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GULF STURGEON STANDARDIZED ABUNDANCE AND MORTALITY STUDY: YEAR ONE REPORT

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Introduction

The Gulf sturgeon, (Gulf of Mexico sturgeon, *Acipenser oxyrinchus desotoi*) was listed as threatened under the Endangered Species Act (ESA) in 1991. This listing was a result of population decline due to heavy fishing mortality in the early twentieth century, as well as probable habitat loss in its historic range (56 FR 49653). Periodic assessments of the Gulf sturgeon are conducted by the National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS). The most recent five-year review recommended the threatened listing under the ESA continue given low abundance in several riverine populations, along with continued habitat loss in critical spawning and "nursery" areas (NMFS and USFWS, 2009).

The Gulf sturgeon is an anadromous species, and its range is defined by the natal rivers the sturgeon return to each spring (Wooley, 1985). The eastern (and southern) boundary of the species is the Suwannee River, FL and the western boundary is the Pearl River, LA. Seven major rivers with actively reproducing Gulf sturgeon have been identified (NMFS and USFWS, 2009): the Suwannee, Apalachicola, Choctawhatchee, Yellow, Escambia (all FL), Pascagoula (MS), and Pearl (LA) Rivers. Several studies have been conducted on the movements of Gulf sturgeon (Fox et al., 2000; Edwards et al., 2003; Heise et al., 2004; Rogillio et al., 2007; Sulak et al., 2009), and long term tag-recapture data indicate that Gulf sturgeon have high site fidelity (NOAA and USFWS, 2003). However, tag-recapture survey effort has been somewhat uneven, and few studies have investigated the inter-riverine movement of Gulf sturgeon. It is therefore difficult to assess abundance trends, and to distinguish emigration from mortality for this species (Pine and Martell, 2009).

Age and growth studies have been published on several North American sturgeon species including the shovelnose *(Scaphirhynchus platorynchus),* green *(Acipenser medirostris),* lake *(A. fulvescens),* white *(A. transmontanus),* Atlantic *(A. o. oxyrinchus)* and pallid *(S. albus).* The ages of these species were determined by removing and observing the banding patterns of calcified structures such as fin rays, otoliths, scutes, opercula, and sphenoids (Brennan and Cailliet, 1989; Nakamoto et al., 1995; Rossiter et al., 1995; Stevenson and Secor, 2000; Hurley et al., 2004; Jackson et al., 2007). However, all structures except the fin rays have proved to be detrimental or required sacrificing the fish (Brennan and Cailliet, 1989). Therefore, the most widely used aging structure for protected sturgeon species is the leading pectoral fin ray or “spine” (Rien and Beamesderfer, 1994; Rossiter et al., 1995; Berg, 2004; Hurley et al., 2004; Whiteman et al., 2004; Allen et al., 2009). Spines have been used to age Gulf sturgeon (Pine et al., 2001; Sulak and Randall, 2002; Berg et al., 2007) based on validation of other sturgeon species (Brennan and Cailliet, 1991; Rien and Beamesderfer, 1994; Rossiter et al., 1995; Stevenson and Secor, 2000), and growth rates have been determined by extensive recaptures (Sulak and Clugston, 1999; Sulak and Randall, 2002). However, these studies have been limited geographically (i.e., Suwannee and Yellow Rivers, FL), and the only peer-reviewed growth curve published for Gulf sturgeon was based on Gulf sturgeon from the Suwannee River (Pine et al., 2001). Age validation for this species has not been published, though internal studies on the spines of recaptured Gulf sturgeon has lent validity to the structure up to approximately age 10 (K. Sulak and M. Randall, USGS, pers. com.). Given the strong river fidelity and disparate population estimates among river locations, Gulf sturgeon growth rates may be different among rivers. Accurate and current age and growth data are used to estimate size and age at maturity, mortality rates and age class strength (Beamish and McFarlane, 1983; Campana, 2001), and are necessary to assess Gulf sturgeon population structure.

The 2009 Gulf Sturgeon 5-Year Status Review NMFS and USFWS (2009) brought forward three recommendations for this species: 1) to prevent further reduction of existing wild populations of Gulf sturgeon within the range of the subspecies, 2) to establish population levels that would allow delisting of the Gulf sturgeon by management units, and 3) to establish a self-sustaining population that could withstand directed fishing pressure within management units. Concurrently Pine and Martell (2009), while analyzing currently available data, found that trends in abundance were unreliable due to “low recapture rates and sparse data.” Therefore the 5-Year Review recommended data gathering be improved and standardized. A workshop was organized and hosted by NMFS and USFWS in 2009 to identify survey protocols and monitoring procedures in order to fulfill the data needs of future assessments. The primary objective was to obtain reliable estimates of natural mortality (M) and abundance throughout the range of the Gulf sturgeon. The focus of this multi-year survey and monitoring project is to facilitate these objectives by standardization of data collection methodology and to collect critical data in order to assess the status of the Gulf sturgeon. In addition, the data will provide opportunity to obtain other life history information.

Five of the seven major rivers that support reproducing Gulf sturgeon populations (68 FR 13370) were included in the initial year of the monitoring project (Apalachicola, Choctawhatchee, Yellow, Pascagoula, and Pearl), and serve as the basis for a five-year natural mortality and abundance study (NMFS and USFWS, 2010b). In order to assess M, acoustic transmitter tags were implanted into Gulf sturgeon. Presence/absence was identified via a system of listening "gates" established in the five rivers to detect sturgeon as they exited the rivers in the fall and reentered in the spring. The gates are passive listening stations (VEMCO VR2Ws), and the detections will be based on active transmitters (VEMCO V16s). The goals of the cooperative study are as follows:

1. Tagging - Tag 20 Gulf sturgeon every year for three years from each of the five previously named rivers with V16s. Fish will be collected during fall outmigration in the rivers This assures that sturgeon are concentrated and avoids surgical procedures on fish during the active spawning period (spring).
2. Deploy receivers - Receivers at the mouths of the five named rivers will act as gates. Placement of additional receivers in all other rivers known to be inhabited by Gulf sturgeon will detect potential inter-riverine movements.
3. Monitor receivers - The V16s have a battery life of approximately six years, therefore receivers will be maintained and the data downloaded for five years to capture data over the 5-year period.

Additional goals include determining river fidelity, and estimating life history parameters such as growth rates and age analysis, genetic tissue sampling, identification of spawning sites, standardization of tagging methodology (i.e. PIT tags) etc. Gulf sturgeon researchers across the Gulf of Mexico are collaboratively collecting ageing structures, fin clips, and water samples to assist in research for the conservation of the Gulf sturgeon.

Methods

Fall sampling, Year 1 (2010)

Based on the outcome of the sampling protocol meeting and the need to harmonize data collection methods, standardized datasheets were created (available online at: http://sero.nmfs.noaa.gov/pr/sturgeon.htm). An Oracle database was created for data entry and to allow for a centralized data repository to be created for the tag-recapture histories of all Gulf sturgeon tagged. All researchers actively sampling for Gulf sturgeon in the known range of the species were issued standardized datasheets, 134.2 kHz PIT tags, PIT tag readers (PowertTracker AVID V), and vials for genetic tissue samples. Those researchers volunteering in the five-year monitoring program were issued 20 V16's and up to five receivers for each river if needed. Tagging protocols were standardized (http://sero.nmfs.noaa.gov/pr/sturgeon.htm) and researchers participated in training for surgical protocol (NMFS and USFWS, 2010a). The Deepwater Horizon Event provided opportunity for purchase and deployment of an additional 70 acoustic tags in the Suwannee, Blackwater, and Escambia Rivers, which supplemented the original mortality study. An additional 50 tags previously implanted during other on-going Gulf sturgeon research events also provided supplemental data to the monitoring program. Each V16 acoustic transmitter provided by the monitoring project was coated in medical grade elastomer (FactorII silicone) to reduce possible rejection by the fish (Damon-Randall et al., 2010), though tags deployed for other projects may not have been coated.

Gulf sturgeon were captured by gillnet, although specific fishing methods differed by river and researcher. Outmigration surveys were conducted on the Apalachicola, Yellow, Pascagoula and Pearl Rivers, while targeted sets were made on the Choctawhatchee and Suwannee Rivers. Outmigration surveys used a series of anchored gillnets deployed from boats, which were set during daylight hours to passively sample Gulf sturgeon as they began to move out of the river for the winter. Outmigration surveys were characterized by long soak times and generally continued over a period of weeks to months. On the other hand targeted sets were made utilizing data from bottom sounders to locate potential Gulf sturgeon and deploying a drift gillnet just upriver of the fish until it was entangled. Targeted sampling was often used in areas with high sturgeon concentrations and soak times were usually of short duration. Fishing time (effort) was recorded as the time when the net first went in the water until the last part of the net was pulled out of the water. Anchored nets, especially outmigration survey nets, were often "tended," or checked periodically but not pulled out of the water, though nets with the smallest mesh sizes were generally pulled and reset with each check.

Once captured, Gulf sturgeon were placed in a live well on board the vessel, and transferred to a holding station on shore. Sturgeon were held in a live well or tail roped and held in the river until surgery. All fish were weighed (kg) and measured for fork (FL) and total lengths (TL cm) using a tape measure across the body from the tip of the nose. Those sturgeon less than 135 cm FL were weighed, measured, tagged with a passive integrated transmitter (PIT) tag, and released. Adults (>135 cm TL) were targeted for tag implantation and those in good condition were held for surgery. The use of the anesthetic MS222 was encouraged, but left to the discretion of the researchers. Those using MS222 used a concentration of 50-100 mg/L. Each sturgeon was positioned to expose the ventral surface while the head and gills remained submerged. A 5-7 cm incision was made in the body cavity 3-5 scutes forward of the pelvic fins, and a sterilized, activated V16 was inserted. The incision was closed using a single interrupted suturing technique with absorbable sutures about 1 cm apart. An antibiotic jelly mixture was used to coat the incision by most researchers, and in some cases a skin adhesive glue was used. A hydrophone was placed in the tank to verify the tag activity, and the tag serial number was recorded. All sturgeon receiving V16 transmitters were injected intramuscularly with 0.05cc/kg of 200 mg/mL oxytetracycline (OTC) in the dorsal cavity. Sturgeon were scanned for the presence of PIT tags and, with the exception of those Gulf sturgeon captured in the Suwannee River, a new 134 kHz PIT tag was inserted to standardize the tag frequency and to ensure maximum detection rates. When possible, a fin clip was taken for genetic tissue analysis. The application of external “t-bar” tags in the pectoral fins was common, but not universal among researchers. Sturgeon were then returned to the river and attended for a minimum of five minutes before release to ensure full recovery from the anesthesia. Data from each set in which Gulf sturgeon were targeted were sent to the NMFS Panama City Laboratory and entered into an Oracle database. Once entered, data were proofed, and exported into an Excel spreadsheet for further analysis.

Remote acoustic receivers were deployed in the Pearl, Pascagoula, Mobile, Escambia, Yellow, Choctawhatchee, Apalachicola, Ochlockonee, and Suwannee Rivers. Receivers were periodically located and detections downloaded onto a computer and then transferred to the NMFS Panama City Laboratory so they could be processed.

Age analysis

Ageing method

Spines, otoliths and fin rays (pectoral, pelvic, dorsal and anal) were collected from Gulf sturgeon carcasses stored at USFWS (n=14). These "hard parts" were evaluated to determine which would be most suitable for further investigation. Suitability was based on three criteria, (1) invasiveness of the removal to the fish, (2) ease of removal for field practicality, and (3) consistency and clarity of the banding pattern.

Pectoral spine removal was laborious and annuli in larger fish were compressed, leading to difficulty in reading bands. While pectoral spines are the most commonly used ageing structure in sturgeon species, Whiteman et al (2004) cautioned against their use due to errors in age estimation due to band absorption, difficulty in identifying patterns, low reader agreement, and/or compressing of annuli. Pelvic, dorsal, and anal fin rays exhibited banding patterns and were easy to remove; however the bands were often inconsistent and unclear. Growth bands in the otoliths were obscure, inconsistent and difficult to read. Removal of the otoliths is also lethal, making them impractical ageing structures for an ESA listed species. The second marginal ray of the pectoral fin was found to be most practical for ageing as it showed consistent and clear band patterns, was simple to remove and only a small piece is necessary for analysis (~ 1.0cm). These observations led to the dismissal of the spines, otoliths, and pelvic, dorsal, and anal fin rays as viable ageing structures; therefore, the second marginal pectoral fin ray was chosen as the most suitable ageing structure for Gulf sturgeon. Based on laboratory preparation and literature review, a quick and harmless sampling method for the second marginal pectoral fin ray was developed for field researchers.

Sampling techniques and processing

Using the protocol to sample the second marginal pectoral fin ray, a scalpel and wire cutter were used to remove a 1.0 – 1.5 cm section of the ventral pectoral fin ray from an area approximately 2.5cm away from the base of the fin from live fish (n=7). This procedure allowed for ease of removal and avoided major blood vessels. Once extracted, individual fin rays were allowed to dry before being mounted in an epoxy mold. Transverse segments were sectioned using a low speed isomet saw at approximately 0.5 mm and mounted on a microscope slide using a clear mounting medium such as Cytoseal. Slides were archived in a temperature-controlled environment at the NMFS Panama City Laboratory for further analysis.

Once sectioned and mounted, fin rays were viewed under a microscope at approximately 30x magnification. Each band pair (one thin opaque, one wide translucent) was considered one year of growth and counted as an annual mark or "annulus". Sections were read independently by two readers with no prior knowledge of the size of the animal. When band counts differed between readers, the section was viewed concurrently until a consensus band count was reached. After band counts were agreed upon, annuli were plotted against both length and weight to ensure annuli formation had a direct relationship to growth.

Age validation

Oxytetracycline (OTC) is an antibiotic that acts as a chemical marker which rapidly incorporates into the calcified structures of fish (i.e spines, fin rays, otoliths, scutes) (Milch et al., 1957; Beamish and McFarlane, 1983; Campana, 2001). This chemical mark fluoresces under UV light, and is visible in the sections of calcified structures. The number of growth bands that appear after the fluoresced mark can be compared with the known marking date to validate annual growth band deposition. Once band formation is validated an age can be assigned. Previous mark-recapture studies have demonstrated that OTC successfully validated the frequency of band formation for several species of sturgeon (Kler, 1916; Tracy and Wall, 1992; Rien and Beamesderfer, 1994; Rossiter et al., 1995). To assess OTC band formation, Gulf sturgeon previously tagged with V16 transmitters and injected with OTC in the Choctawhatchee River were targeted for recapture in the Fall of 2010. A segment of the second marginal pectoral fin ray was extracted (n=1), sectioned, and examined for OTC incorporation.

Results

Fall Sampling, Year 1

A total of 328 Gulf sturgeon were captured during the 2010 fall sampling period (September -November). Because of multiple overlapping projects deploying VEMCO V16 and V13 transmitters during this time period, this report only includes data after NOAA V16 tags were issued to researchers (September 27). Sizes ranged from 30.0 to 200.0 cm FL (Fig 1) and weights ranged from 0.14 to 73.0 kg. Table 1 summarizes number and size of Gulf sturgeon captured by river; meristic data were missing for one individual. Overall, the most Gulf sturgeon (n=82) were captured in the Yellow River, while the Pearl River had the smallest catch (n=11). The Pascagoula River also had small catches of Gulf sturgeon (n=16) despite intensive sampling. Size frequencies showed that the sturgeon captured in the Suwannee and Pearl Rivers were mostly subadults to adults, while those in the Pascagoula River were mostly juveniles (Huff, 1975) (Table 1). The Yellow and Apalachicola Rivers had the broadest length-frequencies of the Gulf sturgeon captured, ranging between 30.0 and 196.0 cm FL.

Of all Gulf sturgeon captured in the fall of 2010, 113 (34%) had previously been PIT tagged (including within-season recaptures). Recapture rates for all rivers except the Suwannee River ranged between 12% (Pascagoula) and 45% (Choctawhatchee) of the total Gulf sturgeon collected (Table 2). The Yellow River had the highest total number of fish collected, but the fourth lowest recapture rate, at 27%. All fish captured on the Suwannee River were recaptures, as indicated by the presence of a PIT tag.

Total time of fishing effort was 2551.4 hours. Catch per unit effort (CPUE) was defined as number of Gulf sturgeon caught per hour of fishing effort (Table 3, Fig. 2), which translated to 2.1 sturgeon per hour. However, CPUE varied across rivers and was highly influenced by targeted sampling. Among the rivers, the CPUE values for the four outmigration surveys (Pearl, Pascagoula, Yellow, Apalachicola) are the most directly comparable because of their similar passive sampling designs and averaged 0.1 sturgeon per hour. Of the outmigration surveys, the lowest total CPUE values were for the Pascagoula and Pearl Rivers, which totaled 922 and 348 hours for 16 and 11 sturgeon, respectively (CPUE = 0.02, 0.03) (Table 3). The CPUE for the Yellow River was the highest among outmigration surveys at 0.15 sturgeon caught per hour of fishing, followed by the Apalachicola River at 0.09 sturgeon per hour (Table 3). The highest CPUE values were for the Blackwater and Choctawhatchee Rivers, though the number for the Choctawhatchee River was slightly inflated because only positive catches were reported. The Suwannee River CPUE (Table 3) was likely inflated due to the reporting of only positive catches and lack of soak time data coupled with targeted sampling. Targeted sampling involved deploying a drift gillnet just upstream of located sturgeon and removing the net as soon as fish were entangled. Because of this type of sampling, negative catches (no sturgeon) were very rare. Researchers on the Blackwater and Escambia Rivers used mostly small mesh sizes (< 15 cm stretched mesh), and a mixture of anchored and drift gillnets.

In all, 174 Gulf sturgeon were implanted with V16 transmitters in the Fall of 2010. One sturgeon was subsequently recaptured in poor condition in the Yellow River; the tag was removed and redeployed in a different fish, bringing the total number of transmitters deployed to 173. Fish length ranged from 89 to 200 cm FL and weighed from 4.5 to 66.9 kg (Fig. 3). Gulf sturgeon were tagged in a total of eight rivers (Table 4, Fig. 4), over a period of three months. Of the total fish implanted with V16 transmitters, 82 (47%) had been previously captured. Concurrently, receivers were deployed throughout the range of the Gulf sturgeon in a total of ten rivers (Fig. 4).

PIT tags (134 Khz) were inserted into a total of 289 Gulf sturgeon across seven rivers (Table 5) from fish between 30.0 cm FL and 200.0 cm FL (Table 5, Fig. 5). Of the total (n=289) 87 (30%) had previously been captured. These totals do not include Gulf sturgeon captured in the Suwannee River as the 134 kHz PIT tags were not deployed in the fall of 2010.

Age analysis, Year 1

Field trials indicated that the removal of the second marginal pectoral fin ray was relatively fast and could be accomplished during the procedure to insert V16 tags. Wounds were small and bled very little (Fig 6a). Examination of a recaptured Gulf sturgeon six months after a fin ray was sampled showed that the fin had healed well and did not show any signs of deleterious effects (Fig. 6b).

A total of 21 fin rays from Gulf sturgeon (14 carcasses and 7 from live fish on the Choctawhatchee River) were analyzed for growth band patterns in 2010. One carcass was too decayed to salvage readable hard parts from. Fish used for aging ranged from 46 to 188 cm FL and 0.5 to 37.9 kg. Annuli were clear and consistent, and showed an expected increasing pattern with increasing size, with evidence of asymptotic growth after 10-12 annuli (Fig. 7a). The oldest fish analyzed had 18 annuli (162 cm FL, 34.0 kg), and the youngest had 1 band pair (46 cm FL, 0.5 kg) (Fig 7a, b).

One sampled fish was recaptured a year after it was initially injected with OTC, and a section of the fin ray was sampled. Analysis of the sectioned fin ray under UV light revealed that the OTC was incorporated into the fin ray at the time of initial capture (Fig. 8a). Viewed under natural light, one band pair was clearly identifiable after the OTC mark (Fig 8b), indicating that band pairs are formed annually in the second marginal pectoral fin ray. The fish was first captured in October 2009, and was recaptured in October 2010. The fish grew from 102 cm (7 kg) to 108 cm FL (10 kg), and at the time of recapture had six band pairs.

The positioning of the OTC mark indicates that the thin, opaque bands are deposited in the fall/winter, while the wide, translucent bands are deposited in the spring/summer. Future recaptures will verify whether this pattern is consistent among all sizes of Gulf sturgeon, and whether adults continue to deposit one band pair per year.

<u>Discussion</u>

Gulf sturgeon were captured more frequently in the eastern range when compared to the western-most Pascagoula and Pearl Rivers. This was not unexpected, as abundance estimates have numbered in the hundreds for these rivers, as opposed to thousands for several other rivers to the east (NMFS and USFWS, 2009). Thus researchers in the eastern Gulf of Mexico often quickly achieved the goal of implanting V16 transmitters in 20 Gulf sturgeon, while those in the Pearl and Pascagoula did not capture 20 viable fish despite intensive sampling.

Length-frequencies showed that overall, captures in the Apalachicola and Yellow Rivers had the broadest representation of length classes of Gulf sturgeon, while those captured on the Pascagoula River were mostly juveniles (< 130 cm TL). All three surveys used a mixture of gillnets with differing mesh sizes to maximize the retention of all sizes of Gulf sturgeon. Gulf sturgeon captured in the Suwannee and Pearl Rivers were larger and presumably mature fish, though this could be due to size of gill net. Both surveys utilized stretched mesh sizes > 20 cm, which could have excluded smaller fish. Only sturgeon > 80 cm FL were caught on the Choctawhatchee and Blackwater Rivers; the nets used on the Choctawhatchee River were > 22 cm and nets were drifted, while a mixture of small and large mesh sizes were used on the Blackwater River, and nets were anchored.

Overall recapture rates were based on Gulf sturgeon previously tagged with PIT tags, as they were the most reliable indicator of previous capture for all rivers. Rates of recapture were similar among the Apalachicola, Blackwater, Yellow, and Pearl Rivers at 26-31%. The Pascagoula River had a relatively low recapture rate in spite of intensive sampling (12%), while the Yellow River also had a surprisingly low recapture rate (27%) given the high total number of fish captured.

Due to the selectivity associated with targeted sampling (i.e. drift nets deployed over known sturgeon locations), it is not appropriate to compare CPUE values as abundance estimates. Comparisons of CPUE estimates should be taken only as trends in context with the sampling design, as the numbers may be misleading otherwise. In this framework, the passive sampling design of outmigration surveys, which used a series of anchored gillnets set across a river, may allow for comparisons of abundance among rivers and across time. CPUE estimates for the outmigration surveys on the Pearl, Pascagoula, Yellow, and Apalachicola Rivers were considered to be comparable in 2010 because sampling was passive and similarly conducted among rivers. The Pearl and Pascagoula Rivers had comparably low CPUE values, and the Yellow River had a higher CPUE than the Apalachicola. While the values were unexpectedly low for the westernmost rivers, past abundance estimates for these rivers have only ranged in the low hundreds (67 to 430 in the Pearl and 162 to 206 in the Pascagoula) (NMFS and USFWS, 2009). The most recent population estimate for the Apalachicola River was approximately 2000 individuals, while estimates for the Yellow River have ranged from 500 to 911 (NMFS and USFWS, 2009). Analysis of mesh-size specific CPUE values for these surveys may help to elucidate abundance trends in these rivers.

Analysis of the second marginal pectoral fin ray as a potential non-lethal ageing structure for Gulf sturgeon was promising. Field trials indicated that the sampling method was fast and harmless; laboratory analysis showed clear banding patterns. The validation of this ageing structure with OTC indicates that band counts are an accurate proxy for age for sturgeon up to 6 years of age. Future analysis will incorporate time of spawning to more accurately age Gulf sturgeon. Targeted sampling of Gulf sturgeon previously marked with OTC will also continue throughout the study to validate ages for larger fish. The overall goal will be to produce river-specific growth curves for the Gulf sturgeon.

Goals for Year Two of the Gulf sturgeon Monitoring Project include ongoing analysis of telemetry data from the spring 2011 river migration to assess detection rates and movements among rivers. Historic data from several rivers dating back to the 1970's will be incorporated into the Oracle based database. This will allow for capture histories to be established and disseminated to researchers in real time from one centralized location. A workshop is scheduled to review required information to populate the standardized data sheet. The database will continue to improve with a goal of researcher access and entry. Additionally, a "lessons learned" presentation will be developed to ensure the continued success of this project while addressing issues that were encountered in the first year. An archive of hard parts from both historic and contemporary collections from the Suwannee, Pascagoula, and Choctawhatchee Rivers has been established, and age-analysis will continue. Collaboration with the researchers who collected these hard parts will continue in order to produce historic length at age curves by river.

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Table 1. Number of Gulf sturgeon captured September – November 2010 by length. The asterisk indicates the approximate size at maturity. Location codes are as follows: AR Apalachicola River, BR Blackwater River, CR Choctawhatchee River, ER Escambia River, PE Pearl River, PR Pascagoula River, SR Suwannee River, YR Yellow River.

FL (cm)	AR	BR	CR	ER	PE	PR	SR	YR
30-40						3		3
40-50	4							2
50-60	2					3		3
60-70	5			1				4
70-80				2				
80-90	6	1	2	6		1		1
90-100	3	1	1	1		3		4
100-110	8	3	4	3		3		5
110-120	2	3	5	2	2	1		2
120-130	3	7	13	3	3			7
130-140*	10	2	17	4	1	1	2	15
140-150	8	7	8	6	2	1	5	20
150-160	6	2	3	2	1		4	10
160-170	2	2	5		1		5	2
170-180	3	3	5		1		4	3
180-190	1	3	5	1				1
190-200	1	1	1					
Grand Total	64	35	69	31	11	16	20	82

Table 2. Gulf sturgeon recapture rates September – November 2010 based on presence of PIT tags. Location codes are as follows: AR Apalachicola River, BR Blackwater River, CR Choctawhatchee River, ER Escambia River, PE Pearl River, PR Pascagoula River, SR Suwannee River, YR Yellow River.

	AR	BR	CR	ER	PE	PR	SR	YR
Total number captured	64	35	69	31	11	16	20	82
Number Recaptured	20	9	31	6	3	2	20	22
Percent recaptured	31.3	25.7	44.9	19.4	27.3	12.5	100.0	26.8

Table 3. Total effort and catch of Gulf sturgeon September – November 2010. Catch per unit effort (CPUE) is the number of Gulf sturgeon caught per hour fished. Sampling methods are outmigration survey (OS) and targeted sampling (TS). Asterisks indicate that the total fishing time is not likely indicative of true effort as only positive catches were reported.

River	Sampling method	Total hours fished	Total fish caught	CPUE
Apalachicola	OS	676.7	64	0.1
Blackwater	TS	5.7	36	6.4
Choctawhatchee*	TS	11.2	69	6.2
Escambia	TS	52.6	31	0.6
Pearl	OS	347.8	11	0.0
Pascagoula	OS	922.5	16	0.0
Suwannee*	TS	6.0	20	3.3
Yellow	OS	528.8	82	0.2
Grand Total		2551.4	334	2.1

Table 4. Number of Gulf sturgeon tagged with V16 transmitters September – November 2010 by length. Location codes are as follows: AR Apalachicola River, BR Blackwater River, CR Choctawhatchee River, ER Escambia River, PE Pearl River, PR Pascagoula River, SR Suwannee River, YR Yellow River.

FL	AR	BR	CR	ER	PE	PR	SR	YR
80-90			1					
90-100		1	1					
100-110			3	3				
110-120			5	1	2			
120-130	1	2	12	3	3			1
130-140	6	2	14	4	1		2	6
140-150	6	7	6	5	2	1	5	9
150-160	4	2	1	2	1		4	4
160-170		1	4		1		5	2
170-180	2	3	4		1		4	3
180-190	1	2	4	1				1
190-200		1						
Grand Total	20	21	55	19	11	1	20	26

Table 5. Number of Gulf sturgeon inserted with 134 kHz PIT tags September – November 2010 by length. Location codes are as follows: AR Apalachicola River, BR Blackwater River, CR Choctawhatchee River, ER Escambia River, PE Pearl River, PR Pascagoula River, SR Suwannee River, YR Yellow River.

FL	AR	BR	CR	ER	PE	PR	YR
30-40						3	3
40-50	4						1
50-60	2					3	3
60-70	4			1			4
70-80				2			
80-90	5	1	2	6		1	1
90-100	2	1	1	1		3	3
100-110	7	3	3	3		3	4
110-120	2	3	5	2	2	1	2
120-130	3	7	12	3	3		6
130-140	10	2	16	4	1	1	14
140-150	8	7	8	6	2	1	16
150-160	6	2	3	2	1		8
160-170	2	2	5		1		1
170-180	3	3	5		1		3
180-190	1	3	5	1			1
190-200	1	1	1				
Grand Total	60	35	66	31	11	16	70

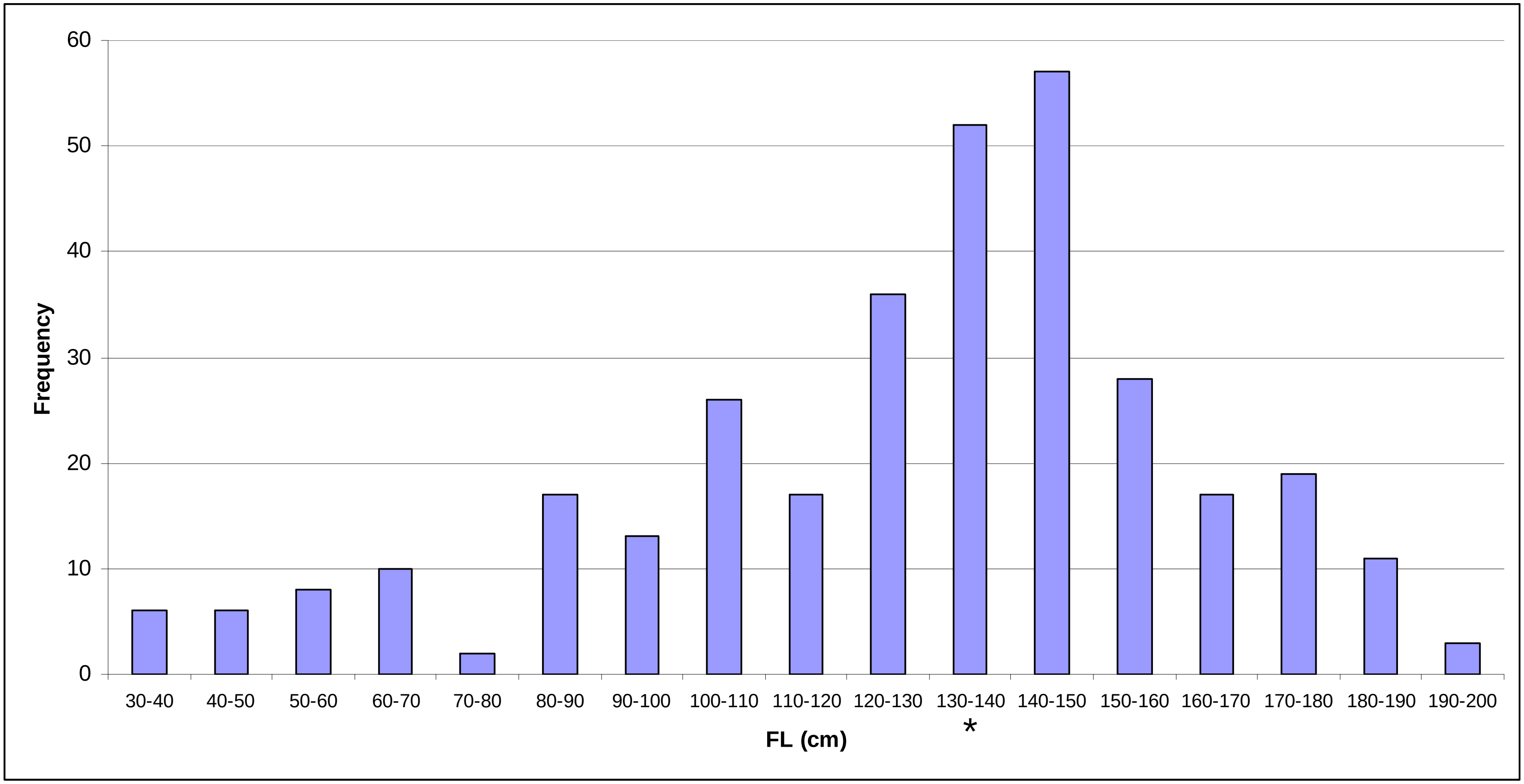

Figure1. Length-frequency of Gulf sturgeon captured September – November 2010 by length. The asterisk denotes approximate size at sexual maturity.

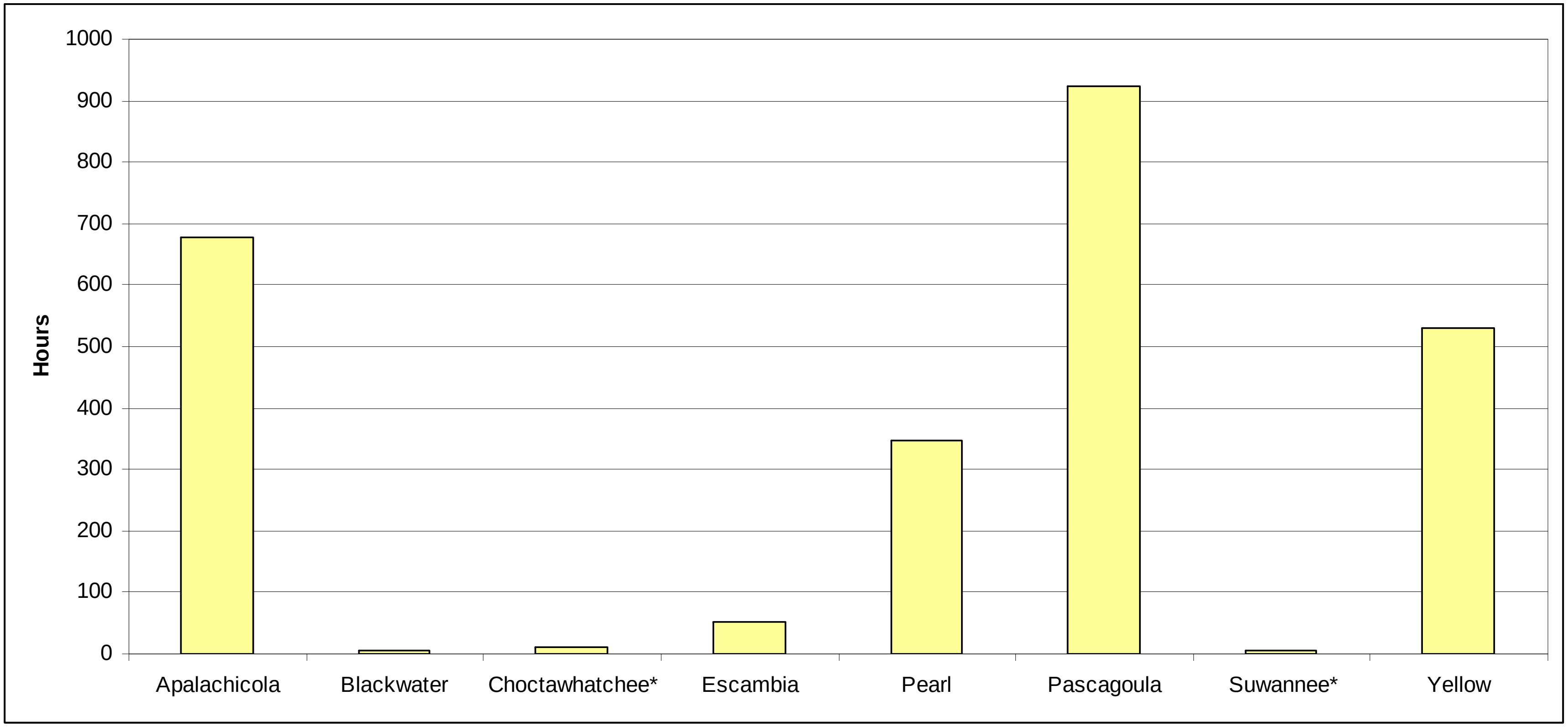

Figure 2. Total effort (hours of nets in the water) for the Fall (September – November) 2010 Gulf sturgeon survey. Asterisks indicate that the total fishing time is likely not indicative of real effort.

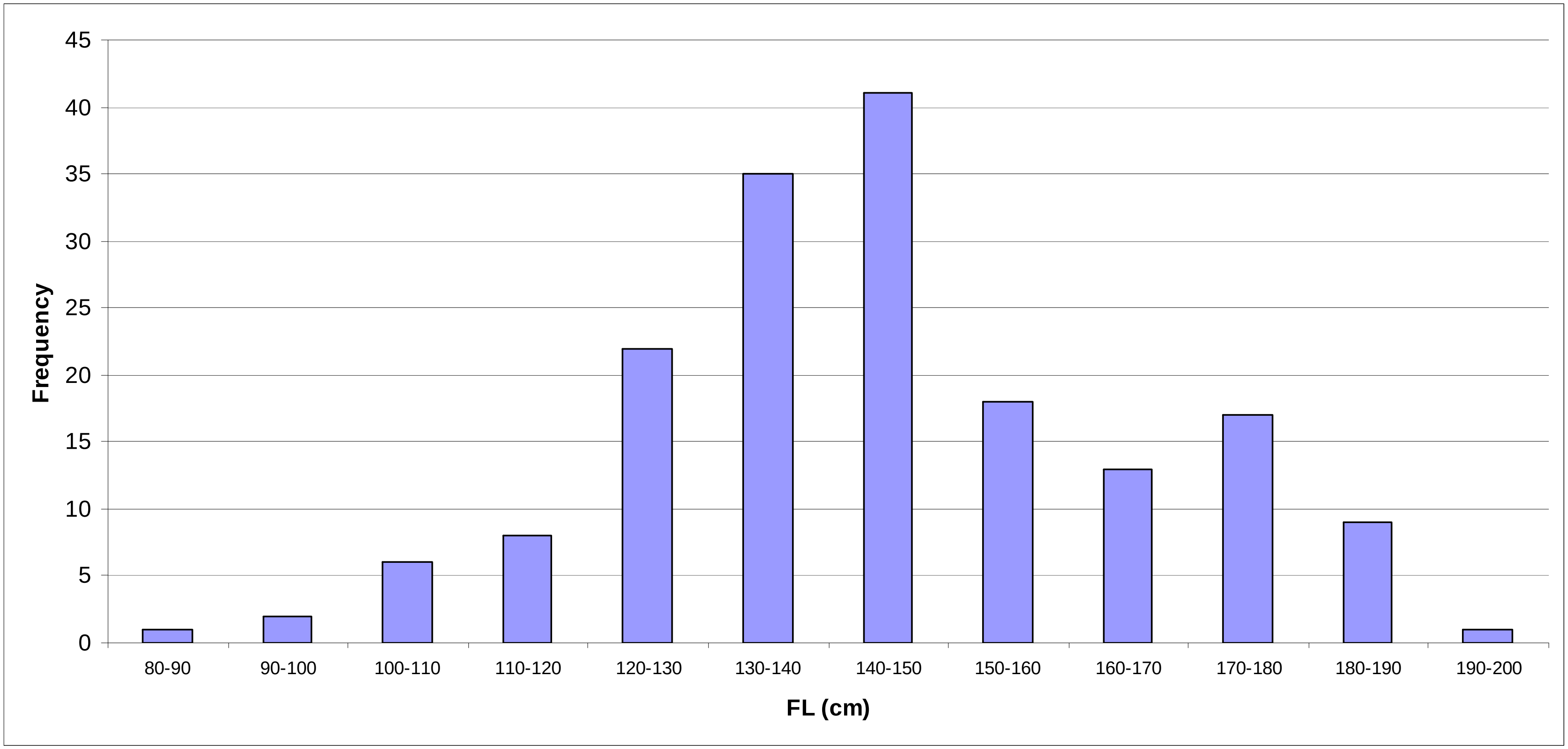

Figure 3. Number of Gulf sturgeon tagged with V16 transmitters by length September – November 2010.

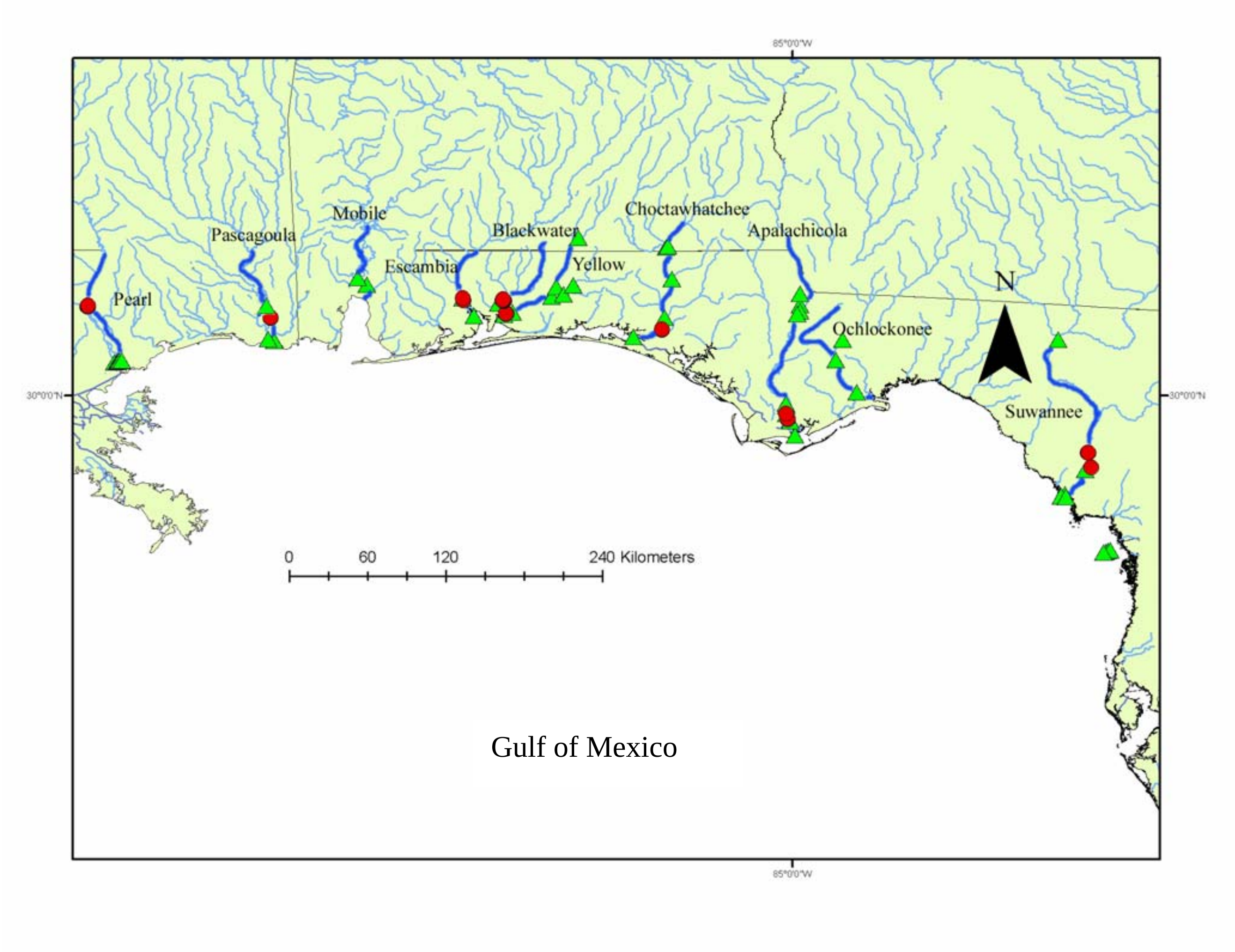

Figure 4. Locations of Gulf sturgeon tagged with V16 transmitters (red circles) and receiver locations (green triangles) during the Fall 2010 Sturgeon Monitoring Project.

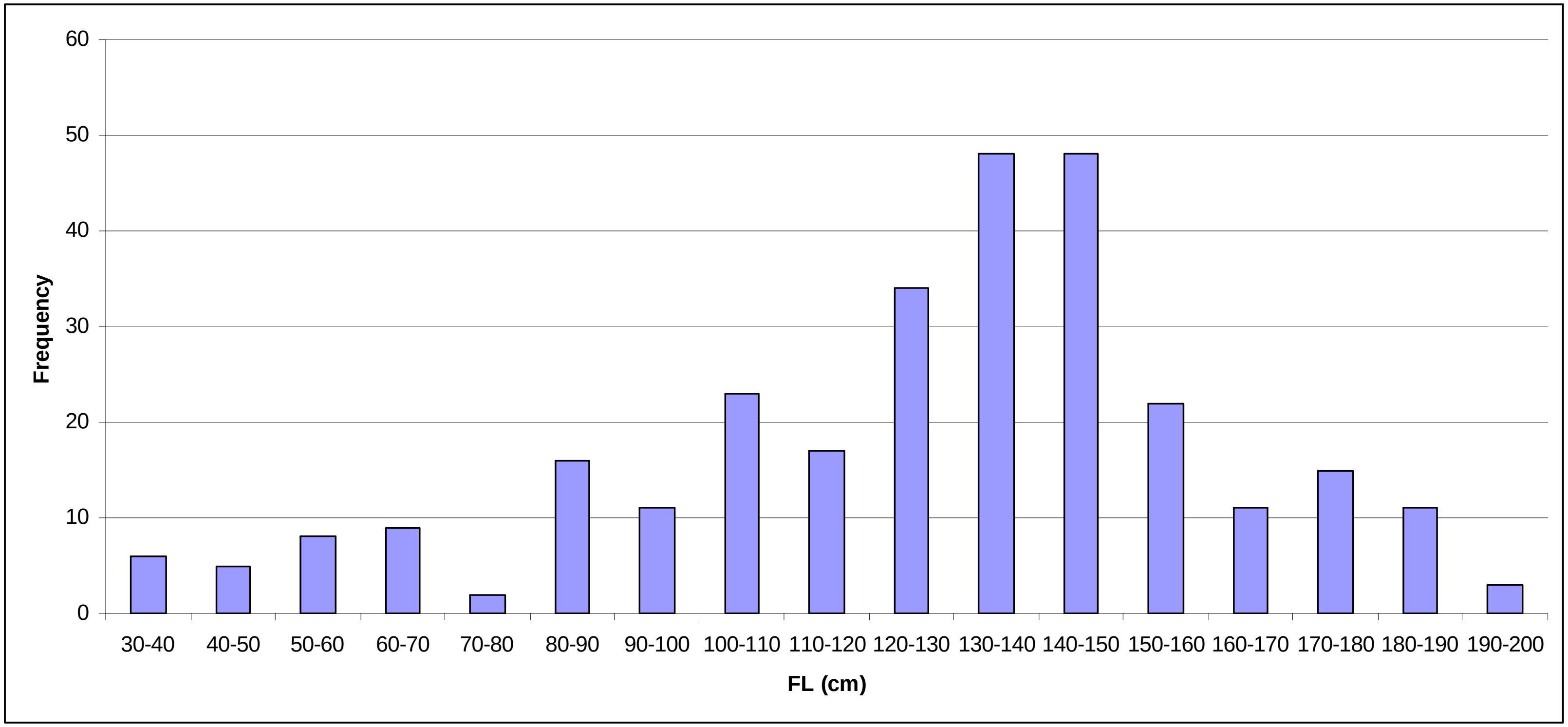

Figure 5. Number of Gulf sturgeon tagged with new 134kHz PIT tags September – November 2010.

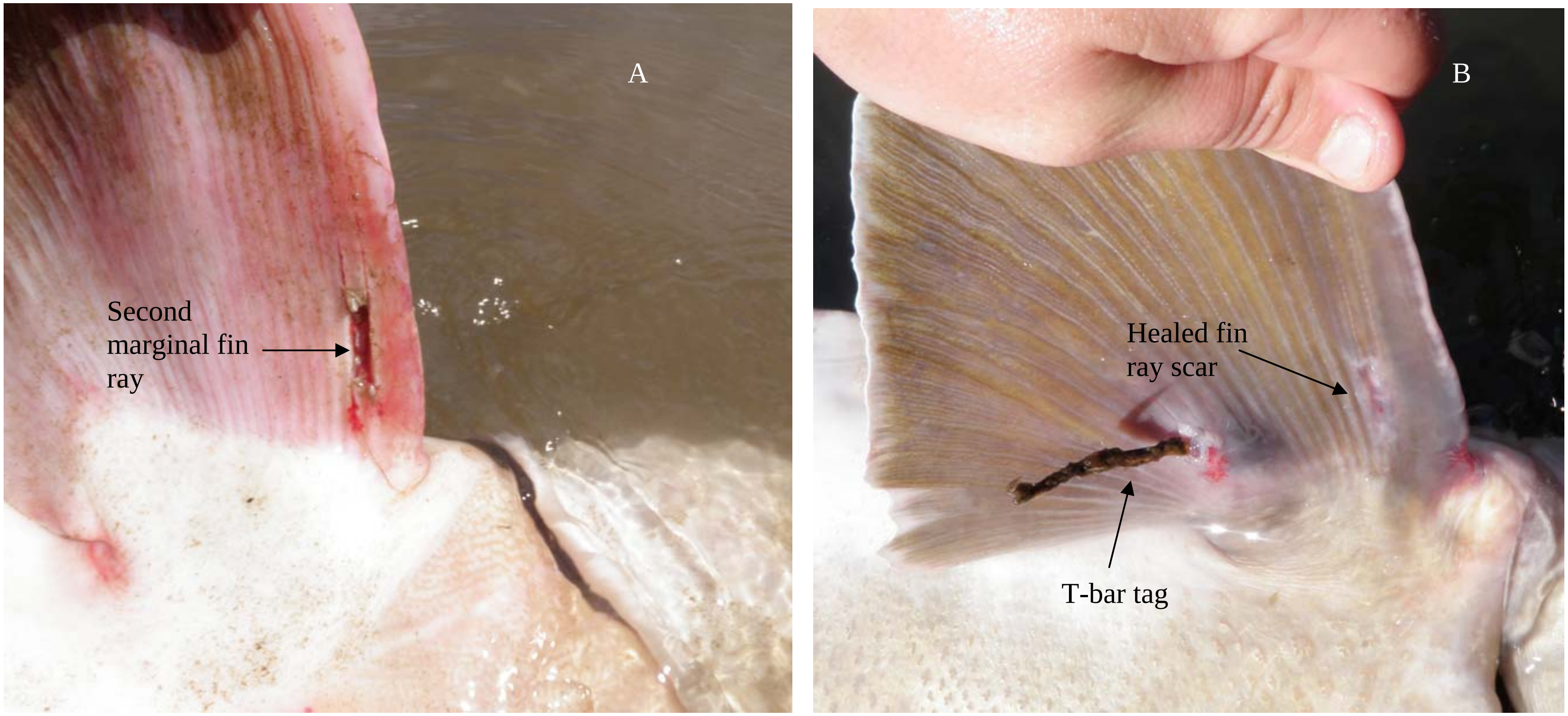

Figure 6. Right pectoral fin of Gulf sturgeon: A) just after removal of second marginal fin ray section and B) six months after second marginal fin ray was sampled. Note presence of T-bar tag in B. Photo credit: Delaware State University.

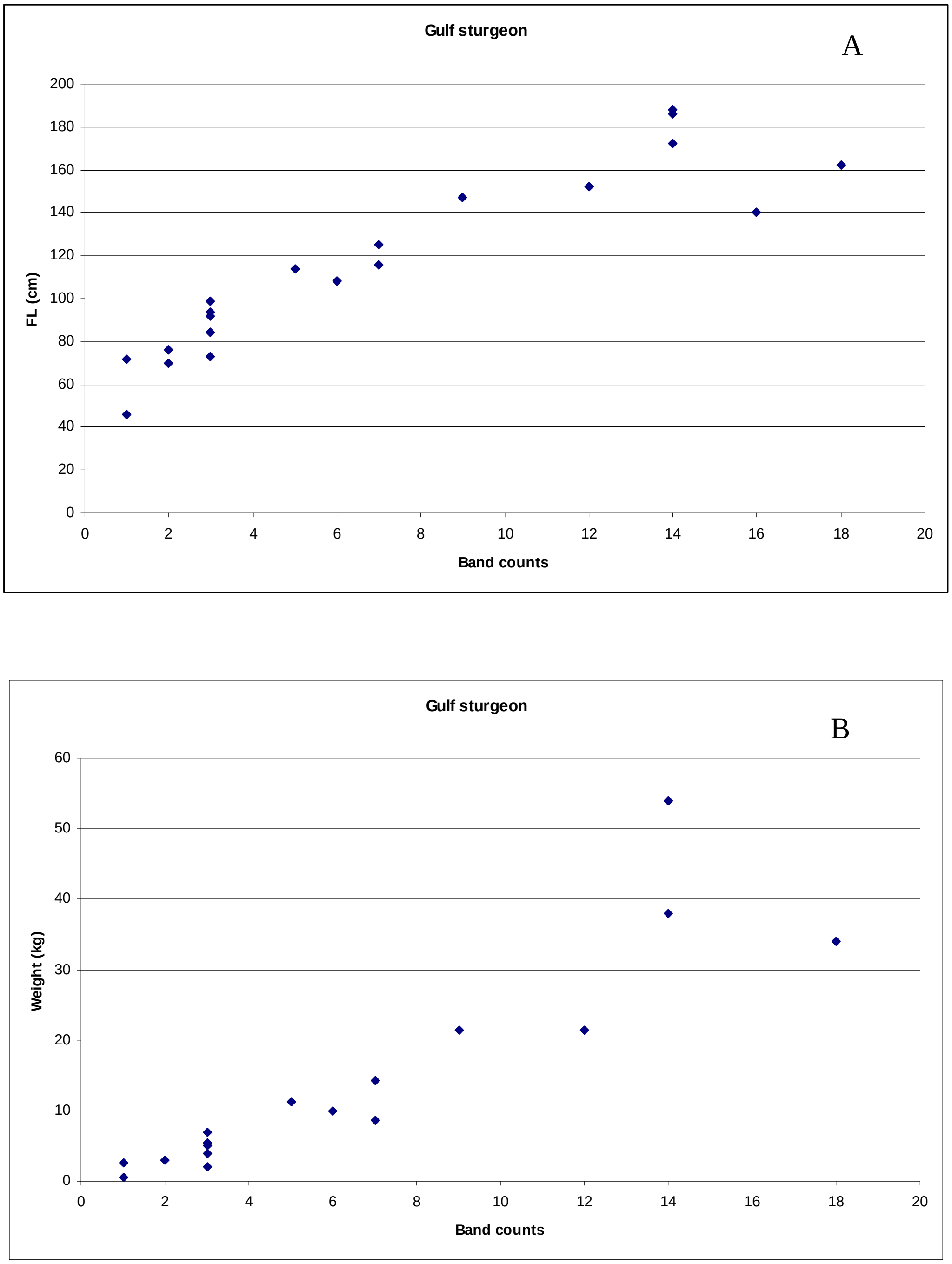

Figure 7. Band counts of Gulf sturgeon second marginal fin ray compared to A) fork length (FL) and B) weight (kg).

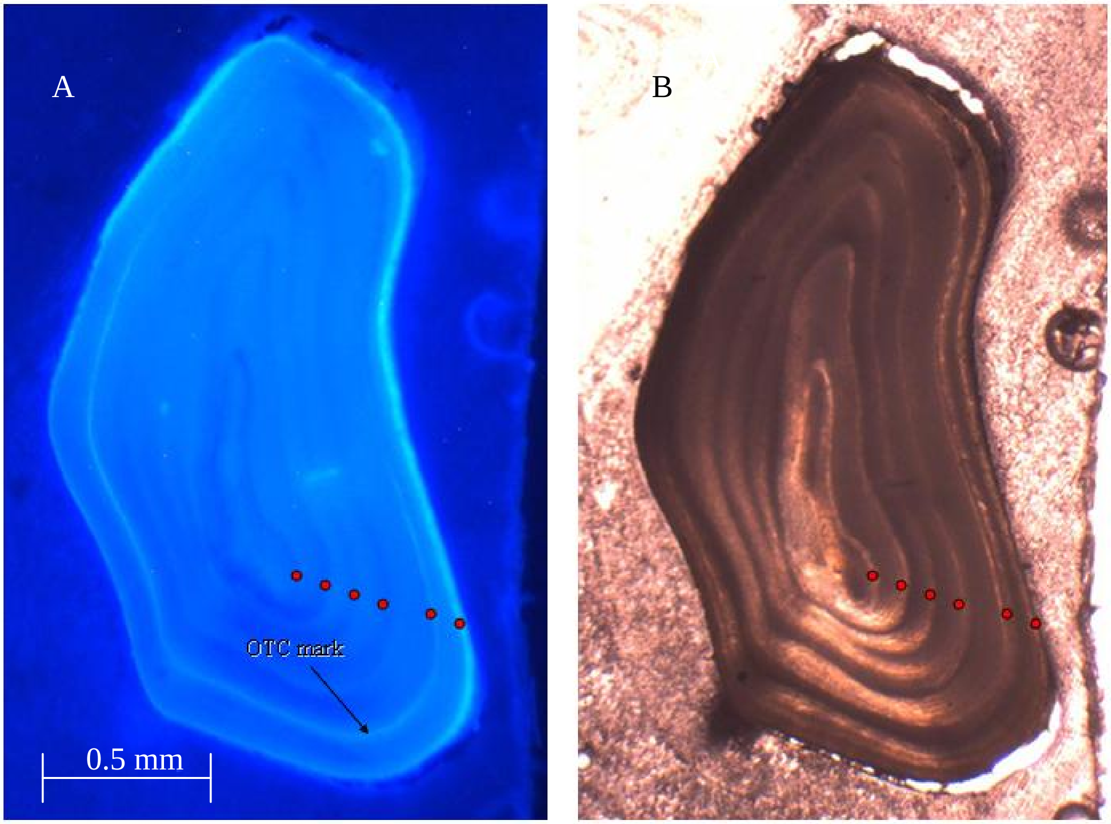

Figure 8. Image of sectioned fin ray from a Gulf sturgeon (106 cm FL) recaptured one year after OTC injection A) under UV light and B) under natural light. Red dots mark ‘winter’ bands, and indicate that this fish was 6 years old at the time of recapture.