Vermilion snapper *Rhomboplites aurorubens* Findings from the NMFS Panama City Laboratory Trap & Camera Fishery-Independent Survey 2004-2014

D.A. DeVries, C.L. Gardner, and P. Raley

SEDAR45-WP-12

19 November 2015

Please cite this document as:

DeVries, D.A., C.L. Gardner, and P. Raley 2015. Vermilion snapper *Rhomboplites aurorubens* Findings from the NMFS Panama City Laboratory Trap & Camera Fishery-Independent Survey 2004-2014. SEDAR45-WP-12. SEDAR, North Charleston, SC. 25 pp.

Vermilion snapper *Rhomboplites aurorubens* Findings from the NMFS Panama City Laboratory Trap & Camera Fishery-Independent Survey 2004-2014

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

November 2015

Panama City Laboratory
Contribution 15-19

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 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 (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 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.

Although nominal cpue and proportion of positive samples for trap data were calculated for vermilion snapper and are presented herein, no model based index was developed.

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.

Results

Since the Panama City lab reef fish survey began in 2004/5, vermilion 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 schooling nature of this species was apparent in the overall frequency distribution of min counts (Fig. 6), with counts up to 25 not uncommon. Vermilion snapper were never encountered in video samples from depths shallower than 18 m and in only 3 out of 427 samples from depths < 20 m; in traps they were caught only once in 358 sets in depths shallower than 20 m (Fig. 7). East of Cape San Blas vermilion snapper were observed in only 5 of 391 samples (1.3%) between 18 and 26 m. Encounter rates did increase noticeably with depth from 20 to ~40 m, but beyond those depths results were difficult to interpret because of small sample sizes (Fig. 7). Because of this pattern, data summaries are presented both for collections from all depths and for collections only from depths 18 m or greater.

Vermilion snapper were more commonly encountered west of Cape San Blas than east, even when data from <18 m depths were excluded. During 2006-2014 (excluding 2013 east of the Cape when sampling was reduced by 2/3 and occurred very late in the year) the annual proportion of positive video samples in depths ≥ 18 m ranged from 0.06 to 0.38 (mean = 0.24) east of Cape San Blas and 0.13 to 0.47 (mean = 0.33) west of the Cape (Table 1, Fig. 8).The annual proportion of positive video samples those same years using data from all depths ranged from 0.23 to 0.39 (mean = 0.14) east of Cape San Blas (excluding 2013), and 0.13 to 0.45 (mean = 0.32) west of the Cape (Table 1, Fig. 8). Much of the difference was directly related to the much larger proportion of shallow (<20 m) sites east of the Cape (Fig. 3). When all the sites <18 m were excluded, the differences were much smaller, and as more deep sites were added in the east in 2009 and 2010, the differences between east and west were minimized and actually reversed in 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. The annual proportion of positive vermilion snapper trap catches during 2004-2014 based on collections from all depths ranged from 0.0 to 0.25 east of Cape San Blas and 0.3 to 0.35 west of the Cape (Table 2).

Along with higher encounter rates, relative abundance estimates of vermilion snapper were also noticeably higher west of the Cape. Respective mean min counts in the west and east from depths ≥18 m were 7.3±1.4 vs 2.5±0.5. This geographical difference in abundance is clearly visible in a kernel density plot of pooled min count data from all years (Fig. 10), which shows a fairly large area between 85° 45' and 86° 15'W with much higher densities than any seen in the entire area east of Cape San Blas.

Vermilion snapper observed with stereo cameras during 2009-2014 averaged only slightly larger than those caught in traps those same years — 263 mm vs 257 mm FL, but had similar modes: ~240--270 mm FL (Fig. 11). Not surprisingly, given the much greater selectivity of the traps, the size ranges of vermilion snapper measured in stereo images were noticeably larger than those from traps: 158-455 mm vs 178-371 mm FL (Fig. 11).

The video survey targeted both pre-recruit vermilion snapper (<232 mm FL, the Gulf Council rec and commercial size limit) and those recruited to fisheries. Of fish measured from stereo images, 51% (171 of 334) were <232 mm. The more selective trap survey targeted recruits much more than pre-recruits — 83% were ≥232 mm FL.

Mean sizes from stereo image measurements were larger east of Cape San Blas than west —272 vs 254 mm FL. However, the pattern from traps was opposite and the difference smaller – 253 vs 263 mm FL, and the overall size structure was very similar between regions (Fig. 12).

There was very little relationship between size of vermilion snapper and depth. Although regressions from both video and trap survey data were significant, primarily because of large sample sizes, respectively, only 1.5% and 3.3% of the variance in size was explained by changes in depth (Figure 13).

Annual mean sizes of vermilion snapper observed with stereo cameras and captured in traps varied little between gears or between areas within gears (Figure 14). Annual size structure from the camera survey showed slightly increasing modes from ~240 mm FL in 2009 to ~270-280 in 2011, and then dropped noticeably in 2012 to a mode of 230-250, suggesting recruitment of a new strong year class into the region (Fig. 15). The size structure appeared to shift to larger sizes in 2013 and 2014, although sample sizes were small those two years. However, evidence of the same pattern of an increased proportion of small individuals was clearly apparent in the trap data in 2013, one year later than seen in the stereo data, and as in the latter, the size structure shifted noticeably to larger sizes in 2014 (Fig. 16).

Vermilion snapper caught in the trap survey ranged from ages 1 to 13 yr with a mean age of 4.8±0.3 yr and a broad mode of 3-6 yr (Fig. 17). Modal and mean ages were considerably older east of the Cape than west (6 vs 3 yr and 5.6±0.4 vs 4.0±0.3 yr, respectively). The range in ages was also greater in the east (1-13 yr) than the west (1-9 yr) (Fig. 17). Annual age structure data of vermilion snapper from the trap catches showed some evidence of a strong 2006 year class, as it dominated the age structure each year 2009-2012 (Fig. 18). Such periodic strong year classes characterize populations of co-occurring reef fish such as gag, red grouper, and red snapper on the northern West Florida Shelf. Overall annual modal ages varied from 2 to 6 yr between 2005 and 2014, and vermilion snapper ages 1 and >8 yr have been rare in the survey since it began in 2005 (Fig. 18). There was no real relationship between age and depth between 20 and 52 m. Although the regression of age on depth was significant (probably because of high sample size), it only explained 3% of the variance (Fig.19).

Abundance trends

Vermilion snapper abundance on the northern West Florida Shelf appears to have been fairly stable during 2008-2012, but declined since then. Mean nominal min counts, which tend to be quite variable, were close to level or increased only slightly during 2008-2012 (whether data from all depths or just those ≥ 18 m are included), and similar to the proportion positive findings discussed earlier, were higher west of the Cape than east those years (Fig. 20). West of Cape San Blas, in depths ≥ 18 m, mean min counts declined considerably from 2012 to 2013 and continued that decline in 2014 (Fig. 20). In contrast, mean nominal min count east of the Cape increased from 1.2 to 7 (585%) from 2012 to 2013, although the standard error also increased an order of magnitude, from 0.39 to 4.1. However, the validity of this data point is suspect, as it could easily be an artifact of the greatly reduced sampling in that area in 2013. In 2014 min counts east and west were almost identical – 3.4 vs 3.5. The similar trends in relative abundance in both areas suggests that vermilion snapper on both sides of Cape San Blas belong to one population or stock and are not sub-populations with different dynamics. When all data are pooled, relative abundance appeared stable 2008 through 2013, then dropped roughly 50% between 2013 and 2014, and trends were very similar whether including data from all depths or just from depths ≥ 18 m (Fig. 21).

Annual GIS plots of video min counts and trap catch/hr of vermilion snapper showed similar geographic patterns in relative abundance trends between 2005 and 2014 (Figure 22).

Literature Cited

DeVries, D.A, J.H. Brusher, C.L. Gardner, and G.R. Fitzhugh. 2008. NMFS Panama City Laboratory trap & camera survey for reef fish. Annual Report of 2007 results. Panama City Laboratory Contribution 08-14. 20 pp.

DeVries, D.A., J. H. Brusher, C. L. Gardner, and G. R. Fitzhugh. 2009. NMFS Panama City Laboratory trap and camera survey for reef fish. Annual report of 2008 results. Panama City Laboratory, Contribution Series 09-10. 22 p.

DeVries, D.A., C.L. Gardner, P. Raley, and W. Ingram. 2012. NMFS Panama City Laboratorytrap and camera survey for reef fish. Annual report of 2011 results. Panama City Laboratory

Ellis, D.M., and DeMartini, E.E. 1995. Evaluation of a video camera technique for indexing abundances of juvenile pink snapper, *Pristipomoides filamentosus*, and other Hawaiianinsular shelf fishes. Fish. Bull. 93(1): 67–441 77.

Gledhill, C., and A. David. 2003. Survey of fish assemblages and habitat within two marine protected areas on the West Florida shelf. NMFS, Southeast Fisheries Science Center. Report to the Gulf of Mexico Fishery Management Council.

Gledhill, C. and W. Ingram. 2004. SEAMAP Reef Fish survey of Offshore Banks. 14 p. plus appendices. NMFS, Southeast Fisheries Science Center, Mississippi Laboratories. SEDAR 7 –DW 15.

GMFMC. 2001. October 2001 report of the Reef Fish Stock Assessment Panel. Gulf of Mexico Fishery Management Council, Tampa, FL. 34 pp.

LO, N. C. H., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-1526.
McGovern, J. C., G.R. Sedberry and P.J. Harris. 1998. The status of reef fish stocks off the southeast United States, 1983-1996. Gulf and Caribbean Fisheries Institute 50: 871-895.
Mahmoudi, B. 2005. State-Federal Cooperative Reef fish Research and Monitoring Initiative in the Eastern Gulf of Mexico. Workshop report. March 3-4 2005, Florida Fish and Wildlife Research Institute, St. Petersburg, Florida.
Zieman, J.C., and R.T. Zieman. 1989. The ecology of the seagrass meadows of the west coast of Florida: A community profile. Biological Report 85(7.25). U.S. Fish and Wildlife Service. 155 p.

Tables

Table 1. Annual video survey sample sizes, proportion positive occurrences, mean nominal video min counts, and standard errors of vermilion snapper east and west of Cape San Blas, 2005-2014, 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
2005	41		41	0.00		0.00	0.00		0.00			
2006	84	25	109	0.23	0.20	0.07	1.21	3.64	1.77	1.190	1.660	0.995
2007	48	24	72	0.33	0.13	0.06	0.08	0.17	0.11	0.083	0.098	0.064
2008	61	29	90	0.32	0.45	0.17	1.02	10.34	4.02	0.984	4.460	1.635
2009	68	44	112	0.39	0.45	0.26	0.72	7.14	3.24	0.352	1.889	0.823
2010	97	50	147	0.34	0.36	0.24	1.89	7.80	3.90	0.670	3.195	1.189
2011	100	60	160	0.38	0.33	0.28	2.12	8.70	4.59	0.523	5.087	1.942
2012	105	53	158	0.34	0.32	0.22	0.93	10.58	4.17	0.308	5.781	1.972
2013	38	67	105	0.64	0.43	0.34	3.50	5.63	4.86	2.106	1.859	1.407
2014	92	71	163	0.24	0.23	0.23	2.35	3.45	2.83	0.689	1.394	0.720

B. Depths <18 m excluded

	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
2005												
2006	22	24	46	0.14	0.21	0.17	4.64	3.79	4.20	4.542	1.724	2.324
2007	16	24	40	0.06	0.13	0.10	0.25	0.17	0.20	0.250	0.098	0.114
2008	18	28	46	0.11	0.46	0.33	3.44	10.71	7.87	3.329	4.607	3.109
2009	33	43	76	0.27	0.47	0.38	1.48	7.30	4.78	0.707	1.926	1.174
2010	71	50	121	0.25	0.36	0.30	2.58	7.80	4.74	0.903	3.195	1.434
2011	66	60	126	0.38	0.33	0.36	3.21	8.70	5.83	0.759	5.087	2.456

2012	82	53	135	0.22	0.32	0.26	1.20	10.58	4.88	0.390	5.781	2.303
2013	19	67	86	0.37	0.43	0.42	7.00	5.63	5.93	4.108	1.859	1.698
2014	64	70	134	0.34	0.23	0.28	3.38	3.50	3.44	0.965	1.413	0.867

Table 2. Annual trap survey sample sizes, proportion positive catches, mean catch per trap hour, and standard errors of vermilion 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	22	30	52	0.00	0.03	0.02		0.133	0.077	0.000	0.133	0.077
2005	68	23	91	0.00	0.35	0.09		1.551	0.392	0.000	0.642	0.175
2006	68	23	91	0.01	0.09	0.03	0.225	0.172	0.212	0.225	0.146	0.172
2007	44	20	64	0.07	0.10	0.08	0.136	0.193	0.154	0.085	0.139	0.072
2008	50	31	81	0.02	0.29	0.12	0.053	1.303	0.532	0.053	0.593	0.237
2009	51	28	79	0.08	0.25	0.14	0.389	0.895	0.569	0.240	0.374	0.204
2010	46	14	60	0.15	0.07	0.13	0.174	0.238	0.189	0.067	0.238	0.074
2011	48	31	79	0.19	0.32	0.24	1.182	1.290	1.224	0.506	0.803	0.437
2012	52	29	81	0.25	0.03	0.17	0.964	0.023	0.627	0.413	0.023	0.269
2013	14	37	51	0.00	0.22	0.16		1.117	0.810		0.663	0.484
2014	48	33	81	0.13	0.12	0.12	0.681	0.121	0.453	0.424	0.061	0.253

Figures

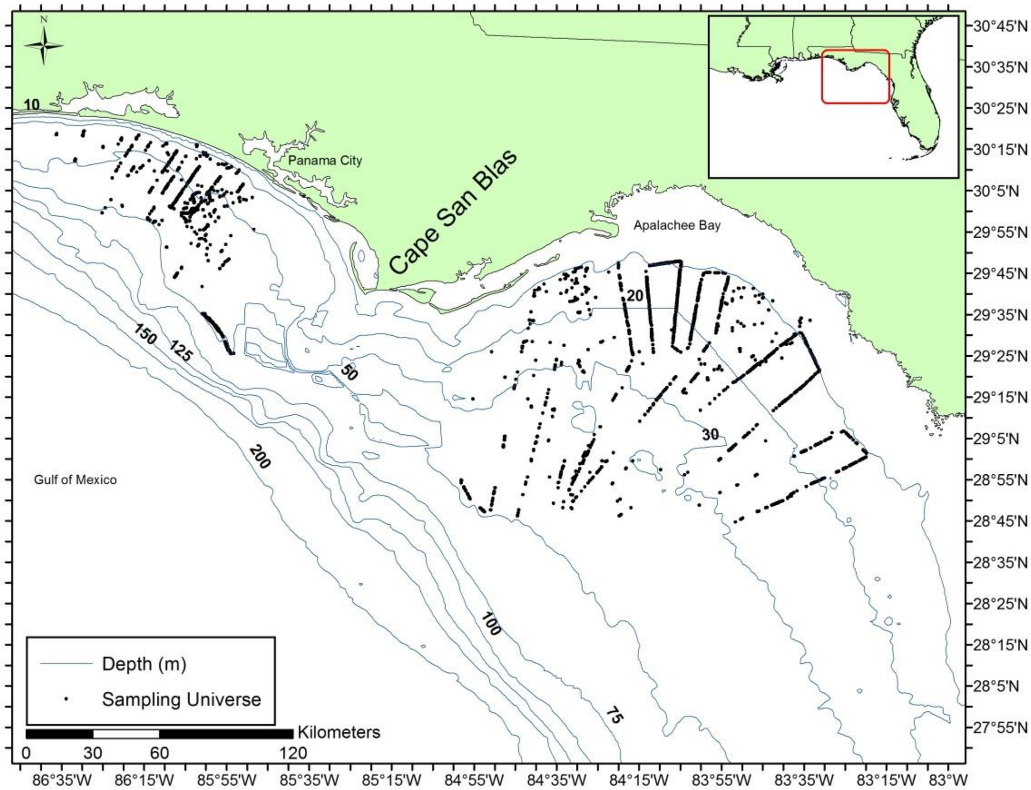

Figure 1**.** Locations of all natural reefs in the sampling universe of the Panama City NMFS reef fish video survey as of November 2014. Total sites: 2985 – 1105 west, and 1880 east, of Cape San Blas. Isobath labels are in meters.

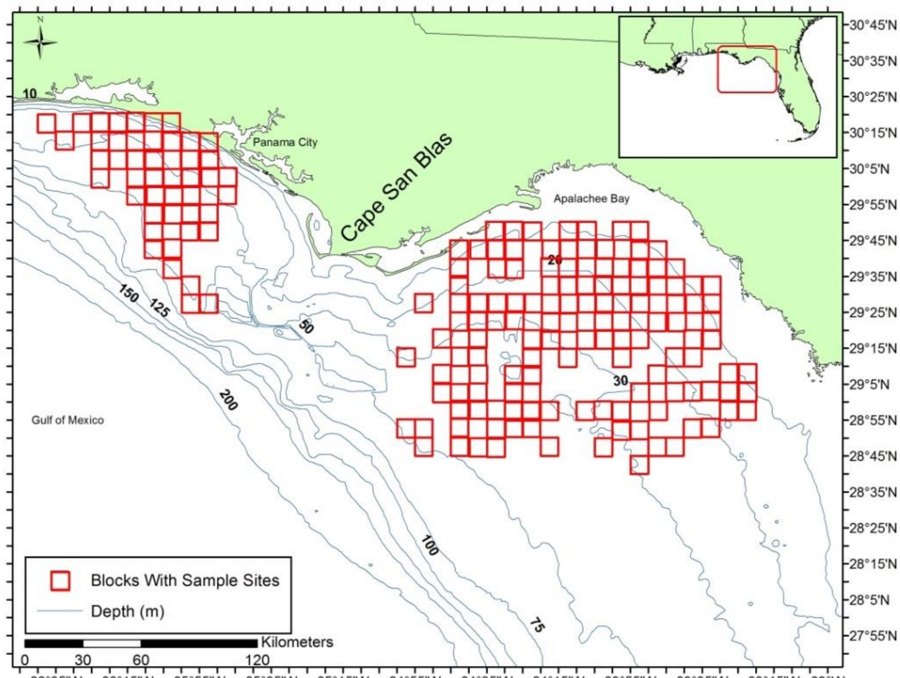

Figure 2. Sampling blocks (5 min lat. x 5 min. long.) of the Panama City reef fish survey as of 2014. Isobath labels are in meters.

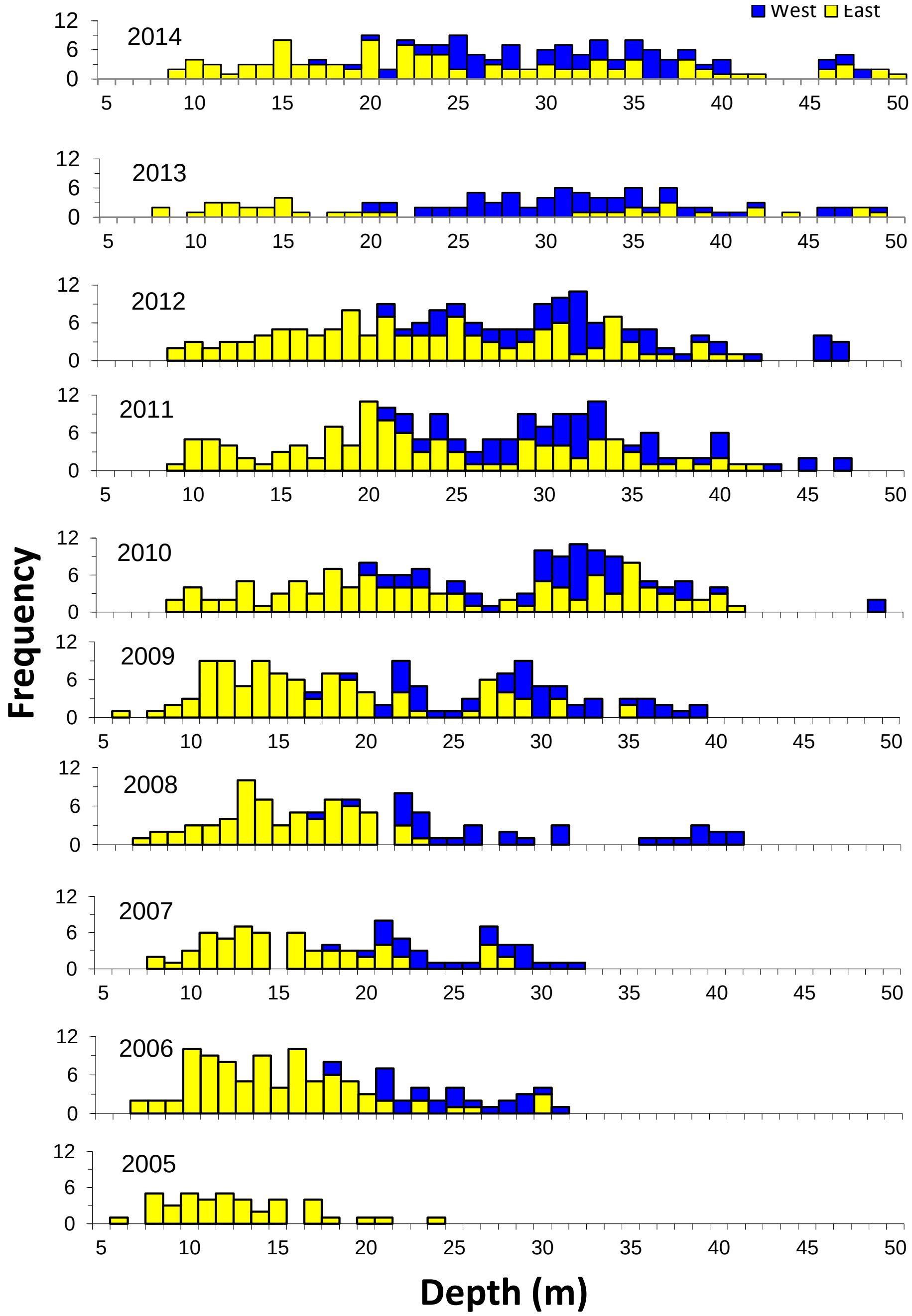

Figure 3. Annual depth distribution of Panama City reef fish survey video sample sites east and west of Cape San Blas, 2005-2014.

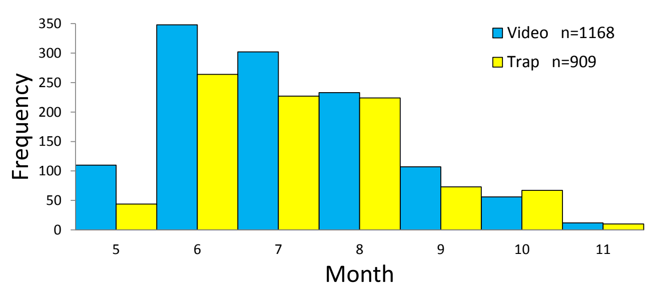

Figure 4. Overall monthly distribution of Panama City reef fish survey video and trap samples (censored data sets only), 2004-2014.

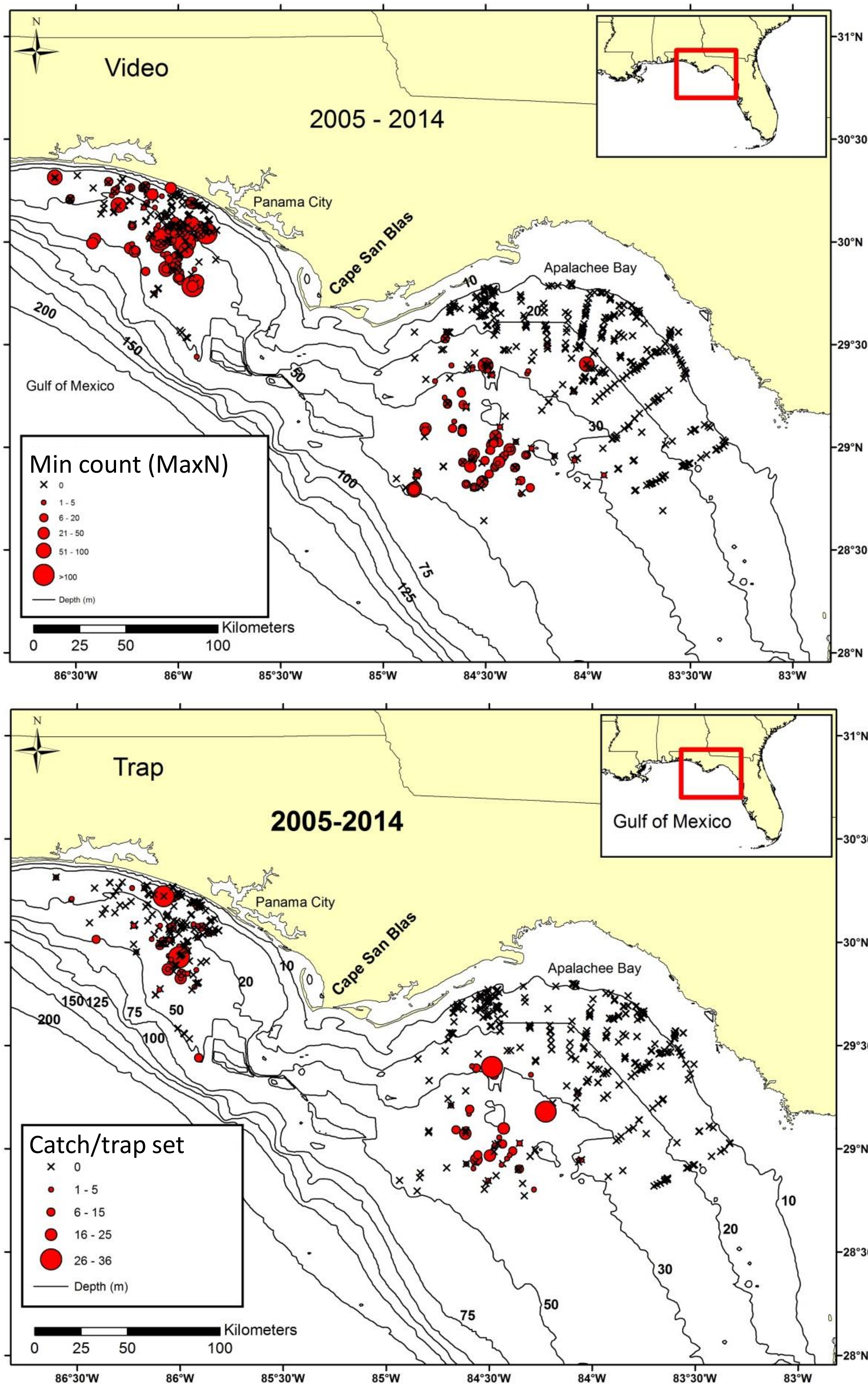

Figure 5. Distribution and relative abundance of vermilion snapper observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2004-2014. Sites sampled, but where no vermilion snapper were caught or observed, are indicated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

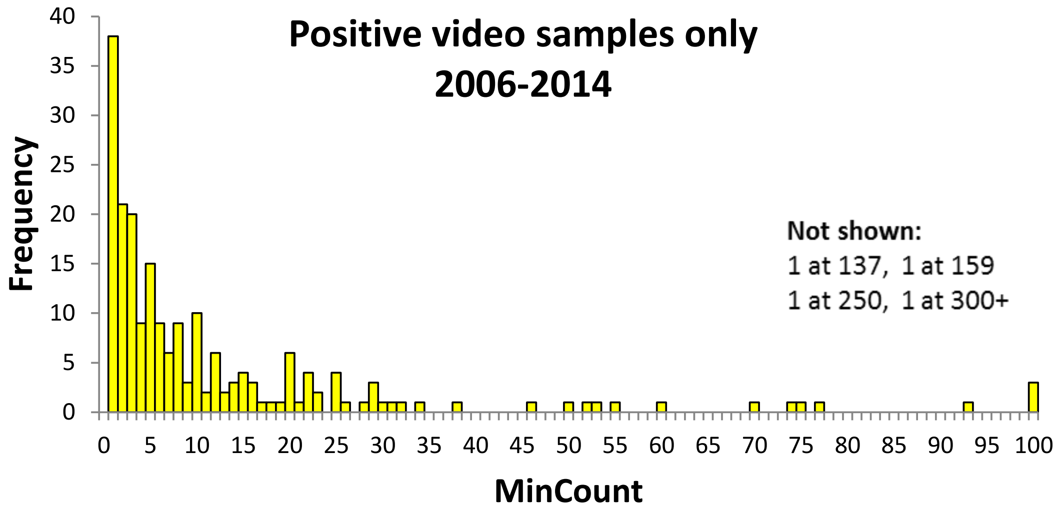

Figure 6. Frequency distribution of non-zero min counts of vermilion snapper from Panama City reef fish video samples, 2006-2014.

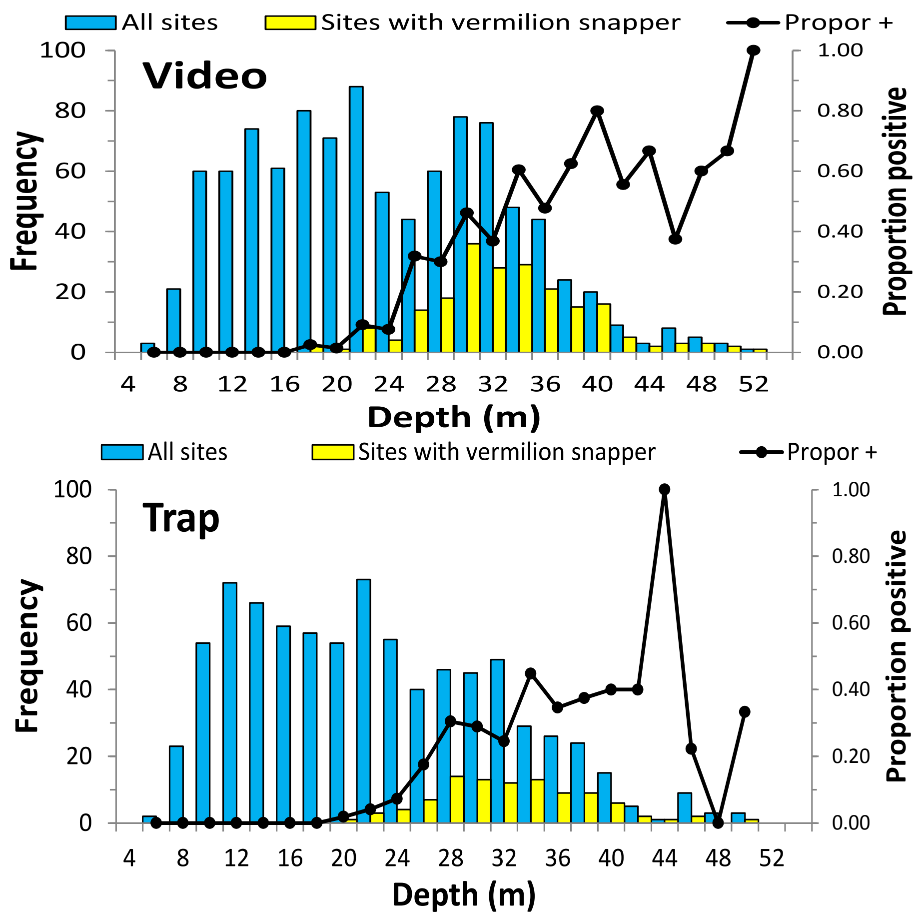

Figure 7. Depth distributions of all video (2004-2013) and trap (2004-2014) sample sites vs only sites positive for vermilion snapper; and overall proportions of positive vermilion snapper video and trap samples, 2004-14, by depth.

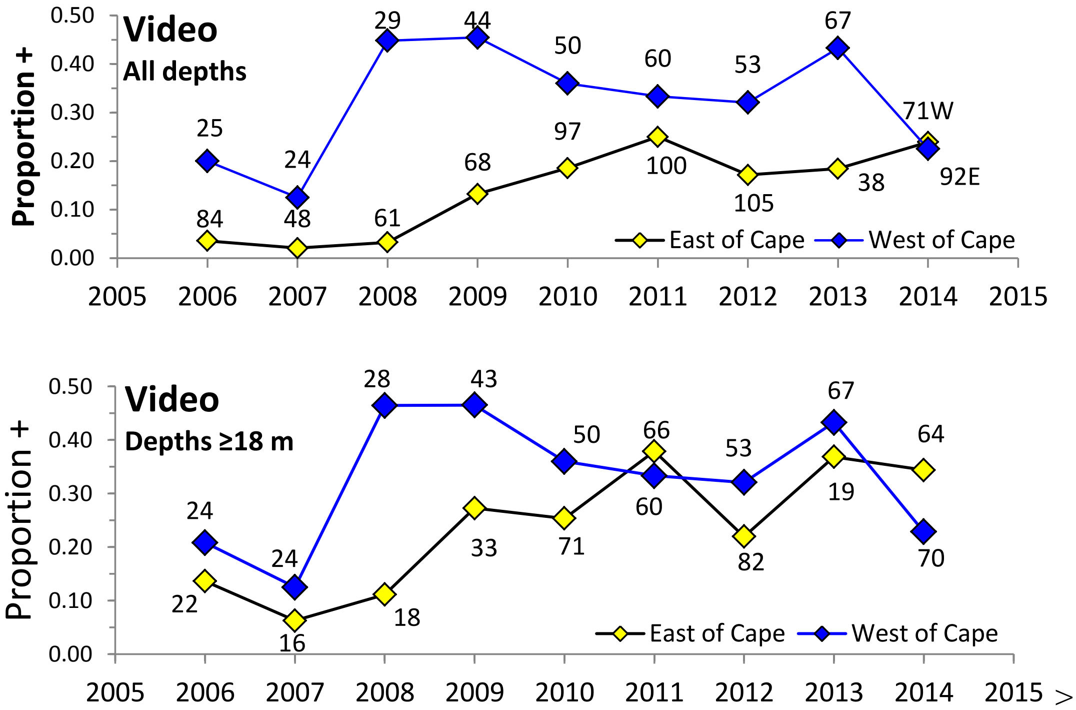

Figure 8. Annual proportions of positive vermilion snapper video samples, 2006-14, by area (east vs. west of Cape San Blas) based on samples from all depths (upper panel) and on samples only from depths ≥18 m (lower panel). Numbers within the plot are total (not just positive) sample sizes for each year.

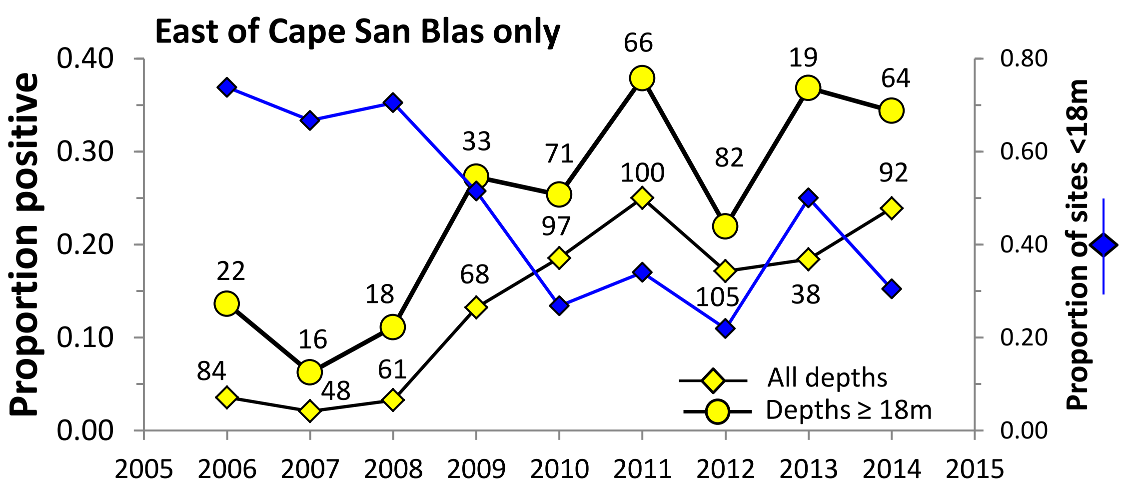

Figure 9. Comparison of proportions of positive vermilion snapper video samples east of Cape San Blas only, 2006-14, for all depths and for only depths ≥18 m, and the annual proportion of all sites east of the Cape in depths < 18 m. Numbers within the plot are total (not just positive) sample sizes for each year.

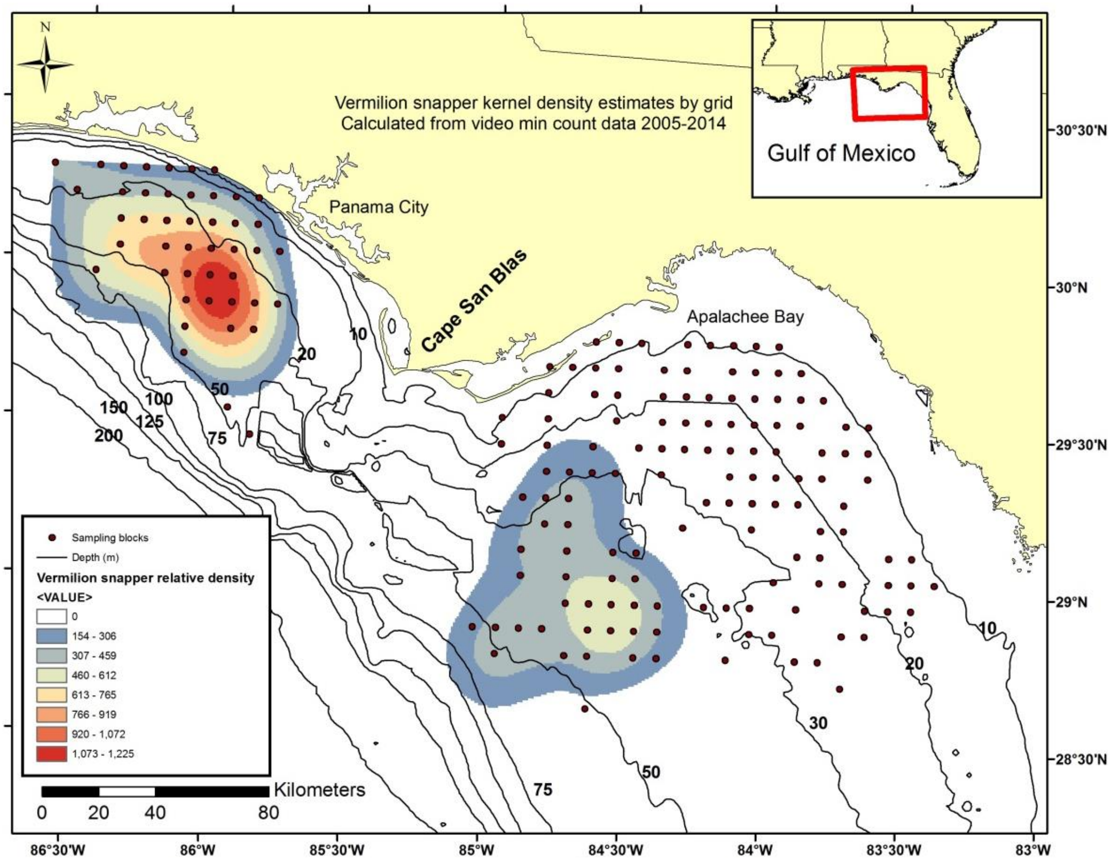

Figure 10. Overall relative density plot of vermilion snapper based on count data (min counts, also called maxN) from video collected with stationary camera arrays in annual surveys, 2005-2014. Min counts were standardized by 5 min latitude x 5 min longitude sampling block, and kernel density estimates were calculated from the mid-point (black dots in the figure) of each block (See Fig. 2).

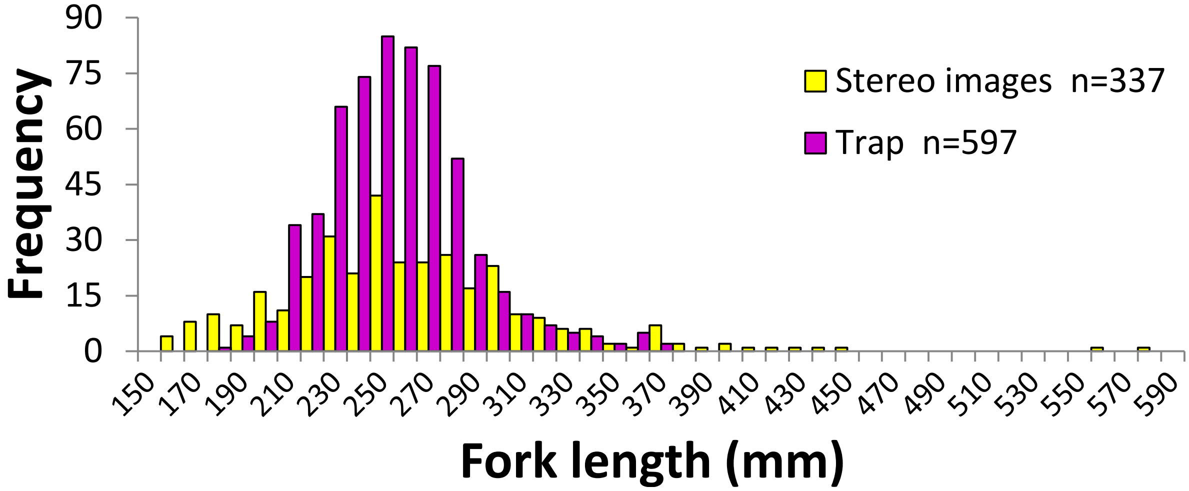

Figure 11. Overall size distributions of all vermilion snapper collected in chevron traps, 2009-2014, and measured in stereo images, 2009-2014.

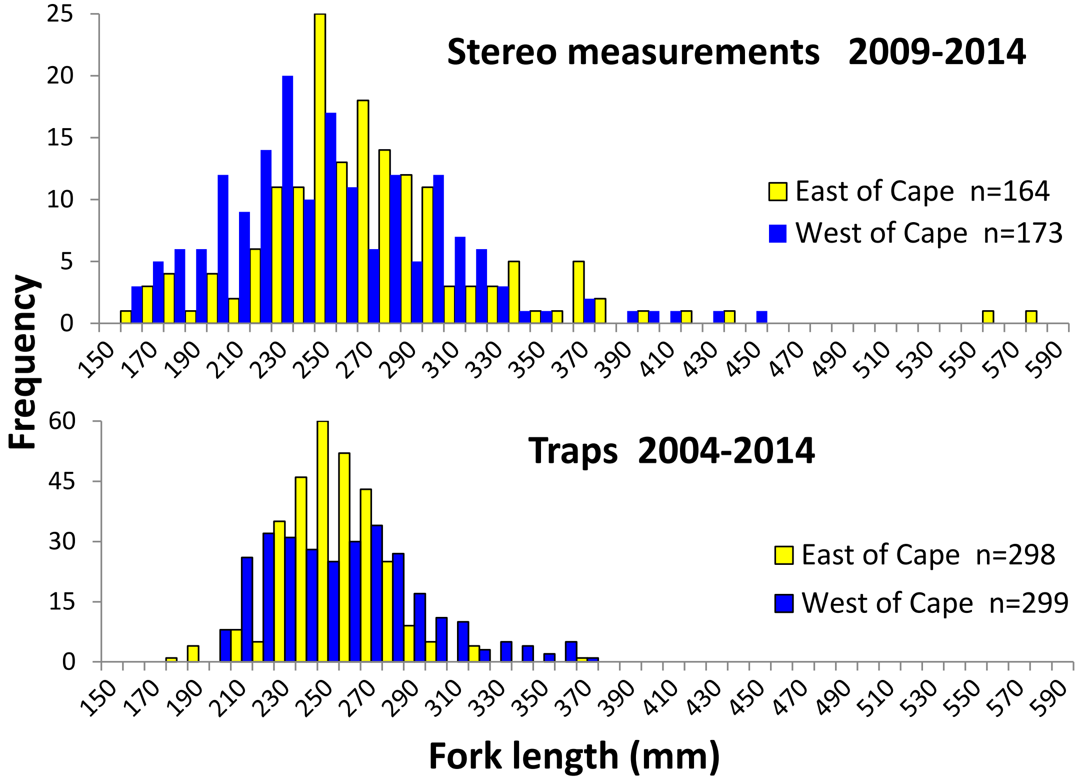

Figure 12. Overall size distributions of vermilion snapper east and west of Cape San Blas caught in chevron traps, 2004-14 and observed with stereo cameras, 2009-14.

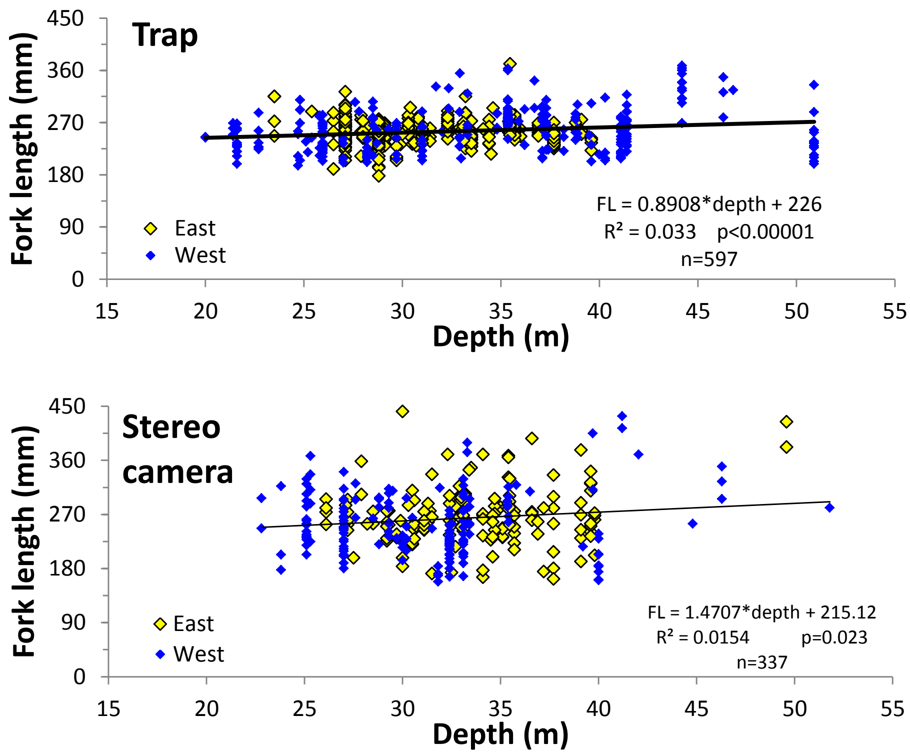

Figure 13. Fork length vs. depth relationship of vermilion snapper collected east and west of Cape San Blas in traps, 2004-2014, and observed with stereo cameras, 2009-14.

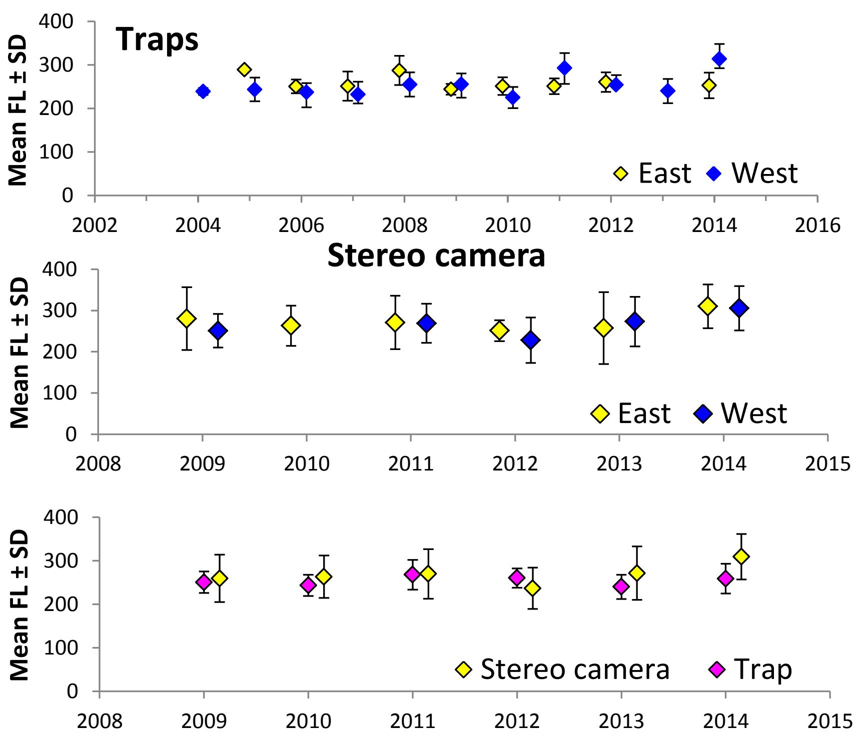

Figure 14. Mean annual fork length (mm) ± standard deviation of vermilion snapper east and west of Cape Blas from traps, 2004-2014, and from stereo images 2009-2014; and by gear from areas combined2009-2014.

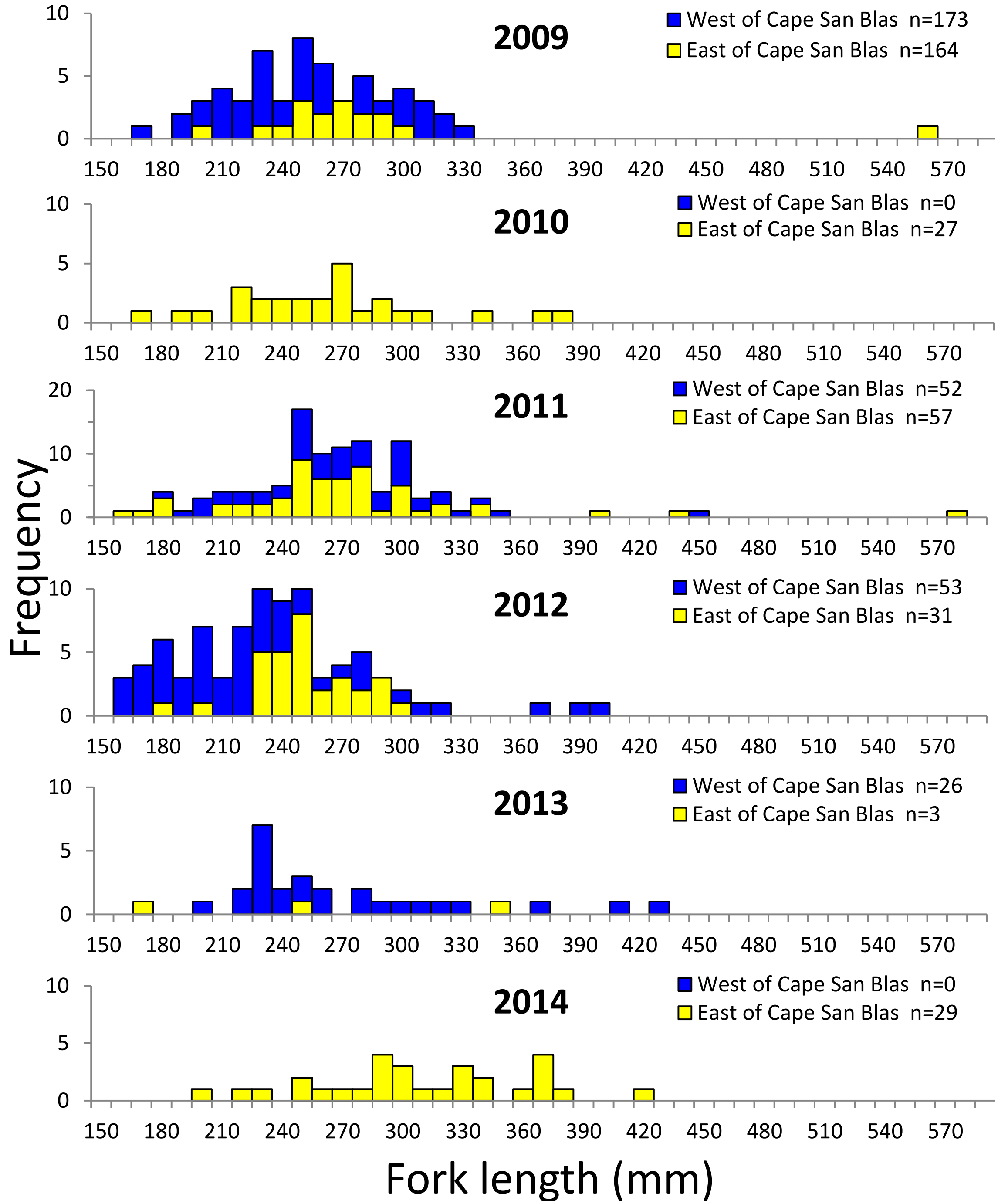

Figure 15. Annual size distributions of vermilion snapper observed with stereo cameras, 2009-14, east and west of Cape San Blas.

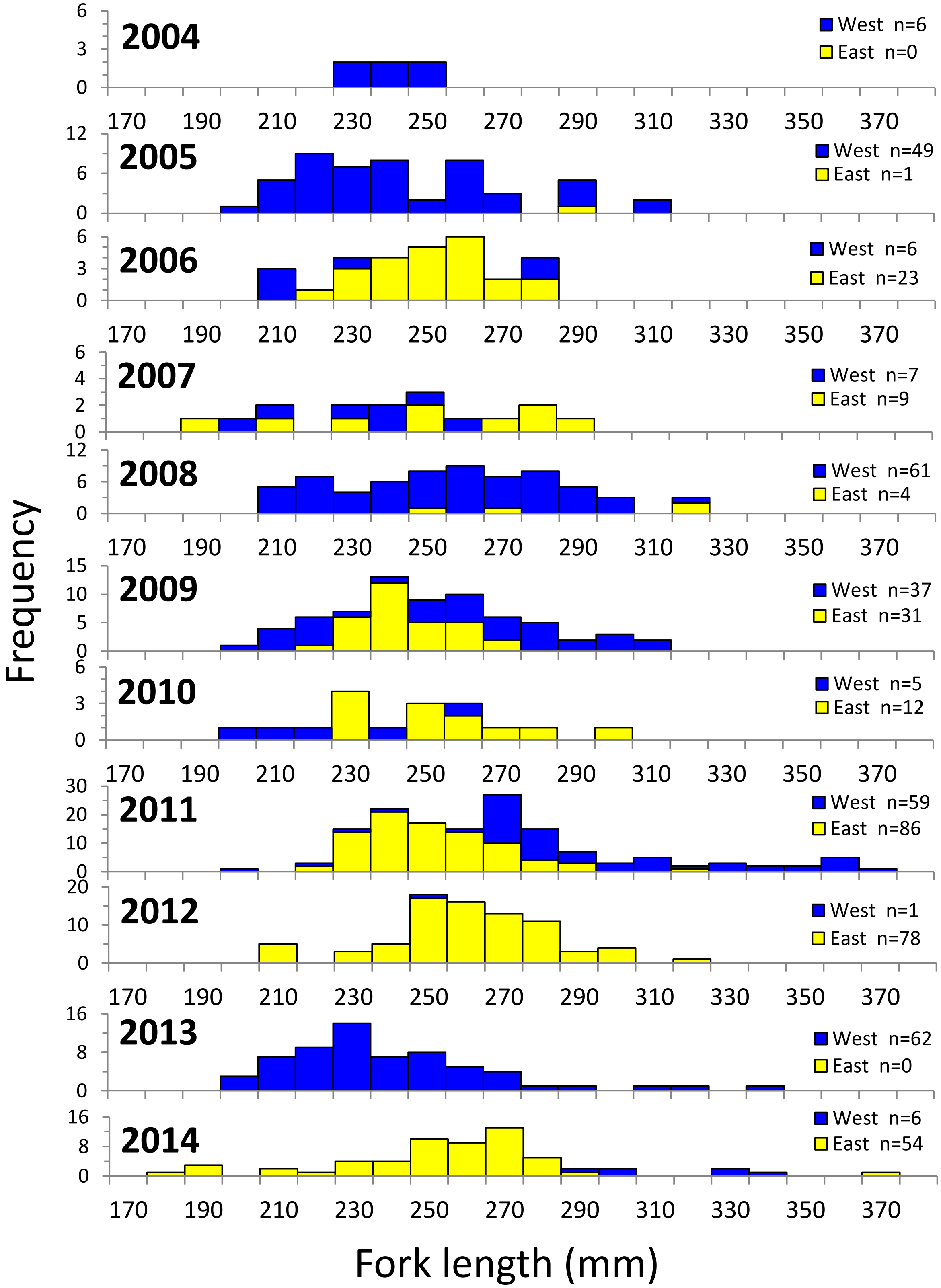

Figure 16. Annual size distributions of vermilion snapper collected in chevron traps, 2004-2014, east and west of Cape San Blas.

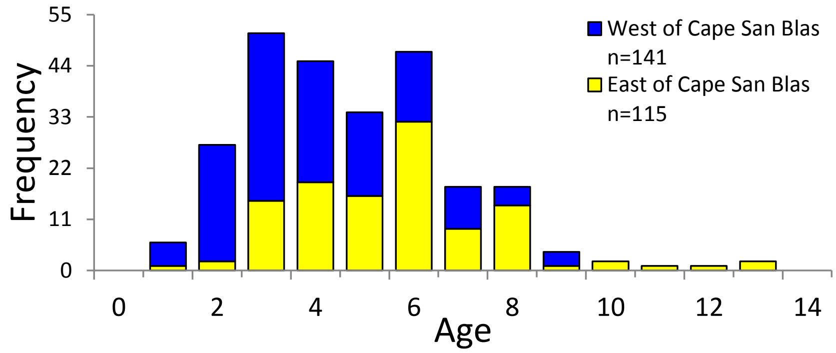

Figure 17. Overall age structure of trap-caught vermilion snapper, 2005-2014, east and west of Cape San Blas.

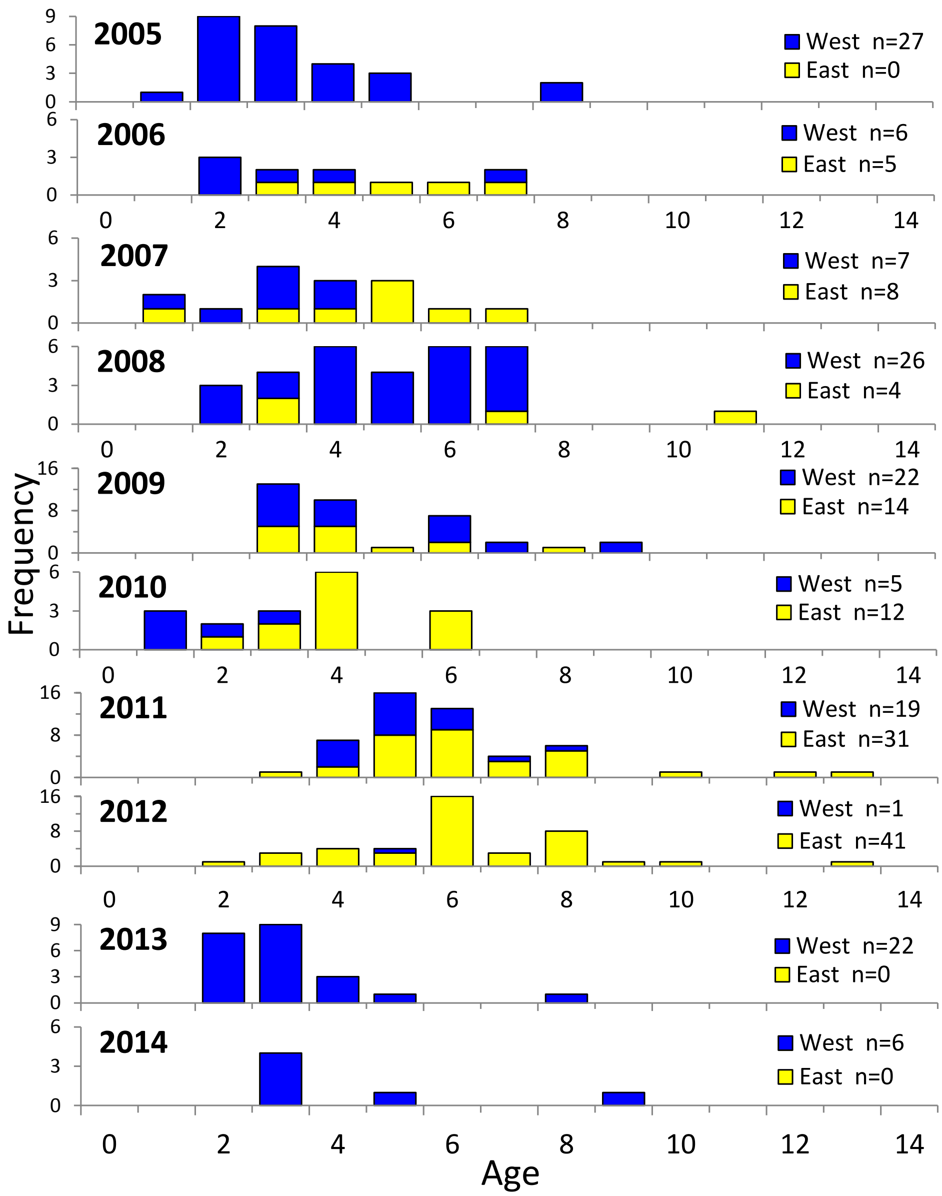

Figure 18. Annual age structure of vermilion snapper caught in chevron traps east and west of Cape San Blas in the NOAA Panama City lab reef fish survey, 2005-2015, by region.

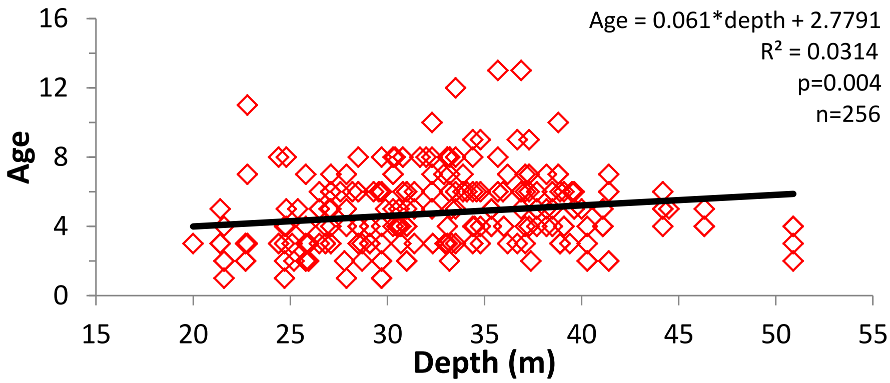

Figure 19. Age vs. depth relationship of vermilion snapper collected in traps, 2005-2014.

.

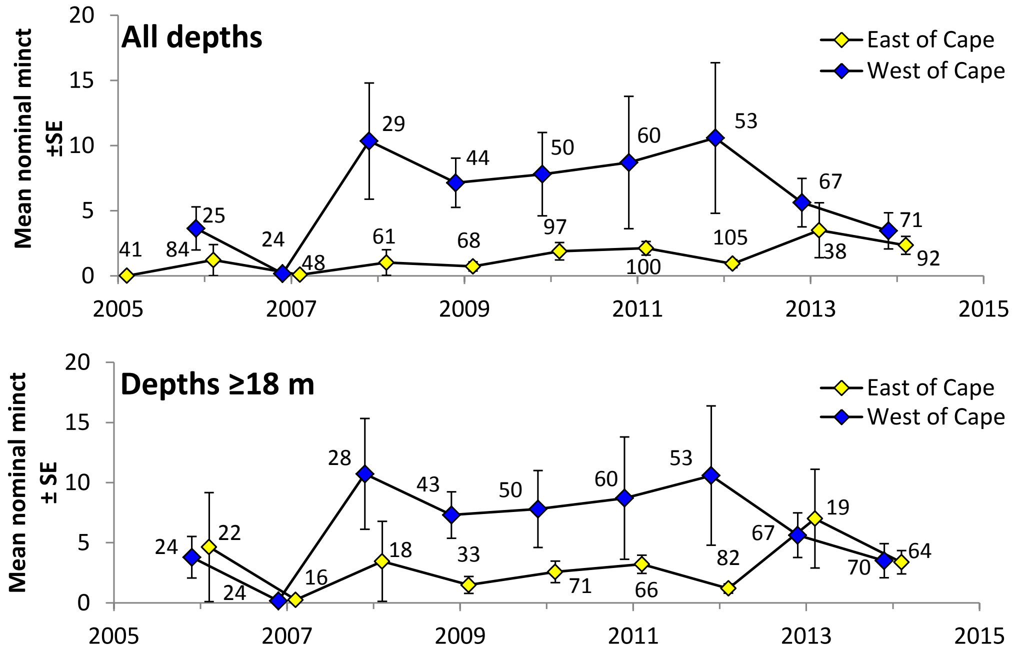

Figure 20. Mean annual nominal video min counts (MaxN) east and west of Cape San Blas, 2006-2014, based on samples from all depths and from only depths ≥ 18m. Numbers within the plot are sample sizes for each year.

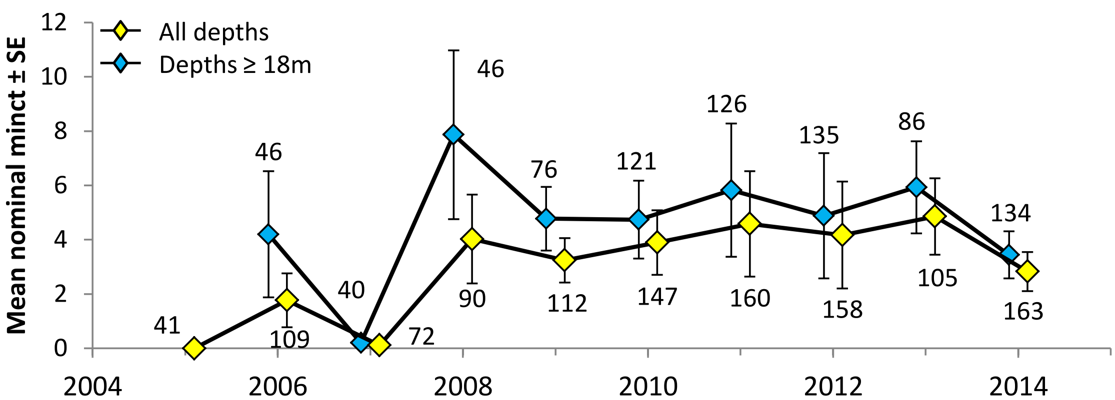

Figure 21. Mean annual nominal video min counts (MaxN), 2006-2014, based on samples from all depths and from only depths ≥ 18m. Numbers within the plot are sample sizes for each year.

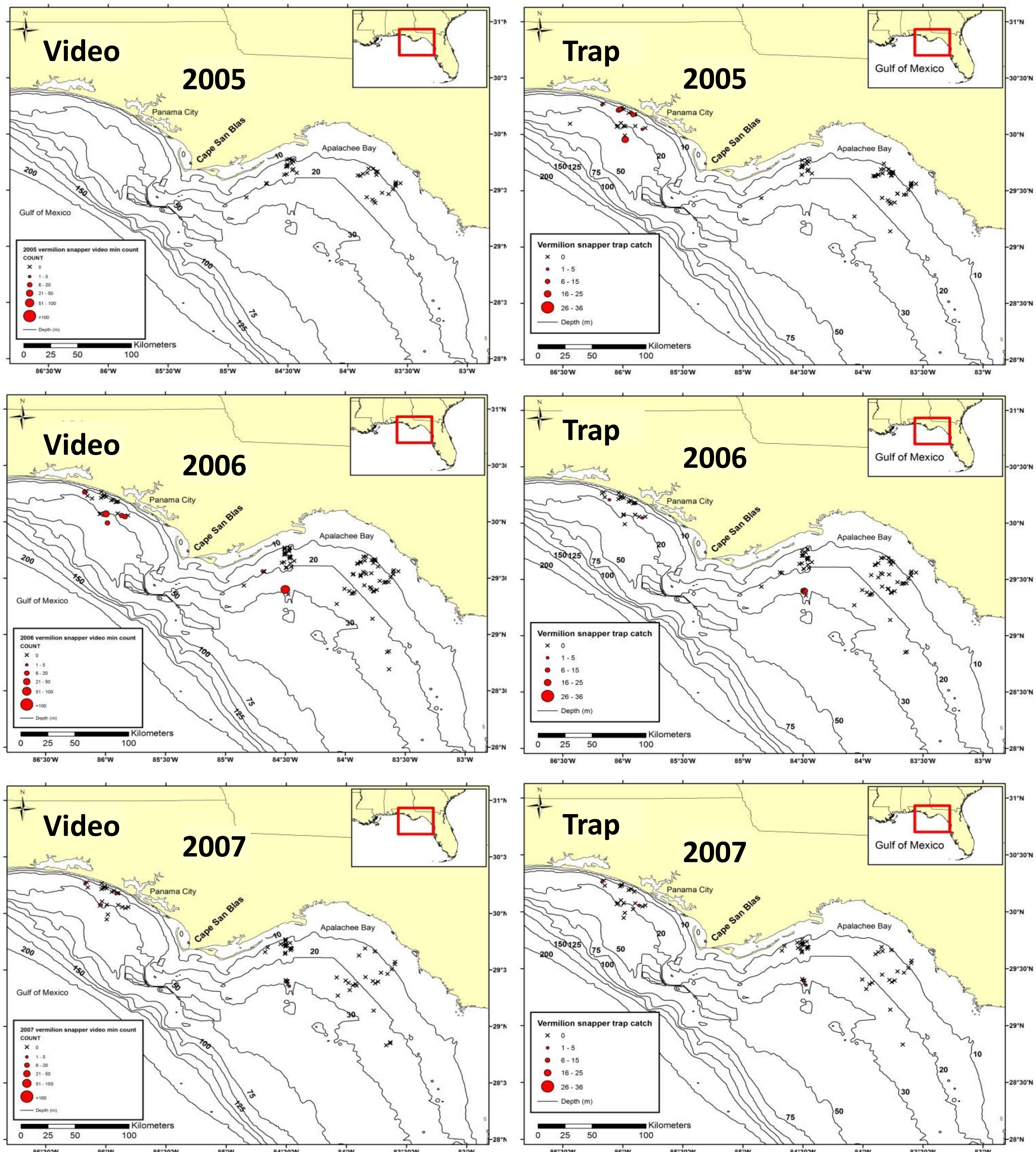

Figure 22. Annual distribution and relative abundance of vermilion snapper observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2005-2014. Sites sampled, but where no vermilion snapper were caught or observed, are indicated with an X.

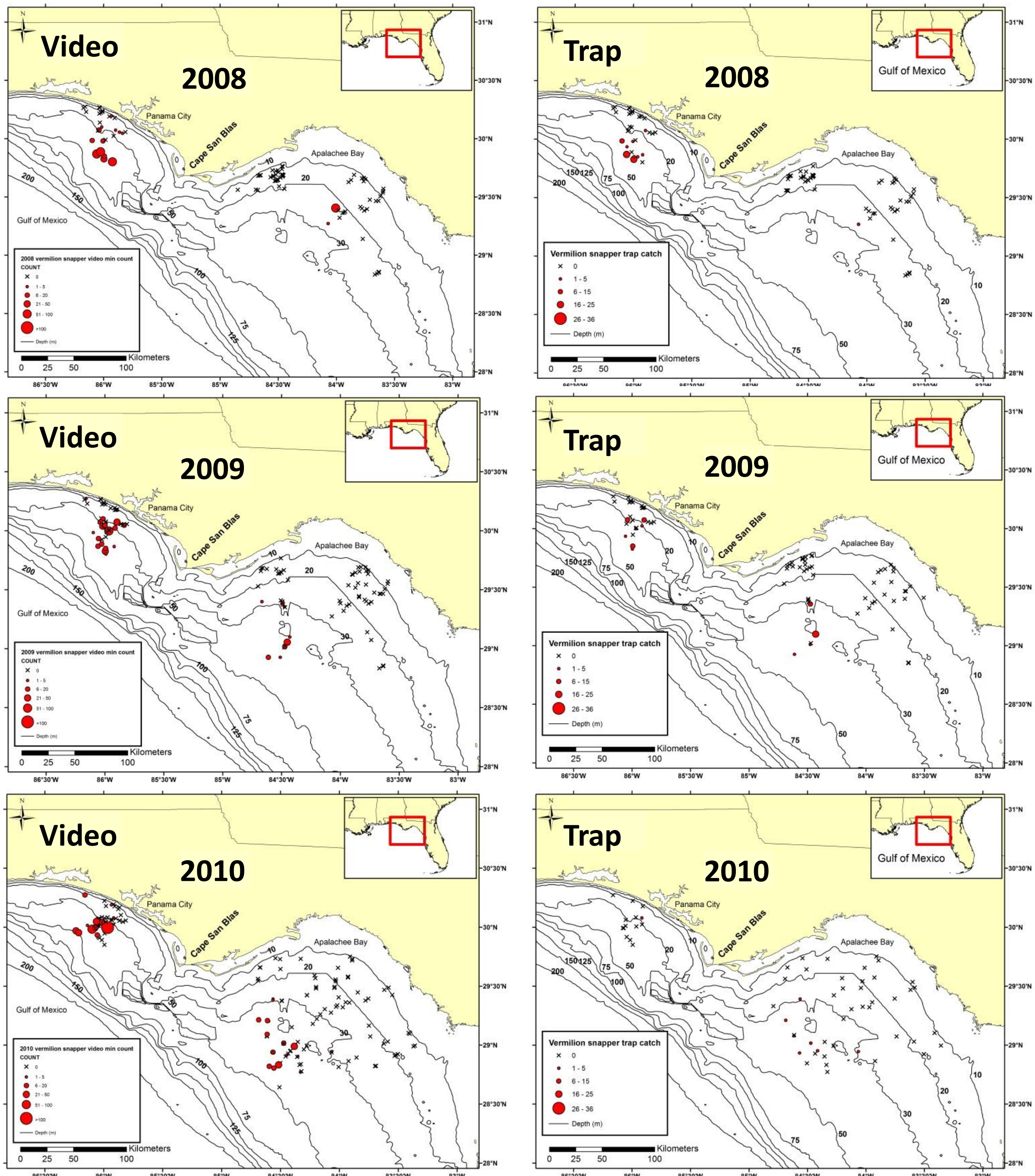

Figure 22 cont. Annual distribution and relative abundance of vermilion snapper observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2005-2014. Sites sampled, but where no vermilion snapper were caught or observed, are indicated with an X.

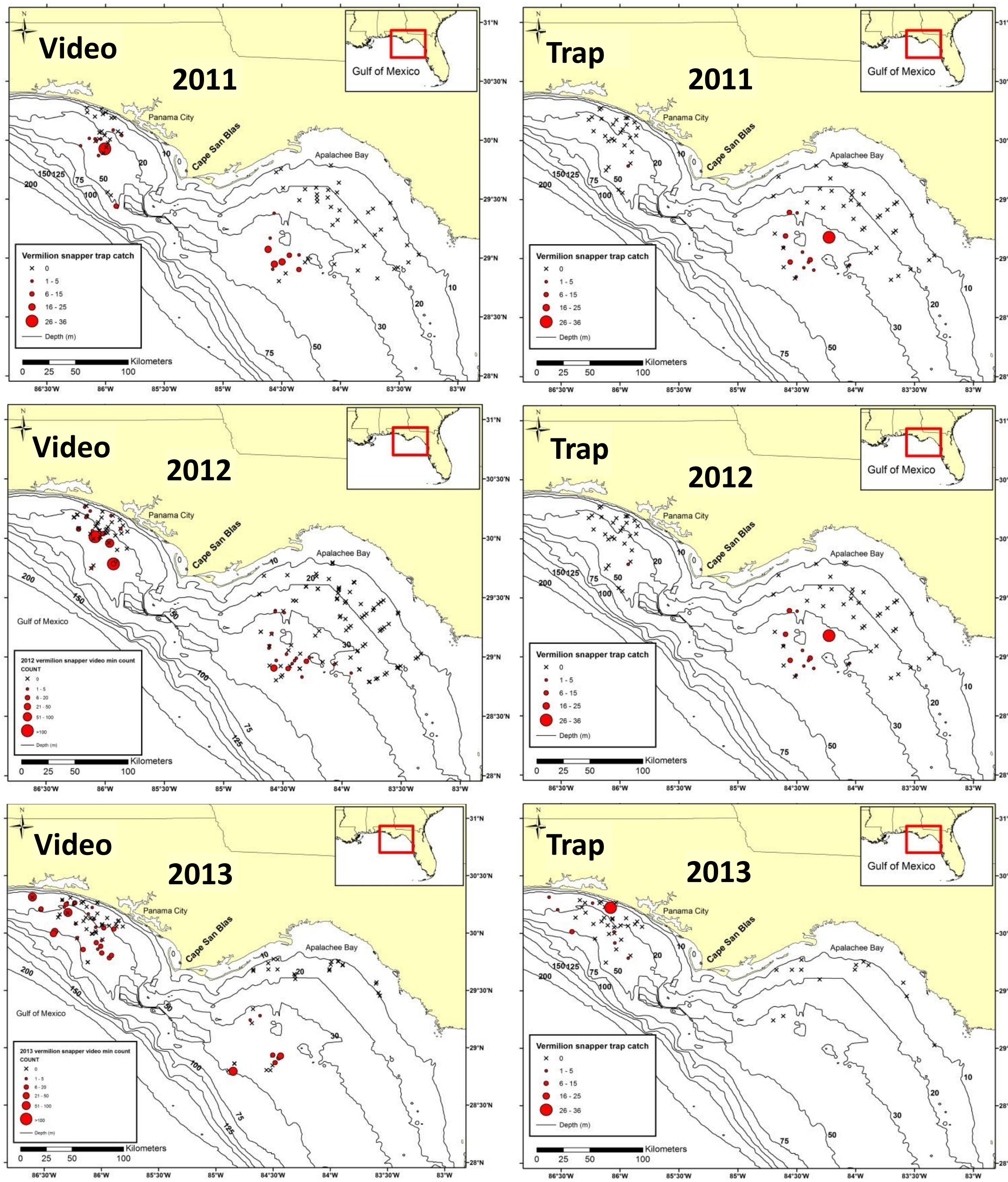

Figure 22 cont. Annual distribution and relative abundance of vermilion snapper observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2005-2014. Sites sampled, but where no vermilion snapper were caught or observed, are indicated with an X.

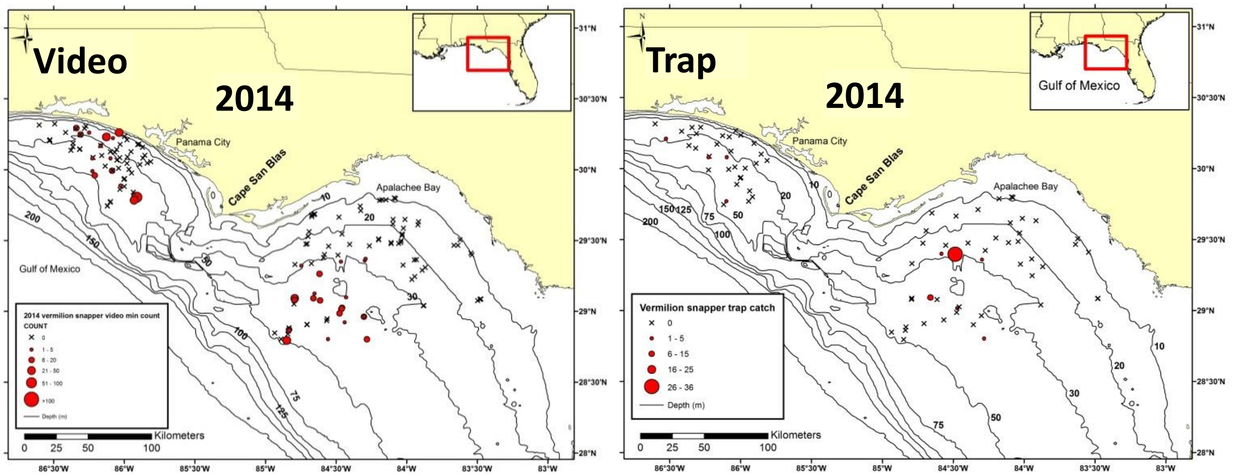

Figure 22 cont. Annual distribution and relative abundance of vermilion snapper observed with stationary, high definition video or mpeg cameras (min counts) and caught in chevron traps in the Panama City NMFS reef fish survey, 2005-2014. Sites sampled, but where no vermilion snapper were caught or observed, are indicated with an X.