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D.A. DeVries, C.L. Gardner, P. Raley, and K. Overly
National Marine Fisheries Service
Southeast Fisheries Science Center
Panama City Laboratory
Panama City, FL

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Panama City Laboratory
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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 (Fig. 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 vermilion snapper, 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 (Fig. 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 (Fig. 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 (Fig. 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 (Fig. 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 41 of 41 in 2005, 84 of 89 in 2006, 48 of 57 in 2007, 61 of 66 in 2008, 68 of 97 in 2009, 97 of 109 in 2010, 100 of 115, in 2011, and 105 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, 25 of 25 sites in 2006, 24 of 29 in 2007, 29 of 31 in 2008, 44 of 47 in 2009, 50 of 53 in 2010, 60 of 64 in 2011, 53 of 59 in 2012, 67 of 72 in 2013, and 71 of 71 in 2014 were retained for analyses.

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.

Results

Since the Panama City lab reef fish survey began in 2004/5, lane snapper 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 overall frequency distribution of min counts strongly suggested that the species is relatively solitary, as about 79% of video observations involved one individual, with 14% of the remaining observations being 2 fish (Fig. 6). Lane snapper were never encountered in video samples in depths <13 m, and in only 6 of 238 samples from depths < 18 m (where 28% of all samples were taken) (Fig.7). Only 4 of the 135 positive trap sets occurred in depths

<19.4 m (Fig. 7). No lane snapper were observed in video samples deeper than 41.4 m, although 40 sites deeper than that were sampled. East of Cape San Blas lane snapper were observed in only 6 of 245 samples (2.1%) shallower than 18 m. Encounter rates did increase noticeably with depth starting at about 26 m and continued high to ~40 m, but beyond those depths results were difficult to interpret because of small sample sizes (Fig. 8). Because of this scarcity or absence of lane snapper in shallower depths, data summaries and analyses on proportion positives and nominal catch rates are presented both for collections from all depths and for collections only from depths ≥18 m.

Encounter rates: From 2006 through 2010, lane snapper were more commonly encountered west of Cape San Blas than east, even when data from <18 m depths were excluded. During those years the annual proportion of positive video samples in depths ≥18 m ranged from 0.00 to 0.48 (mean = 0.19) east of Cape San Blas and 0.29 to 0.73 (mean = 0.46) west of the Cape (Table 1, Fig. 9). The annual proportion of positive video samples those same years using data from all depths ranged from 0.02 to 0.26 (mean = 0.11) east of Cape San Blas, and 0.29 to 0.74 (mean = 0.45) in the west (Table 1, Fig. 9). Much of the difference across the Cape was directly related to the much larger proportion of shallow (<20 m) sites east of the Cape (Fig. 3 and 5). As more deep sites were added in the east in 2009 and especially in 2010, the differences between east and west narrowed, and when all the sites <18 m were excluded, proportion positives were about equal in 2011 and then the pattern actually reversed during 2012- 2014 (Fig. 3 and 9). The overall mean proportion of positive video samples for east and west combined was 0.21 for all depths and 0.29 for depths ≥ 18 m.

Chevron traps were much less effective than video gear for detecting/capturing lane snapper. The annual proportions of positive lane snapper trap catches from all depths during 2004-2013 ranged from 0.0 to 0.05 (mean = 0.01) east of Cape San Blas and 0.05 to 0.16 (mean = 0.10) west of the Cape, with west catches exceeding those in the east each year (Table 2, Fig. 10). In 2014 positive catches in the east rose from 0.00 the previous 6 years to 0.11, and exceeded those in the west (0.06); and then in 2015 in both regions increased dramatically – to 0.31 in the east and 0.23 in the west (Table 2, Fig. 10). This almost two-fold increase on both sides of the Cape strongly suggests the entrance of a strong year class into the population, and given the same obvious trend in both areas, it’s reasonable to assume both groups were part of one stock or sub-population.

Abundance trends: Not surprisingly, patterns in relative abundance of lane snapper were very similar to those seen in proportion positives. From 2006 through 2010, when data from all depths were included, relative abundance of lane snapper was higher (110-4900%) west of Cape San Blas than east. During those years mean nominal video min counts ranged from 0.02 to 0.74 (mean = 0.25) east of and 0.29 to 1.55 (mean = 0.81) west of Cape San Blas (Table 1, Fig. 11). During those same years, excluding data from depths <18 m, the pattern was the same 2006-2008 (much higher in the west), but beginning in 2009, and through 2011, relative abundance was quite similar on both sides of the Cape (2-8% differences) (Table 1, Fig. 11). As with proportion positives, the earlier pattern was opposite during 2012-2014 when relative abundance was considerably higher in the east than the west, ranging from 0.73 to 0.77 (mean = 0.75) in the former and 0.30 to 0.40 (mean = 0.34) in the latter (Table 1, Fig. 11). Video min counts also showed the same large spike in 2009 followed by a fairly sharp decline on both sides of Cape San Blas seen in the proportion positives, further evidence of the entrance of a strong year class, and likely a single stock inhabiting both sides of Cape San Blas. CPUE data from the much more selective trap survey showed a spike in 2007 in the east and

2008 in the west but both with very large standard errors, and no evidence of the dominant jump seen in the video data in 2009 (Fig. 12). The trap data did show a very large spike in relative abundance in 2015 on both sides of the Cape, but especially on the east – a 1246% increase over 2014 compared to 252% increase in the west (Table 2, Fig. 12). The video data for 2015 are not yet available, but it is very likely it will show the same dramatic increase.

Annual GIS plots of video min counts and trap catch/hr of lane snapper showed similar geographic patterns in relative abundance trends between 2005 and 2014 (Fig. 13).

Lane snapper observed with stereo cameras during 2009-2014 averaged only slightly larger than those caught in traps those same years — 295 mm vs 274 mm FL, but their distributions differed somewhat – the former was basically unimodal with a mode at ~250 mm FL while the latter was more bimodal, with modes at ~200 and 300 mm FL (Fig. 14). The more selective traps had a slightly truncated distribution, with sizes ranging from 167 to 439 mm FL compared to 153 to 501 mm from stereo images, but the former did seem to be more effective at capturing smaller individuals (Fig.14).

Mean sizes of lane snapper from stereo image measurements were larger west of Cape San Blas than east —318 vs 283 mm FL. Minimum size was much smaller and the proportion of small fish was much higher in the east than the west – 153 vs 219 mm and 22% <219 mm FL in the east vs none in the west (Fig. 15). The pattern from the trap catches was very similar. Mean and minimum sizes were 319 and 223 mm in the west vs 253 and 167 mm in the east. The proportion of small fish in trap catches in the east was much higher than that observed in the stereo data – 69% were <219 mm FL vs none<219 mm in the west (Fig. 15).

There appears to be little if any relationship between size of lane snapper and depth. The regression of fork length on depth from the video survey was not significant ($p=0.346$) (Fig. 16). Although the regression from the trap survey data was highly significant, showing a positive relationship between size and depth, high sample size and a very few observations from the shallowest depths overly influenced those results.

Annual size distributions from the stereo camera survey shifted to larger sizes (although sample sizes were small) each year from 2009 to 2011, and then dropped noticeably in 2012 to a median size of ~250 mm, suggesting recruitment into the region of a new year class noticeably larger than those in the previous two years (Fig. 17). The size structure then shifted again to larger sizes in 2013, but showed no change in 2014, although sample sizes were small those two years and no fish from the west were measureable in 2014. As with stereo data, small sample sizes in the trap survey obscured modal progressions of annual length frequencies, especially from 2004 to 2008, making it difficult to interpret the observed patterns (Fig. 18). However, there was evidence of the same increasing size structure from 2009 through 2011 seen in the stereo data, and then the definite shift to smaller sizes in 2012, followed by a steady progression to larger size modes through 2015. These results add credence to the previous assertion that there appeared to be a new strong year class that first became vulnerable to survey gear in 2012, and probably a similar event in 2009.

Not surprisingly, plots of annual mean sizes of lane snapper observed with stereo cameras and captured in traps showed the same increases in size from 2009 to 2011 and from 2012 to 2014 (Fig. 19).

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Tables

Table 1. Annual video survey sample sizes, proportion positive occurrences, mean nominal video min counts, and standard errors of lane snapper east and west of Cape San Blas, 2006-2014, for all depths (A) and for all depths ≥18 m (B). Estimates calculated using censored data sets (see Methods).

A. All depths included

	Total sites sampled			Proportion positive occurrences			Mean nominal min count			Standard error		
Year	East	West	Total	East	West	Total	East	West	Total	East	West	Total
2006	84	24	108	0.04	0.33	0.10	0.06	0.63	0.19	0.039	0.334	0.082
2007	47	24	71	0.02	0.29	0.11	0.02	0.29	0.11	0.021	0.095	0.038
2008	60	28	88	0.02	0.46	0.16	0.02	1.00	0.33	0.017	0.313	0.110
2009	68	38	106	0.26	0.74	0.43	0.74	1.55	1.03	0.293	0.322	0.223
2010	97	50	147	0.20	0.44	0.28	0.43	0.58	0.48	0.201	0.125	0.139
2011	99	58	157	0.12	0.17	0.14	0.20	0.33	0.25	0.073	0.138	0.069
2012	105	53	158	0.26	0.13	0.22	0.57	0.40	0.51	0.146	0.284	0.136
2013	34	60	94	0.21	0.23	0.22	0.38	0.30	0.33	0.152	0.076	0.073
2014	96	72	168	0.25	0.24	0.24	0.56	0.32	0.46	0.163	0.074	0.098
Total	**690**	**407**	**1097**	**0.15**	**0.34**	**0.22**	**0.34**	**0.54**	**0.41**	**0.051**	**0.066**	**0.040**

Depths ≥18 m

	Total sites sampled			Proportion positive occurrences			Mean nominal min count			Standard error		
Year	East	West	Total	East	West	Total	East	West	Total	East	West	Total
2006	22	23	45	0.14	0.35	0.24	0.227	0.652	0.444	0.146	0.348	0.192
2007	16	24	40	0.00	0.29	0.18	0.000	0.292	0.175	0.000	0.095	0.061
2008	17	27	44	0.06	0.48	0.32	0.059	1.037	0.659	0.059	0.322	0.211
2009	33	37	70	0.48	0.73	0.61	1.455	1.568	1.514	0.581	0.330	0.322
2010	71	50	121	0.27	0.44	0.34	0.592	0.580	0.587	0.273	0.125	0.168
2011	65	58	123	0.18	0.17	0.18	0.308	0.328	0.317	0.109	0.138	0.087
2012	82	53	135	0.33	0.13	0.25	0.732	0.396	0.600	0.183	0.284	0.157
2013	17	60	77	0.41	0.23	0.27	0.765	0.300	0.403	0.278	0.076	0.087
2014	67	71	138	0.31	0.23	0.27	0.761	0.310	0.529	0.228	0.074	0.118
Total	**390**	**403**	**793**	**0.27**	**0.31**	**0.29**	**0.615**	**0.538**	**0.576**	**0.093**	**0.066**	**0.057**

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

	Total sites sampled			Proportion positive catches			Mean nominal catch/trap hr			Standard error		
Year	East	West	Total	East	West	Total	East	West	Total	East	West	Total
2004	16	18	34	0.00	0.11	0.06	0.000	0.067	0.036	0.000	0.046	0.025
2005	44	18	62	0.05	0.11	0.06	0.061	0.073	0.064	0.048	0.050	0.037
2006	68	23	91	0.04	0.09	0.05	0.059	0.136	0.078	0.036	0.112	0.039
2007	44	20	64	0.05	0.10	0.06	0.294	0.094	0.231	0.229	0.068	0.159
2008	50	31	81	0.00	0.16	0.06	0.000	0.320	0.122	0.000	0.202	0.079
2009	53	29	82	0.00	0.14	0.05	0.000	0.171	0.060	0.000	0.091	0.033
2010	52	17	69	0.00	0.06	0.01	0.000	0.039	0.010	0.000	0.039	0.010
2011	50	30	80	0.00	0.07	0.03	0.000	0.044	0.017	0.000	0.031	0.012
2012	59	30	89	0.00	0.10	0.03	0.000	0.111	0.037	0.000	0.072	0.025
2013	14	37	51	0.00	0.05	0.04	0.000	0.036	0.026	0.000	0.025	0.018
2014	47	33	80	0.11	0.06	0.09	0.052	0.061	0.056	0.024	0.045	0.023
2015	35	36	71	0.31	0.17	0.24	0.700	0.215	0.454	0.221	0.118	0.127
Total	**532**	**322**	**854**	**0.04**	**0.10**	**0.07**	**0.088**	**0.121**	**0.100**	**0.026**	**0.028**	**0.019**

Figures

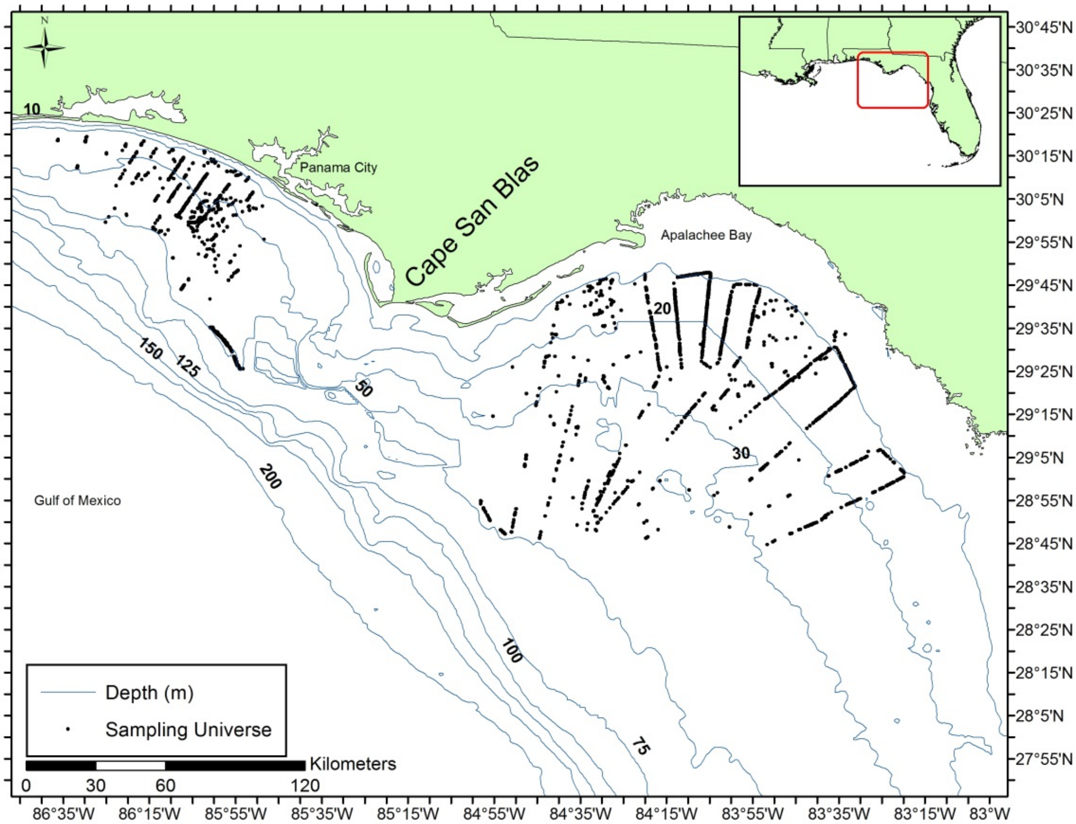

Figure 1. Locations of all natural reefs in the sampling universe of the Panama City NMFS reef fish video survey as of November 2014. Total sites: 2985 – 1105 west, and 1880 east, of Cape San Blas. Isobath labels are in meters.

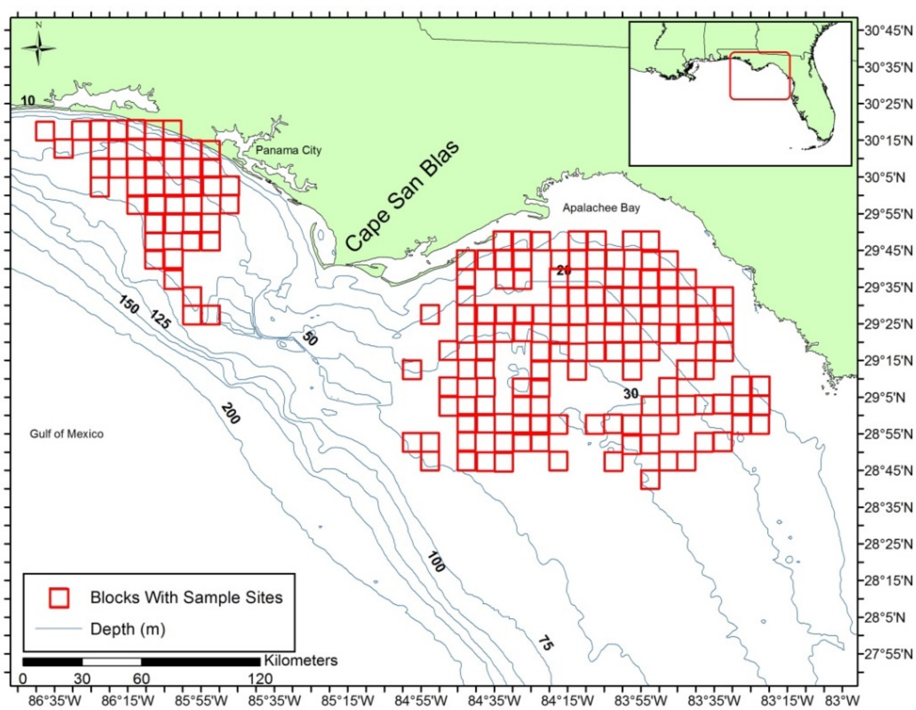

Figure 2. Sampling blocks (5 min lat. x 5 min. long.) of the Panama City reef fish survey as of 2014. Isobath labels are in meters.

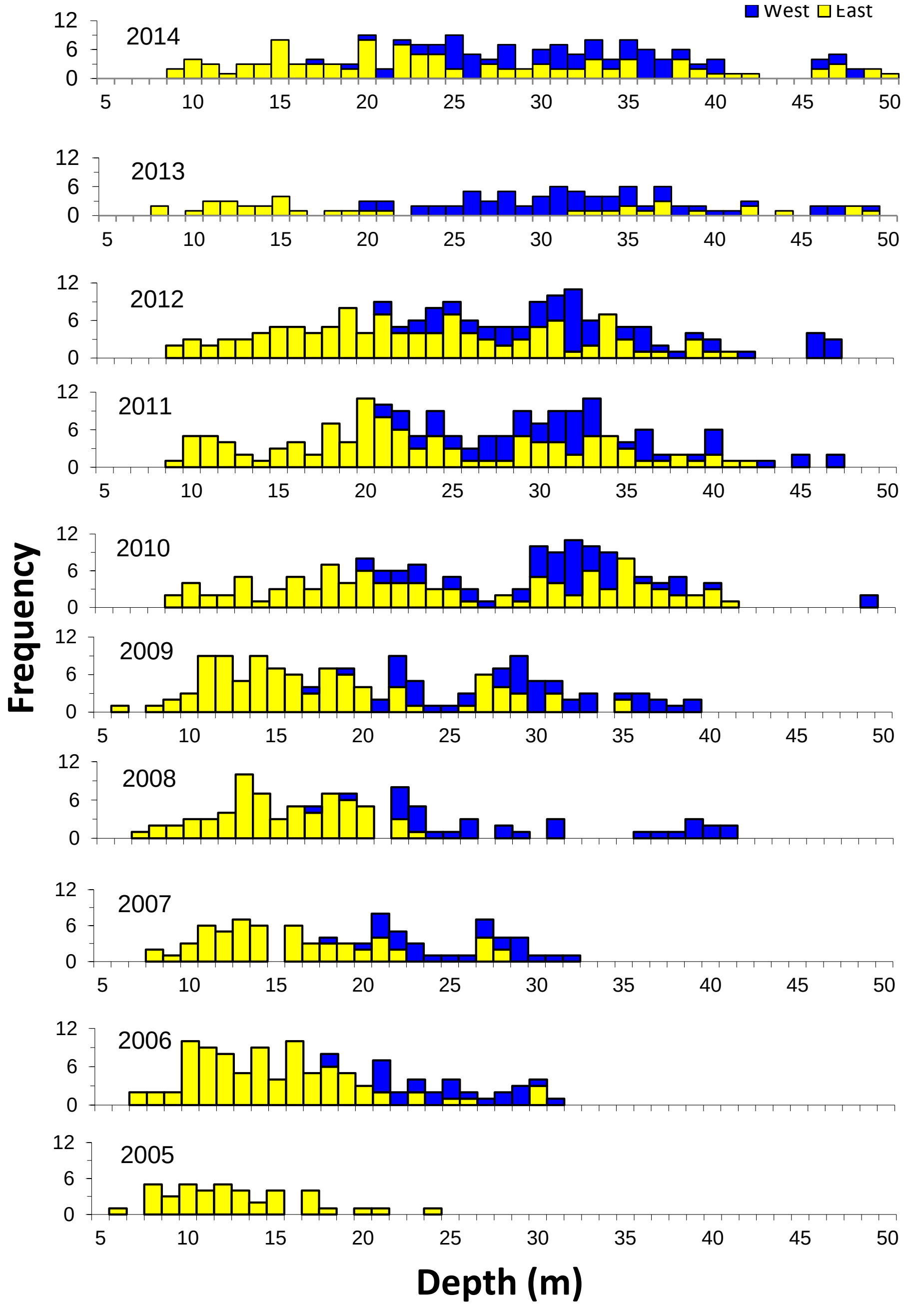

Figure 3. Annual depth distribution of Panama City reef fish survey video sample sites east and west of Cape San Blas, 2005-2014.

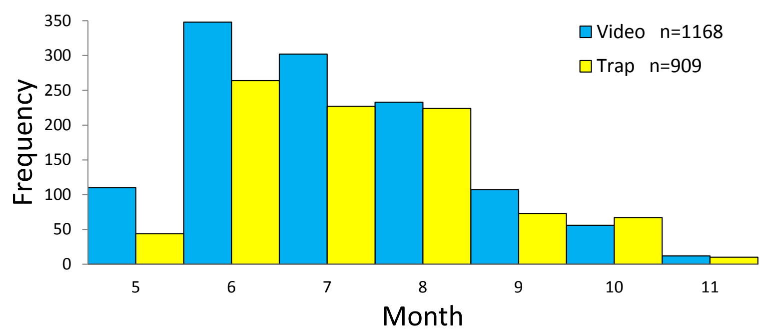

Figure 4. Overall monthly distribution of Panama City reef fish survey video and trap samples (censored data sets only), 2004-2014.

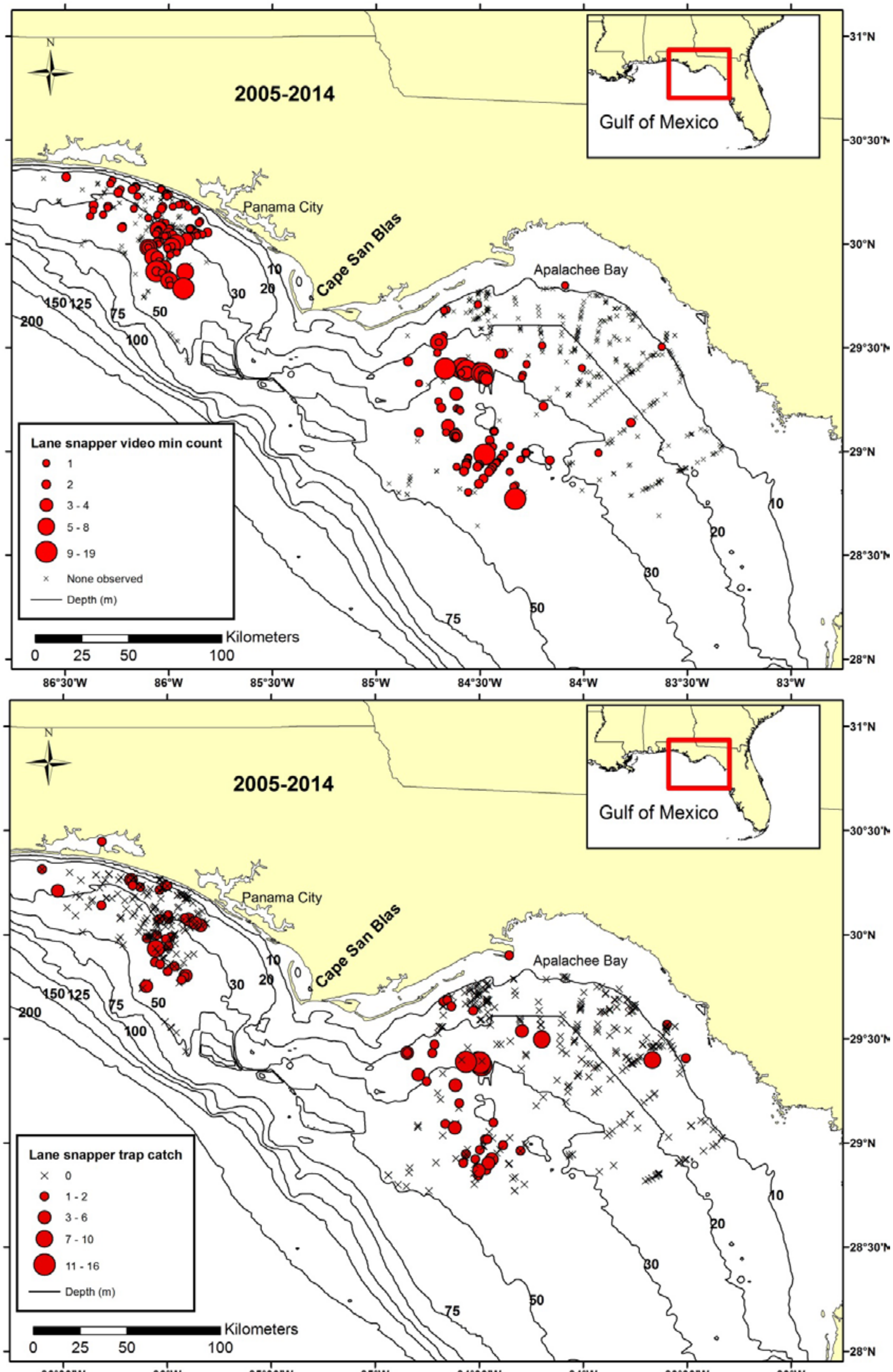

Figure 5. Distribution and relative abundance of lane snapper observed with stationary, high definition video or mpeg cameras (min counts) 2005-2014, and caught in chevron traps in the Panama City NMFS reef fish survey, 2004-2015. X's are sites sampled, but where no vermilion snapper were caught or observed.

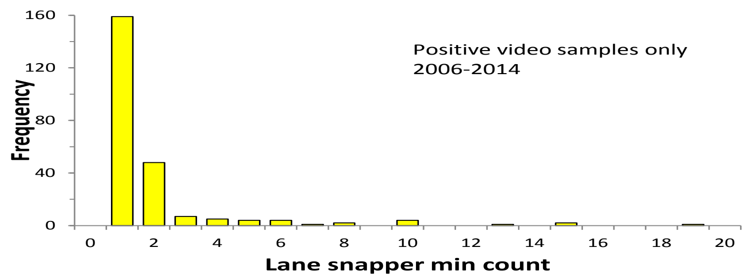

Figure 6. Frequency distribution of non-zero min counts of lane snapper from Panama City reef fish video samples, 2006-2014.

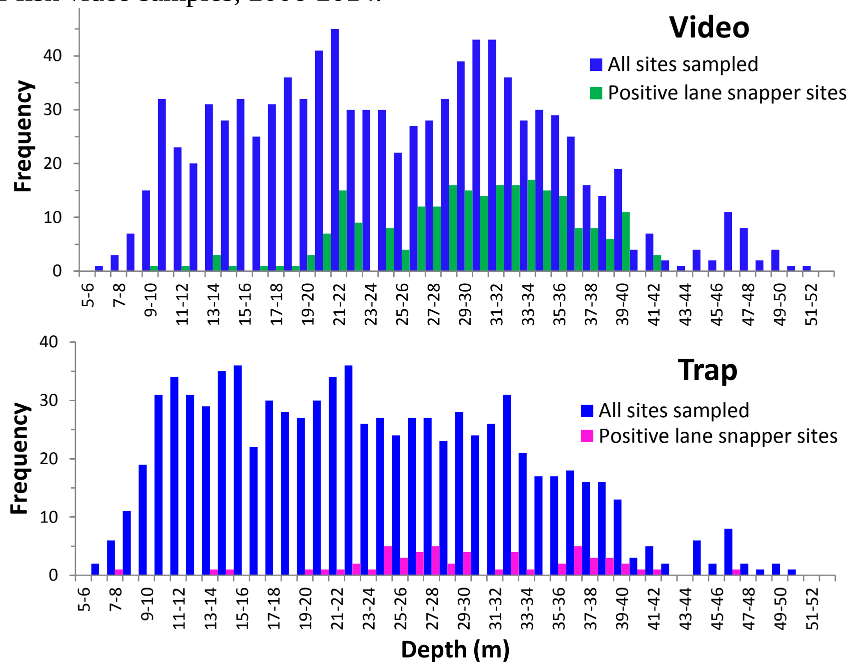

Figure 7. Depth distributions of all video (2006-2014) and trap (2004-2015) sample sites vs only sites positive for lane snapper.

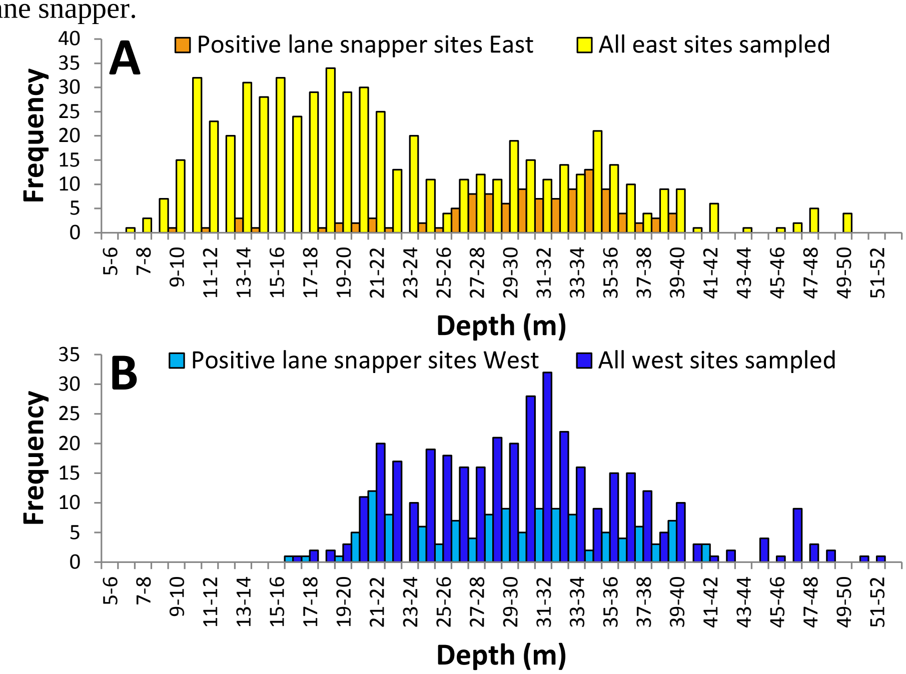

Figure 8. Depth distributions of all video sample sites vs only sites positive for lane snapper for east of Cape San Blas (A) and west of Cape San Blas (B).

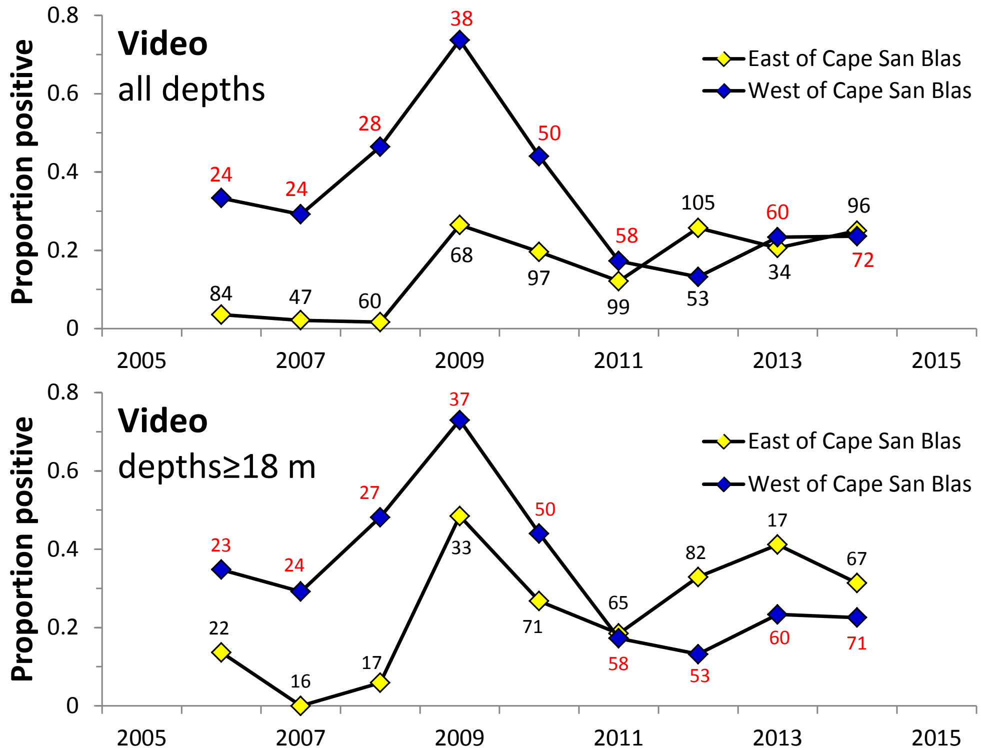

Figure 9. Annual proportions of positive vermilion snapper video samples, 2006-14, east and west of Cape San Blas based on samples from all depths (upper panel) and on samples only from depths ≥18 m (lower panel). Numbers within the plot are total (not just positive) sample sizes for each year.

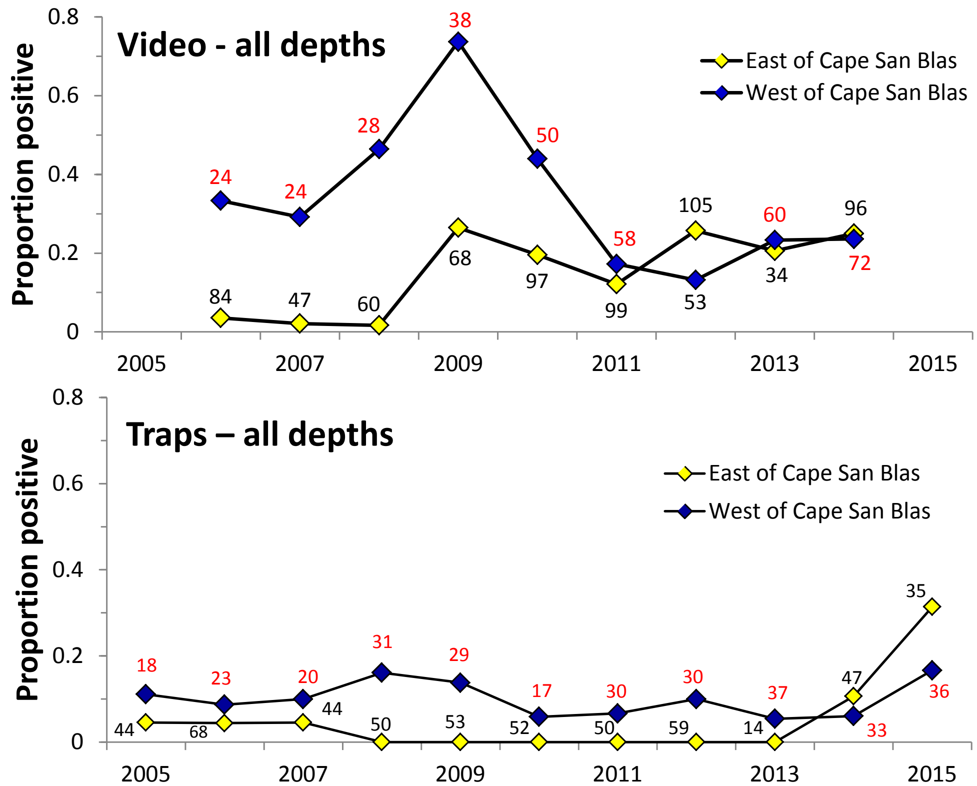

Figure 10. Annual proportions of positive vermilion snapper video samples, 2006-14, by area (east vs. west of Cape San Blas) based on samples from all depths (upper panel) and on samples only from depths ≥18 m (lower panel). Numbers within the plot are total (not just positive) annual sample sizes.

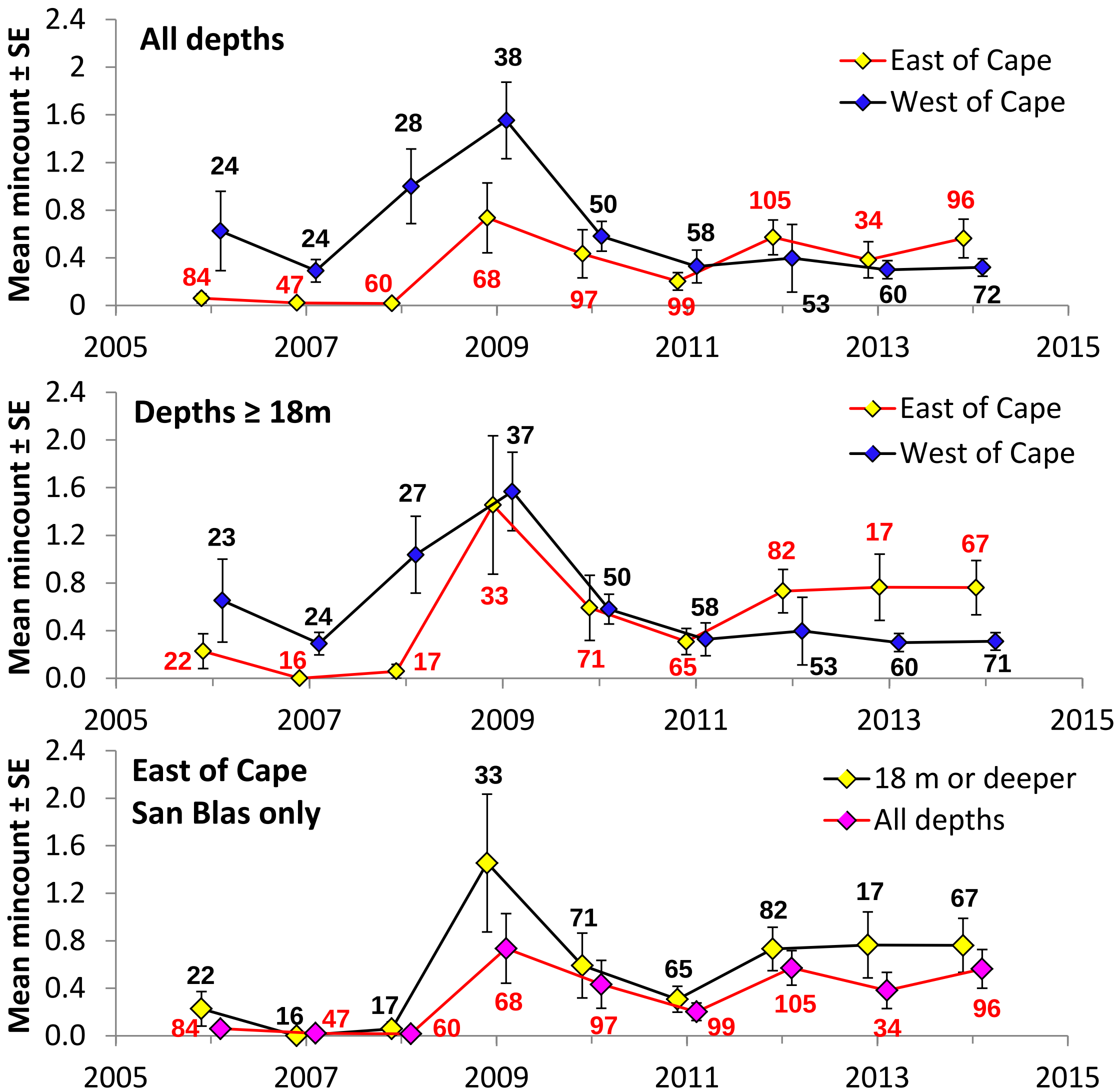

Figure 11. Mean annual nominal video min counts (MaxN) and standard errors of lane snapper east and west of Cape San Blas, 2006-2014, for all depths and only depths ≥ 18m (top and middle panels); and for east of the Cape only for all depths and only depths ≥ 18m (bottom panel) . Numbers within the plots are sample sizes for each year.

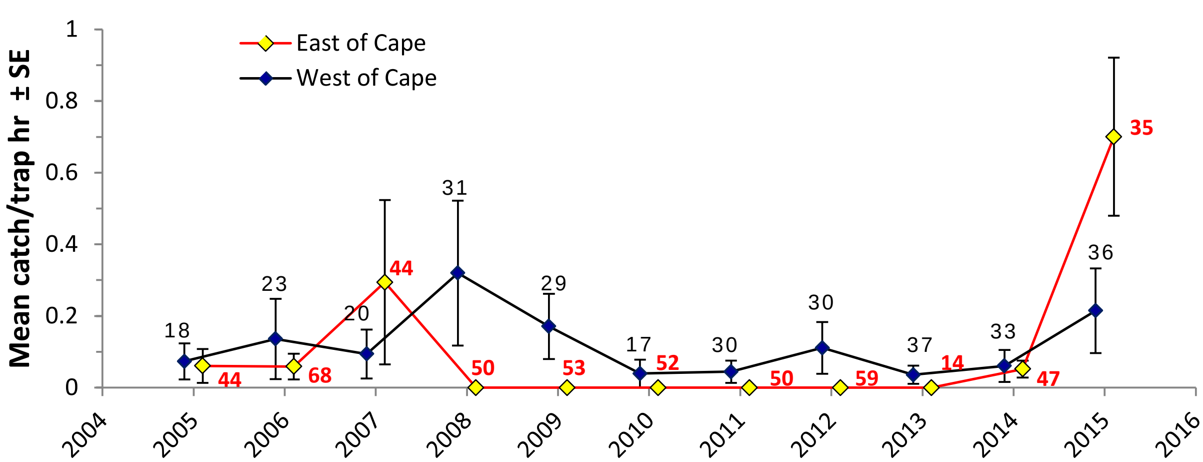

Figure 12. Mean annual catch per trap hr and standard errors of lane snapper east and west of Cape San Blas, 2005-2015 (all depths included). Numbers within plots are annual sample sizes.

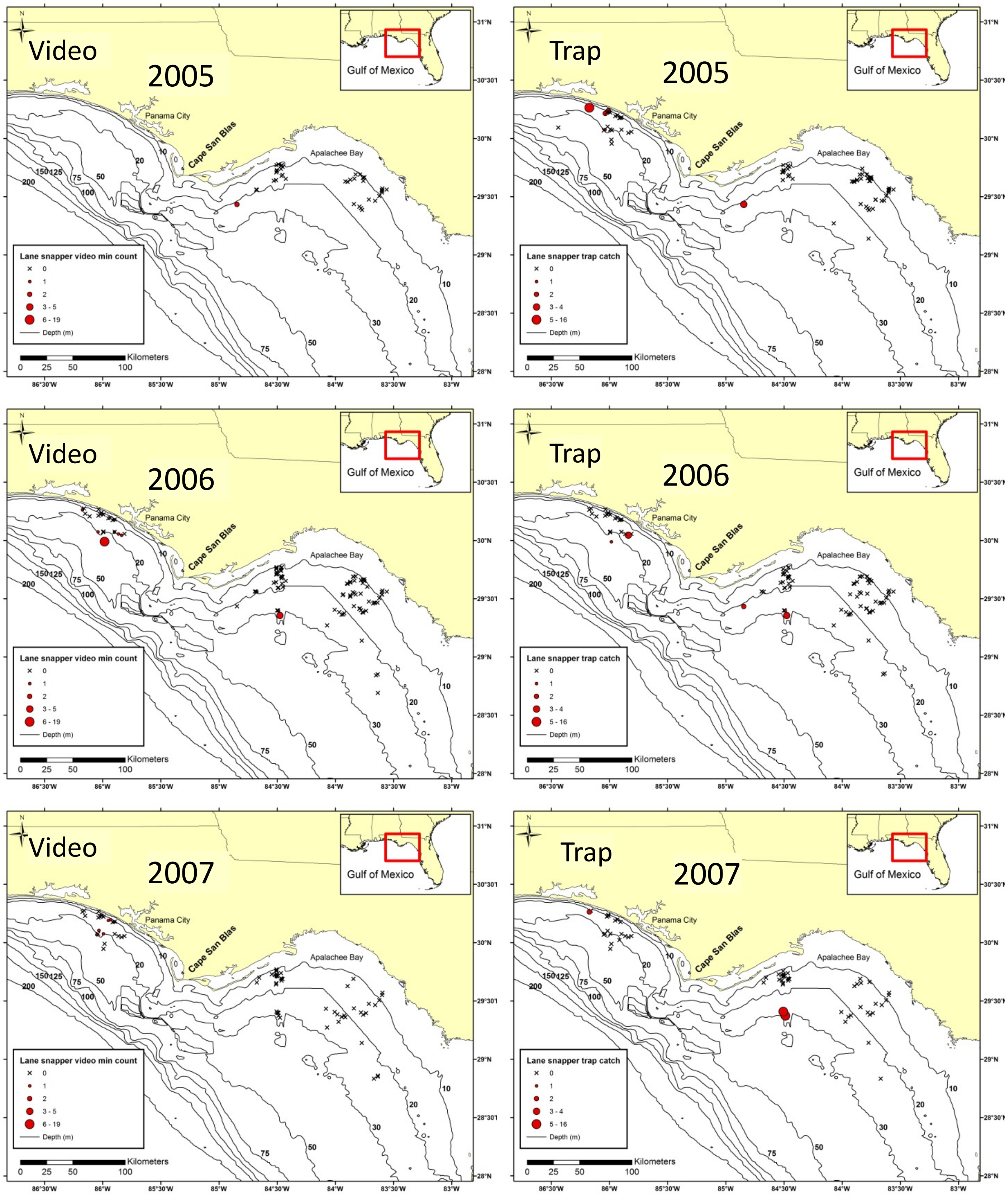

Figure 13. Annual distribution and relative abundance of lane snapper observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2005-2015. Sites sampled, but where no lane snapper were caught or observed, are indicated with an X. Isobath labeled 20m west of Cape San Blas is mislabeled and is actually 30m.

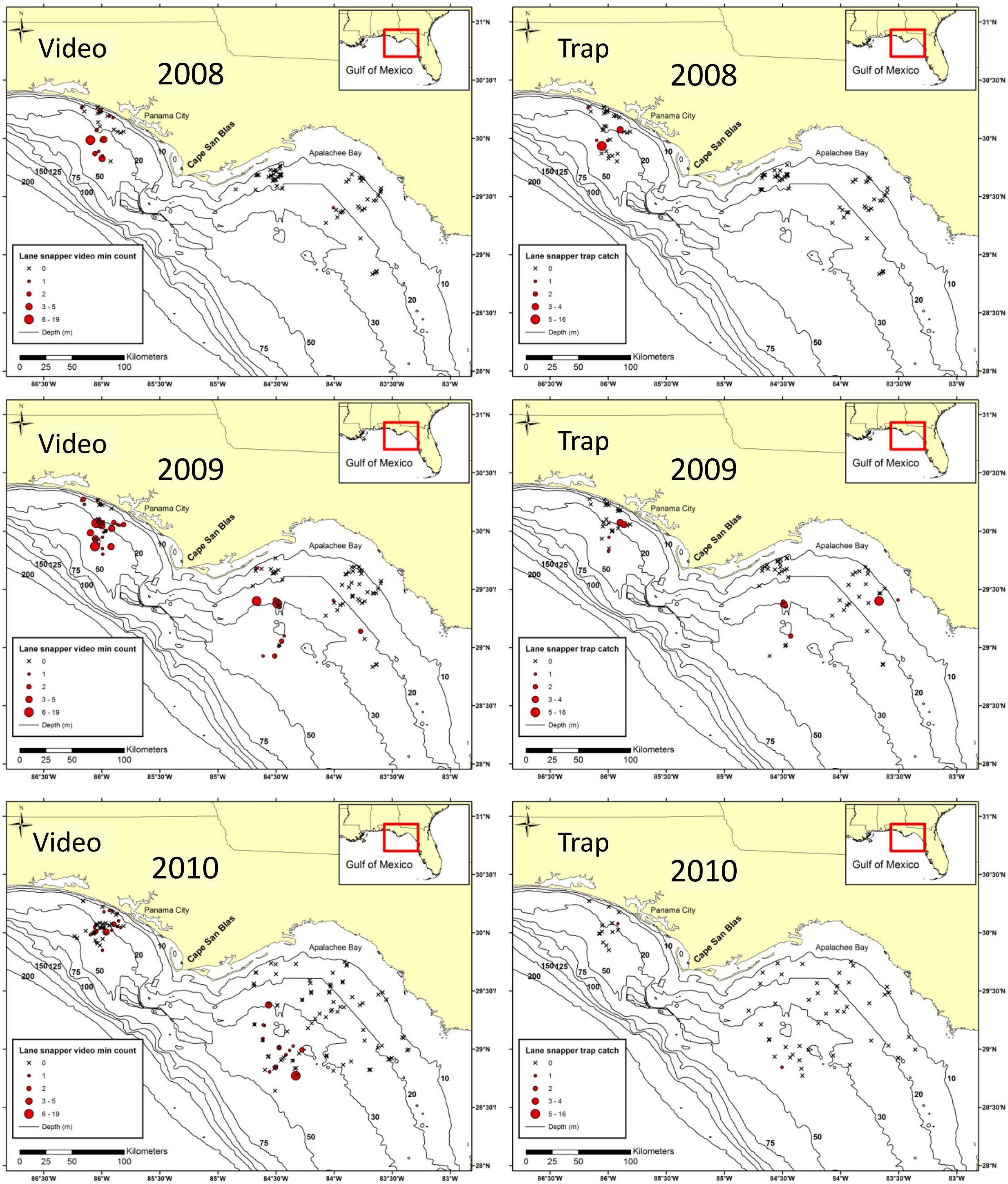

Figure 13 cont. Annual distribution and relative abundance of lane snapper observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2005-2015. Sites sampled, but where no lane snapper were caught or observed, are indicated with an X. Isobath labeled 20m west of Cape San Blas is mislabeled and is actually 30m.

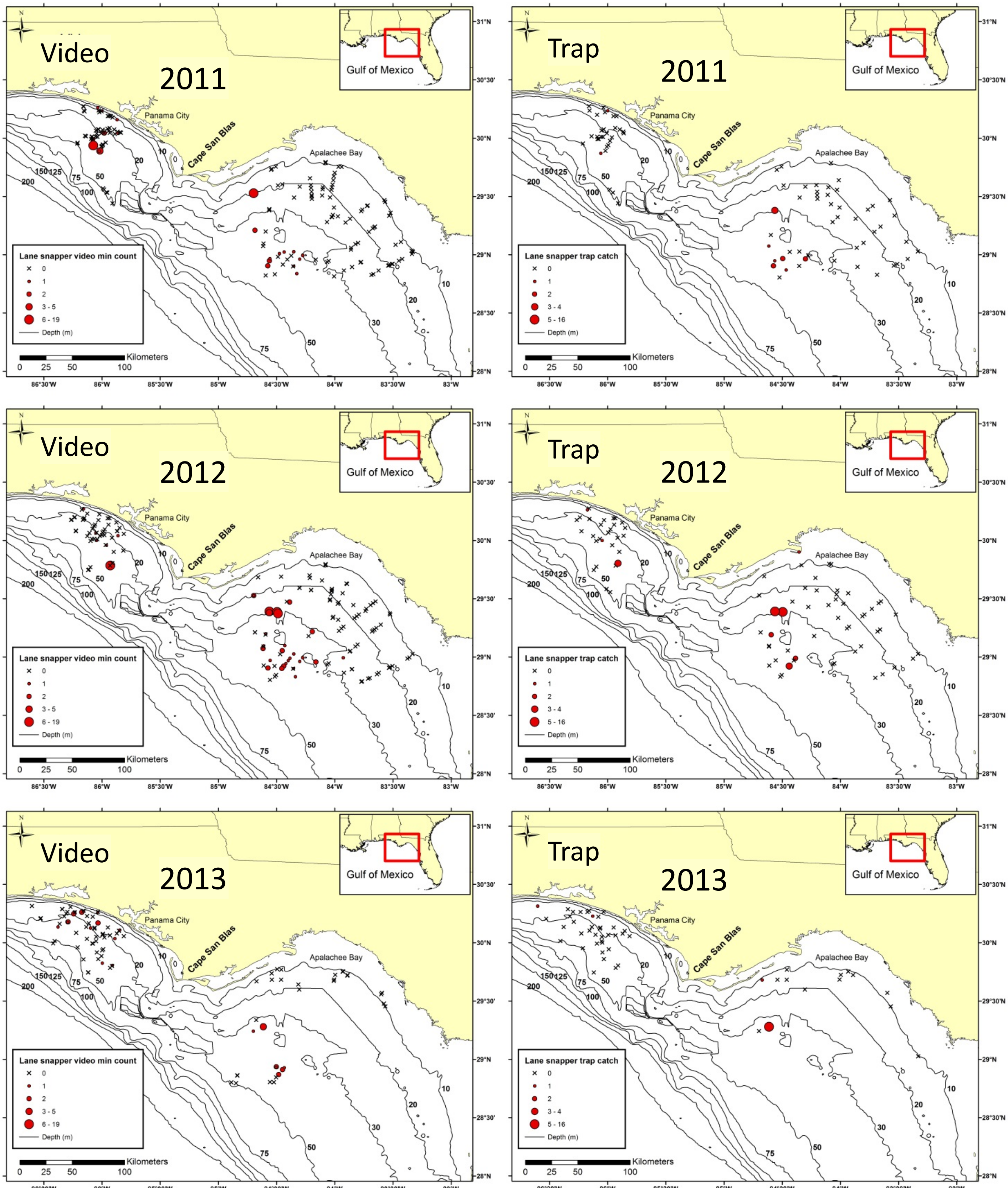

Figure 13 cont. Annual distribution and relative abundance of lane snapper observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2005-2015. Sites sampled, but where no lane snapper were caught or observed, are indicated with an X. Isobath labeled 20m west of Cape San Blas is mislabeled and is actually 30m.

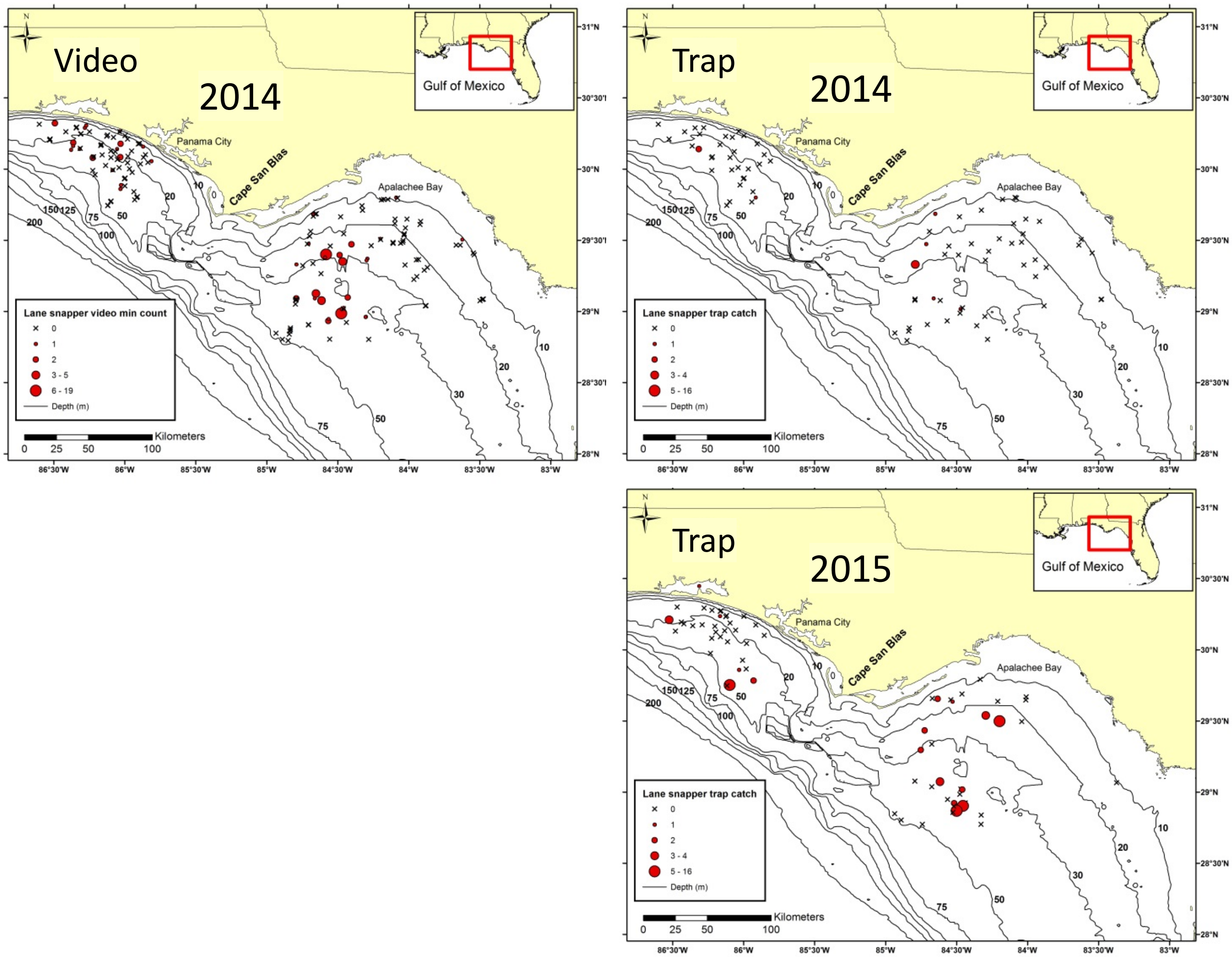

Figure 13 cont. Annual distribution and relative abundance of lane snapper observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2005-2015. Sites sampled, but where no lane snapper were caught or observed, are indicated with an X. Isobath labeled 20m west of Cape San Blas is mislabeled and is actually 30m.

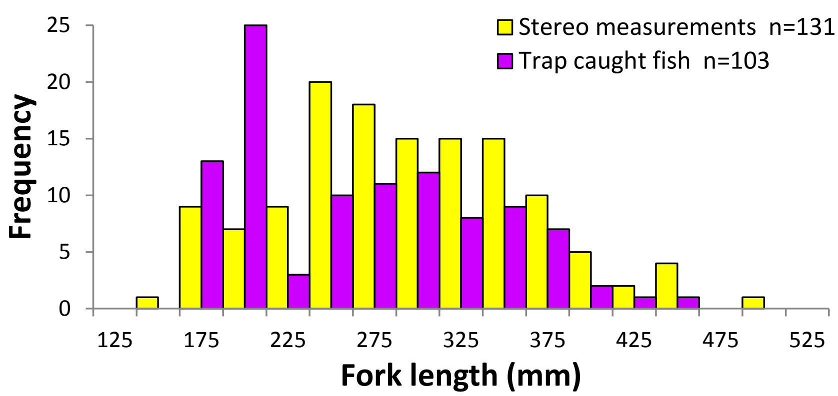

Figure 14. Overall size distributions of all lane snapper collected in chevron traps and measured in stereo images, 2009-2014.

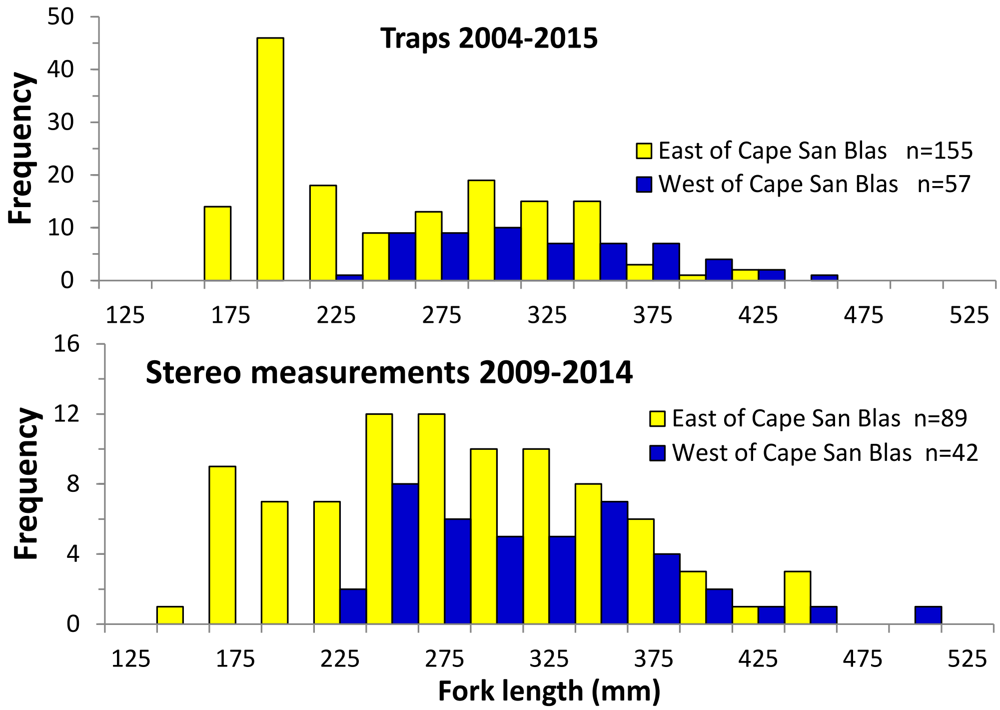

Figure 15. Overall size distributions of lane snapper east and west of Cape San Blas caught in chevron traps, 2004-15 and observed with stereo cameras, 2009-2014.

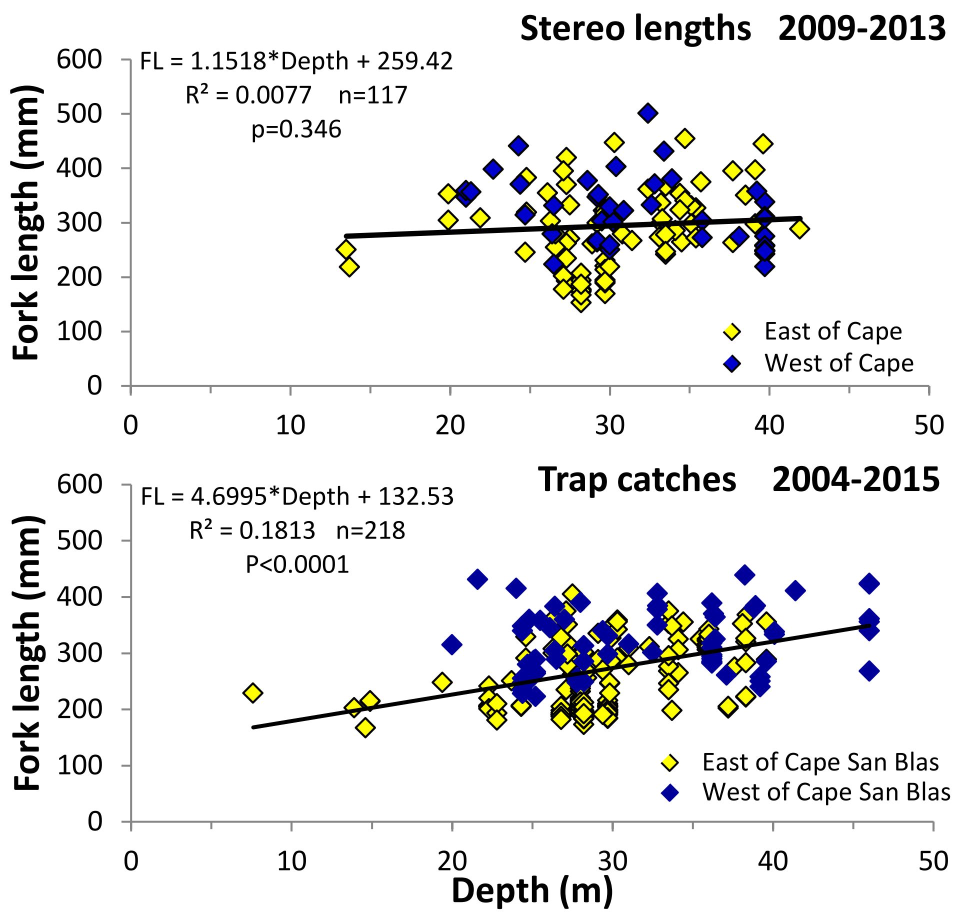

Figure 16. Fork length vs. depth relationship of lane snapper collected east and west of Cape San Blas in traps, 2004-2015, and observed with stereo cameras, 2009-13.

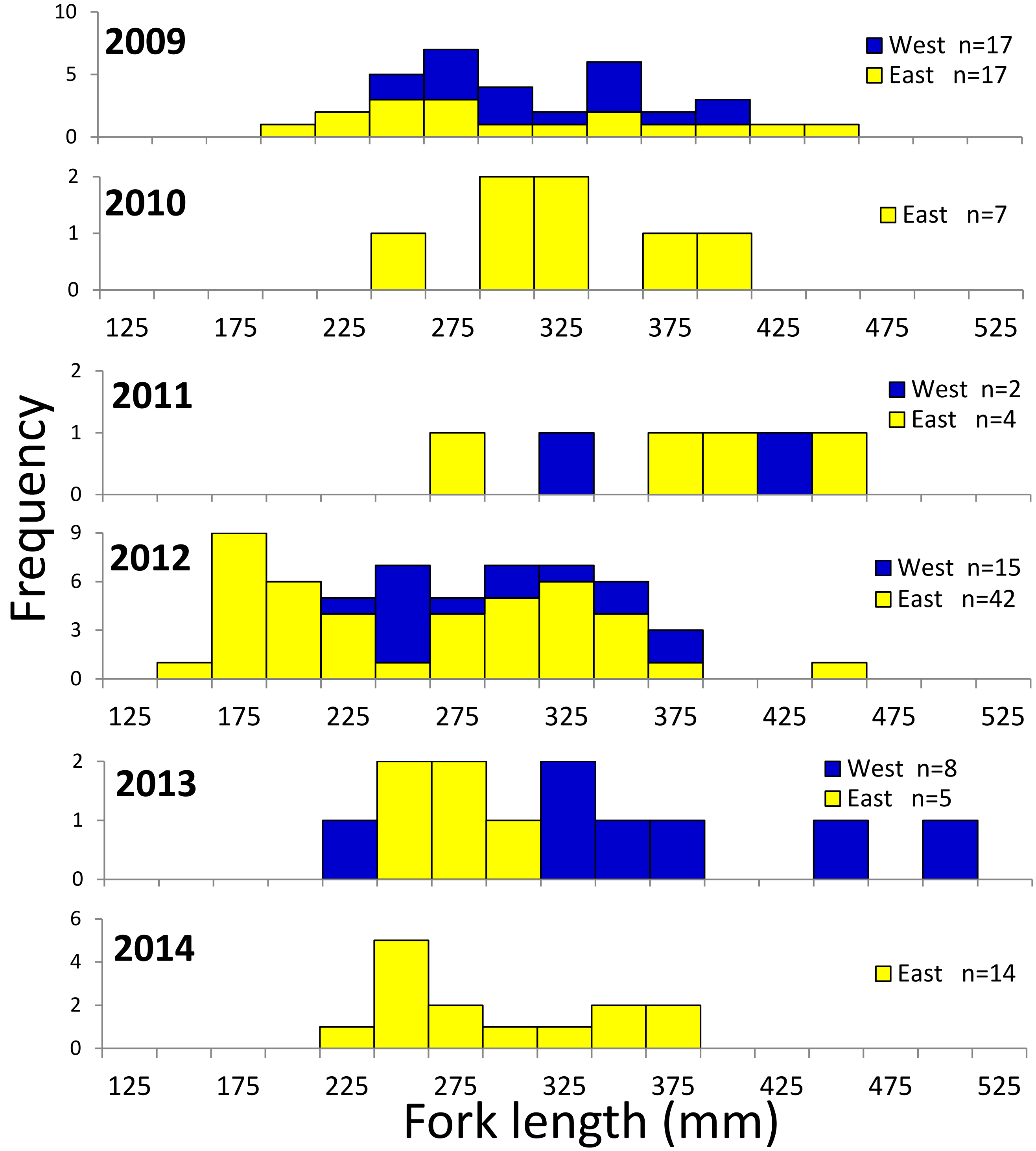

Figure 17. Annual size distributions of lane snapper observed with stereo cameras, 2009-14, east and west of Cape San Blas.

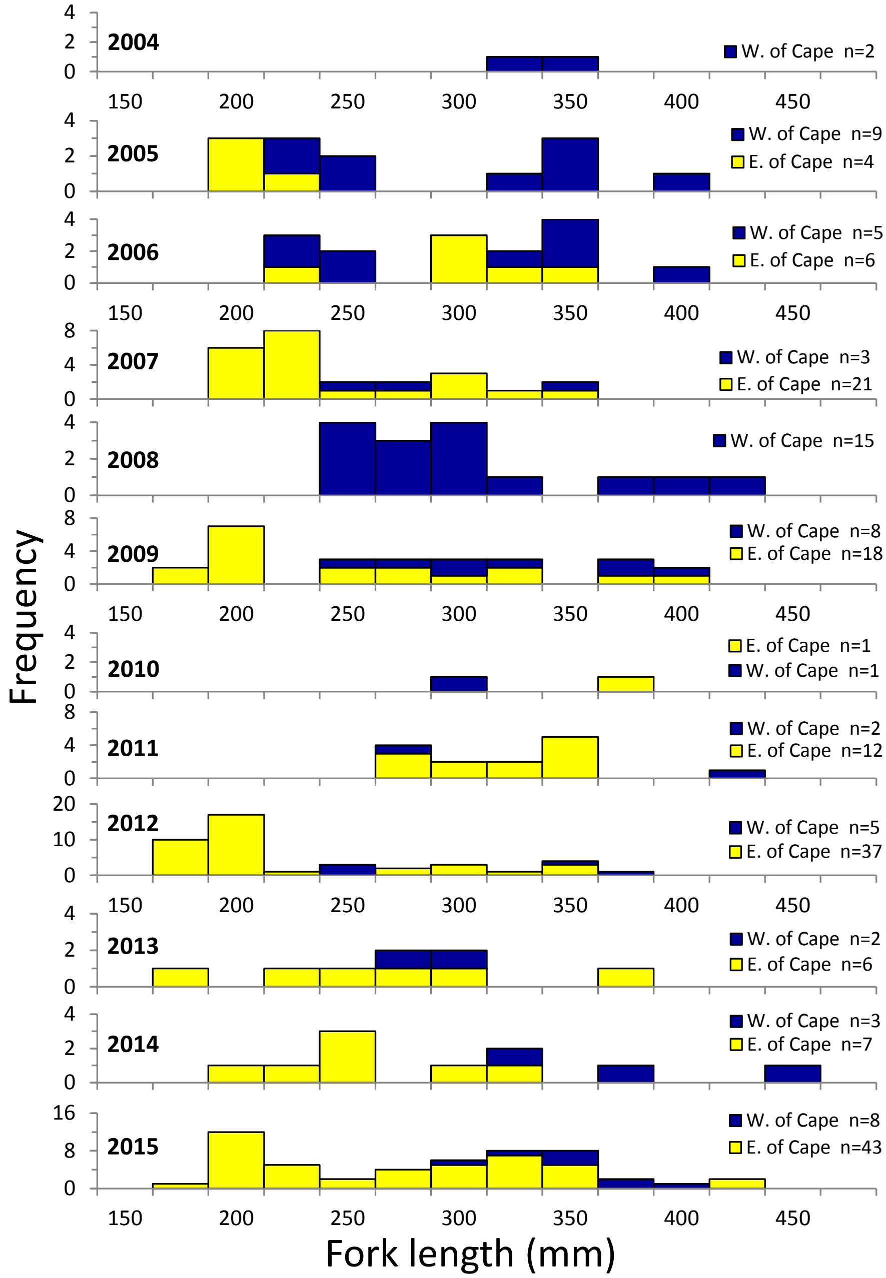

Figure 18. Annual size distributions of lane snapper collected in chevron traps, 2004-2015, east and west of Cape San Blas.

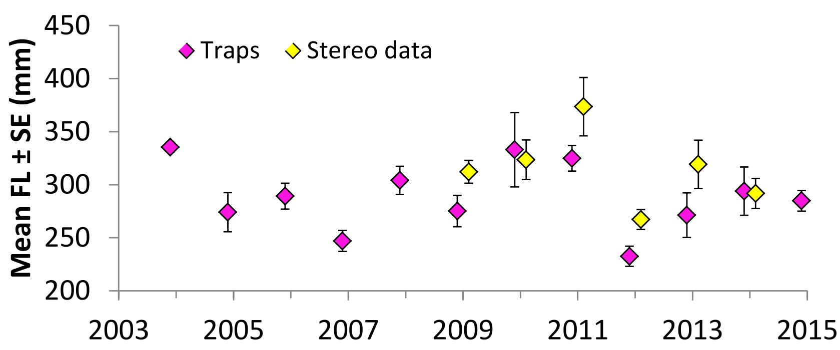

Figure 19. Mean annual fork length (mm) ± standard error of lane snapper from east and west of Cape Blas combined, from traps 2004-2015 and from stereo images 2009-2014.