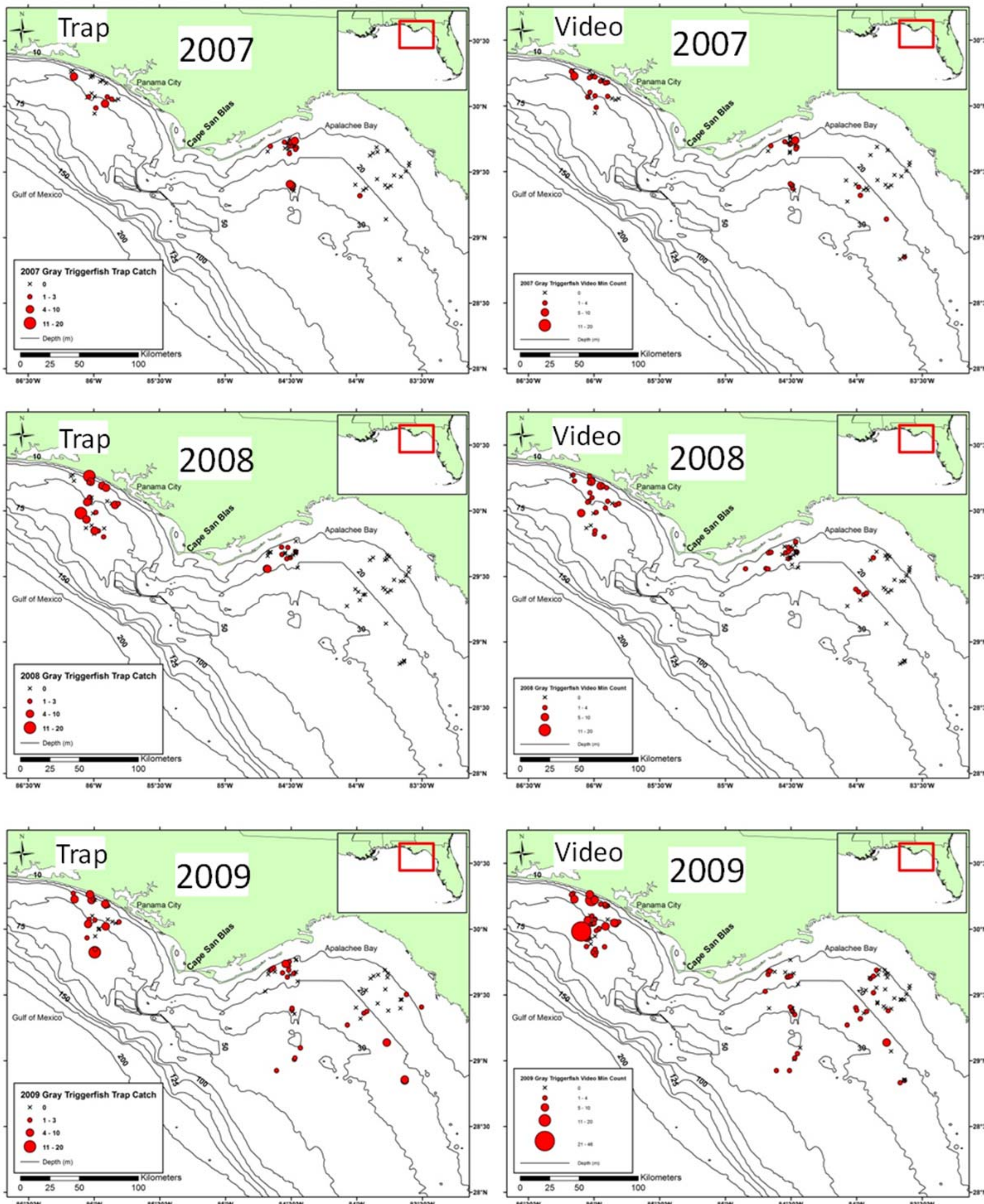


Figure 17 cont. Annual distribution and relative abundance of gray triggerfish observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2004-2014. Sites sampled, but where no gray triggerfish were caught or observed, are indicated with an X.

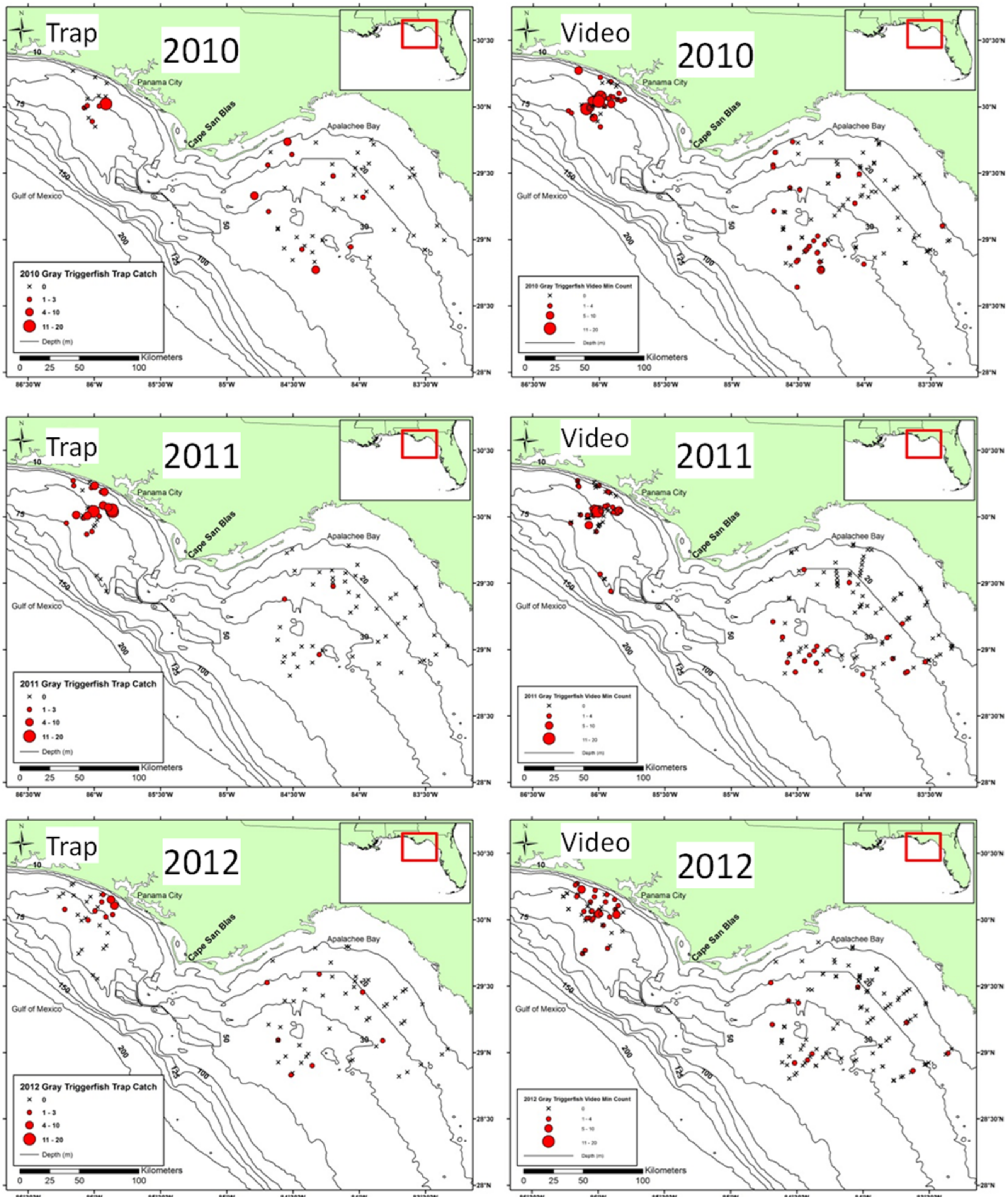


Figure 17 cont. Annual distribution and relative abundance of gray triggerfish observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2004-2014. Sites sampled, but where no gray triggerfish were caught or observed, are indicated with an X.

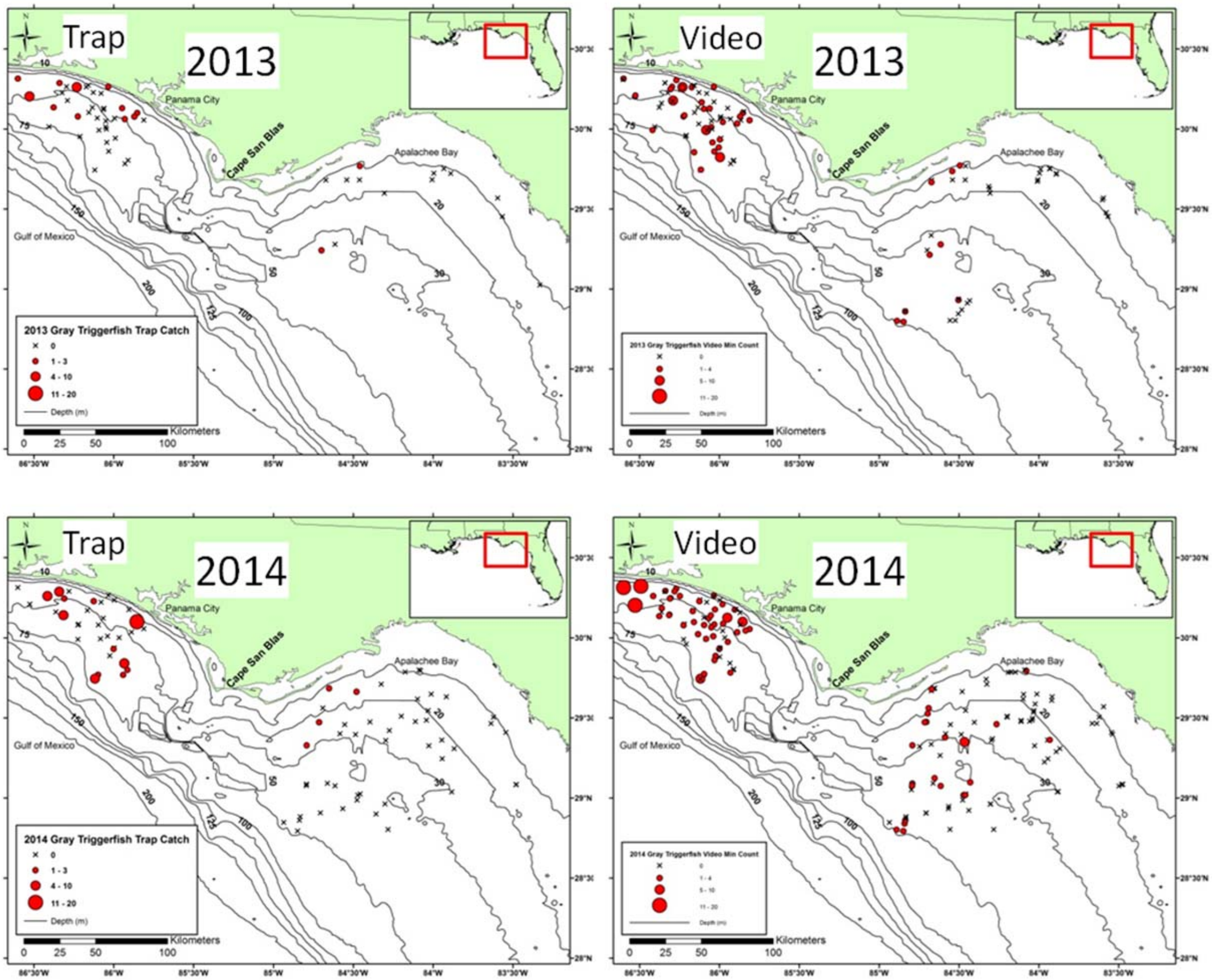


Figure 17 cont. Annual distribution and relative abundance of gray triggerfish observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2004-2014. Sites sampled, but where no gray triggerfish were caught or observed, are indicated with an X.

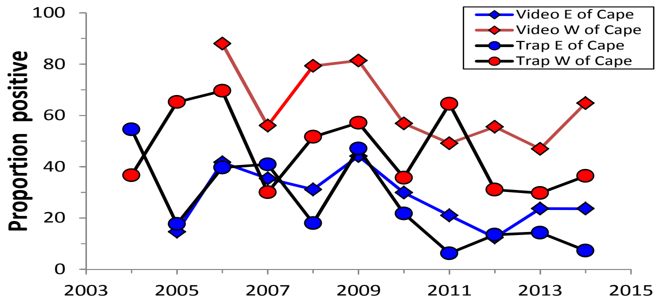


Figure 18. Annual proportion of positive gray triggerfish samples by gear by area (east and west of Cape San Blas).

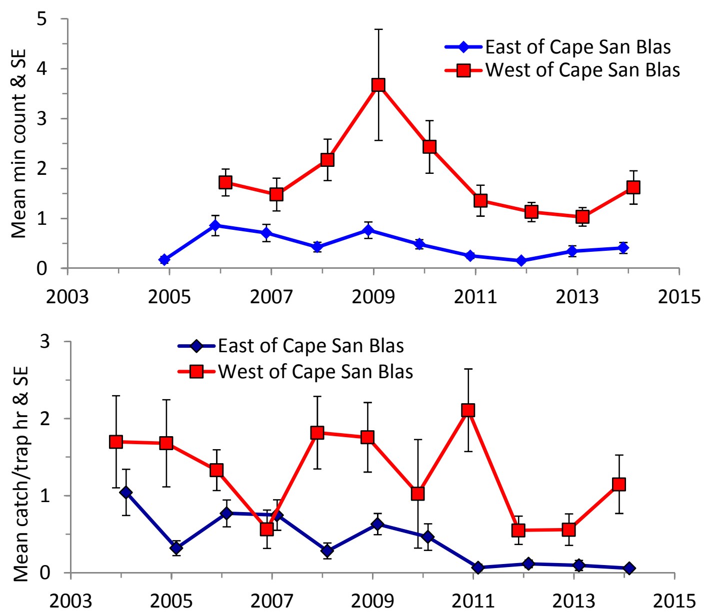


Figure 19. Annual nominal catch/trap hr ± std error (lower panel) and mean video min count ±std error (upper panel) for gray triggerfish east and west of Cape San Blas, 2004-2014.

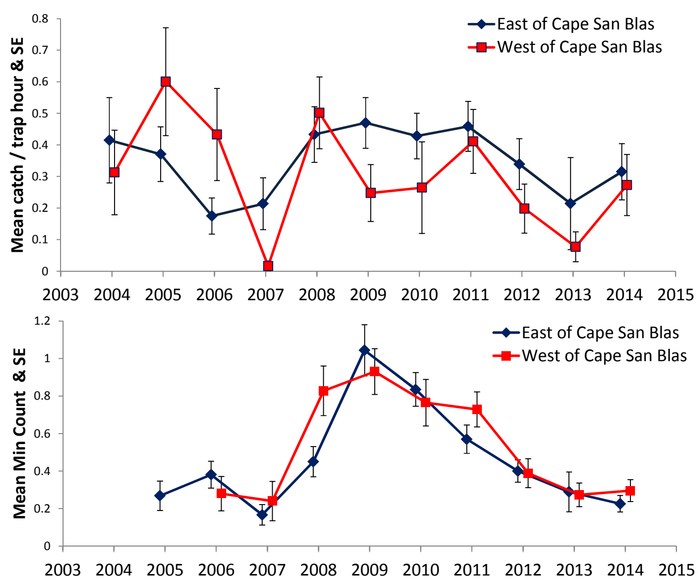
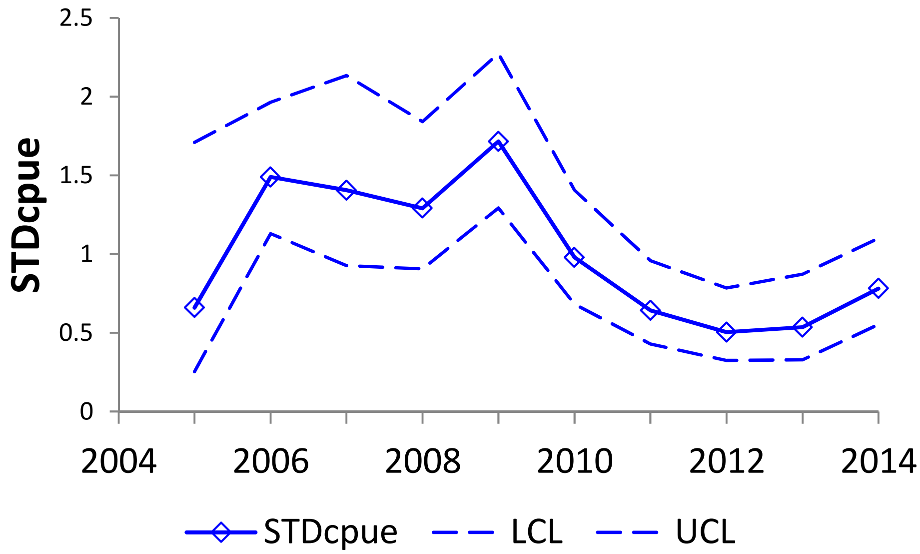


Figure 20. Annual nominal catch/trap hr ± std error (upper panel) and mean video min count ± std error (lower panel) for red grouper east and west of Cape San Blas, 2004-2015.



Survey Year	Nominal Frequency	N	Index	Scaled Index	CV	LCL	UCL
2005	0.14634	41	0.61577	0.65962	0.50429	0.25459	1.70902
2006	0.52294	109	1.38967	1.48864	0.13893	1.12899	1.96286
2007	0.43836	73	1.31178	1.40520	0.21075	0.92612	2.13213
2008	0.46667	90	1.20547	1.29132	0.17833	0.90645	1.83959
2009	0.57658	111	1.60028	1.71425	0.14175	1.29288	2.27294
2010	0.39865	148	0.91369	0.97877	0.18241	0.68161	1.40547
2011	0.30818	159	0.59933	0.64201	0.20281	0.42969	0.95926
2012	0.27044	159	0.47079	0.50432	0.22384	0.32408	0.78479
2013	0.38462	104	0.49973	0.53532	0.24753	0.32870	0.87182
2014	0.41463	164	0.72866	0.78056	0.17307	0.55358	1.10059

Figure 21. PC Video abundance indices for gray triggerfish. STDcpue is the index scaled to a mean of one over the time series. Obscpue is the average nominal CPUE, and LCI and UCI are 95% confidence limits for the scaled index. In the table above, the *frequency* listed is nominal frequency, *N* is the number of video stations, *Index* is the abundance index in CPUE units, *Scaled Index* is the index scaled to a mean of one over the time series, *CV* is the coefficient of variation on the index value, and *LCL* and *UCL* are 95% confidence limits.