Status Review Report:
Lesser Electric Ray (*Narcine bancroftii*)

June 14, 2016

National Marine Fisheri :s Service
National Oceanic and Atmosphe ·ic Adminis ration

ACKNOWLEDGEMENTS

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1. INTRODUCTION

1.1 Petition Background

On September 7, 2010, National Marine Fisheries Service (NMFS) received a petition from WildEarth Guardians to list the lesser[1] electric ray as threatened or endangered throughout its historic and current range and to designate critical habitat within the territory of the United States concurrently with listing the species under the Endangered Species Act (ESA). On March 22, 2011 (76 FR 15947), NMFS made a 90-day finding that the petition did not present substantial scientific or commercial information indicating that the petitioned action may be warranted.

On March 22, 2012, NMFS received from WildEarth Guardians a 60-day notice of intent to sue on the negative 90-day finding. On February 26, 2013, WildEarth Guardians filed a Complaint for Declaratory and Injunctive Relief in the United States District Court for the Middle District of Florida, Tampa Division, on the negative 90-day finding. On October 1, 2013, NMFS entered a court settlement agreement to accept a supplement to the 2010 petition, if any is provided, and to make a new 90-day finding based on the 2010 petition, its supplement, and any additional information readily available in our files.

On October 31, 2013, NMFS received a supplemental petition from WildEarth Guardians and Defenders of Wildlife. On January 30, 2014, NMFS published a 90-day finding that the petition did present substantial scientific or commercial information indicating that the petitioned action may be warranted and announced our initiation of a status review on the species. To ensure that the status review is comprehensive, NMFS solicited scientific and commercial (e.g., bycatch) information pertaining to this species from any interested party.

1.2 ESA Requirements

In determining whether a listing under the ESA is warranted, two key questions must be addressed:

1. Is the entity in question a species as defined by the ESA?
2. If the petitioned entity is a species as defined by the ESA, is the "species" threatened or endangered?

The term “species” is defined by the ESA to include taxonomic species as well as “any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. The ESA defines the term "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." The term "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a

[1] WildEarth Guardians used the common name “Caribbean electric ray” to refer *to Narcine bancroftii* in its petition. Although this is an acceptable common name for the species, it is very rarely used. The species is typically referred to in both published and grey literature as the “lesser electric ray.” Thus, the species is referred to as such throughout this document.

significant portion of its range."
Neither NMFS nor the United States Fish and Wildlife Service (USFWS) has developed any formal policy guidance about how to interpret the definitions of threatened or endangered species in the ESA. NMFS considers a variety of information in evaluating the level of risk faced by a species in deciding whether the species is threatened or endangered. Important considerations can include 1) absolute numbers of fish and their spatial and temporal distribution; 2) current abundance in relation to historical abundance and carrying capacity of the habitat; 3) any trends in abundance; 4) natural and human influenced factors that affect survival and abundance; 5) possible threats to genetic integrity; and 6) recent events (e.g., a drought or a change in management or habitat use) that have predictable short-term consequences for abundance of the species. Additional risk factors, such as disease prevalence or changes in life history traits, may also be considered in evaluating risk to populations.

NMFS is required by law (ESA Sec. 4(a)(1)) to determine whether one or more of the following factors is or are responsible for the species' threatened or endangered status:

(A) The present or threatened destruction, modification or curtailment of its habitat or range;
(B) overutilization for commercial, recreational, scientific, or educational purposes;
(C) disease or predation;
(D) inadequacy of existing regulatory mechanisms; or
(E) other natural or human factors affecting its continued existence.

Section4(b)(1)(A) of the ESA requires that NMFS make listing determinations solely on the basis of the best scientific and commercial data available, after conducting a review of the status of the species and after taking into account those efforts, if any, being made by any state or foreign nation, or any political subdivision of a state or foreign nation, to protect such species, whether by predator control, protection of habitat and food supply, or other conservation practices, within any area under its jurisdiction, or on the high seas.

This status review is being used to inform our decision on whether NMFS should propose listing the lesser electric ray under the ESA. To conduct a comprehensive review of the status of the species, we, the Status Review Team, gathered all known records of and data on lesser electric rays by contacting fishery managers, museums and other collections within the species' historic range. This status review contains the best scientific and commercial information available on lesser electric rays.

2. LIFE HISTORY, BIOLOGY, AND ECOLOGY

2.1 Taxonomy

Kingdom: Animalia
Phylum: Chordata
Class: Chondrichthyes
Order: Torpediniformes
Family: Narcinidae
Genus: *Narcine*

Species *Narcine bancroftii*
Common names: Lesser electric ray, Bancroft's numbfish, Caribbean electric ray

Rays within the genus *Narcine*, collectively known as numbfishes, occur globally in temperate to tropical marine waters and according to Eshmeyer (2015) are composed of 23 species (http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp). Until recently, rays of the genus *Narcine* within the western North Atlantic Ocean were considered to be one widely distributed species, *N. brasiliensis* (von Olfers 1831). However, Garman (1913) was the first to notice that there was sufficient regional variability among individuals he examined to suggest nominal *N. brasiliensis* specimens could in fact be separable into two distinct species. Later, in a taxonomic revision of the genus *Narcine*, de Carvalho (1999) separated numbfishes of the western Atlantic Ocean into two species; *N. brasiliensis*, known as the Brazilian electric ray, and *N. bancroftii* (Griffith and Smith 1834), known as Bancroft's numbfish, or more commonly, the lesser electric ray. *N. brasiliensis* are thought to range from southeastern Brazil to northern Argentina, whereas *N. bancroftii* are reported to range from North Carolina to northeastern Brazil, including the Gulf of Mexico (GOM) and the Caribbean Sea (de Carvalho 1999).

According to de Carvalho (1999) "The separation of both species is presently inadequate, but given their extreme geographical separation and distinctions in tooth rows and coloration they are considered two distinct species." *N. bancroftii* has relatively small spots forming incomplete ocelli on the disc and base of the tail whereas *N. brasiliensis* lacks ocelli and instead has horizontal stripes over the same regions (McEachran and de Carvalho 2002). Typically, adult *N. bancroftii* have fewer exposed vertical tooth rows than *N. brasiliensis*. However, intraspecific differences in tooth row counts among individuals of varying sizes bring the value of these counts for identification purposes into question as ranges can overlap for the two species. Furthermore, de Carvalho (1999) reported latitudinal variability in tooth counts. For example, *N. bancroftii* specimens from the Caribbean area have tooth counts intermediate to those from specimens collected off the coasts of South America (*N. brasiliensis*) and North America (*N. bancroftii*). Because taxonomic changes are sometimes accepted in ichthyology without adequate or supporting proof and that the de Carvalho (1999) study remains unpublished, the taxonomy of *Narcine* in the western Atlantic Ocean remains uncertain. A genetics-based examination (e.g., mitochondrial DNA analysis) of *Narcine* specimens from throughout their known range in the western Atlantic Ocean needs to be conducted to verify the presence of two distinct species.

2.2 Physical Appearance

The lesser electric ray is a small, shallow-water batoid characterized by a flattened, oval-shaped disc, large pelvic fins, and oversized dorsal and caudal fins that cover most of its tapering tail (Tricas *et al.* 1997). The dorsal surface of the lesser electric ray varies from a light yellow brown to a darker greyish brown with dark blotches over the snout and small incomplete ocelli over the disc and base of the tail (Figure 1). The underside of the species is white or cream colored sometimes with grey or brown blotches (McEachran and Carvalho 2002). The lesser electric ray contains electric organs that can produce 14–37 volts of electricity (Smith 1997; Tricas *et al.* 1997).

Figure 1. Dorsal and ventral views of the lesser electric ray (© *George Burgess*, Florida Museum of Natural History)

2.3 Range and Distribution

The lesser electric ray is widely distributed in warm temperate to tropical waters of the western Atlantic from North Carolina, through the GOM, the Caribbean, the Lesser and Greater Antilles, and the north coast of South America (Figure 2) (McEachran and de Carvalho 2002). Bigelow and Schroeder (1953) wrote: "This Electric Ray has been reported from localities so widely distributed, and it is so well represented in the larger museums of both America and Europe, that is expected anywhere in the American littoral [zone], provided that the type of bottom and depth be suitable..." The southern extent of the range of lesser electric rays is uncertain. De Carvalho (1999) reports specimens taken from the southern hemisphere off the State of Bahia, Brazil, however, McEachran and de Carvalho (2002) later placed the southern extent of the range within the northern hemisphere off Venezuela.

The lesser electric ray exhibits a patchy distribution throughout its range and is locally abundant in areas that contain specific habitat characteristics. Fishery independent trawl surveys in the Gulf of Mexico show that the species is patchily distributed (see Section 3.1). Its localized abundance is best documented by Rudloe (1989a) who found lesser electric rays abundant in barrier beach surf zones and adjacent passes between barrier islands at depths of 8-16 m around Cape San Blas, Florida, in the northern GOM. Rudloe (1989a) collected 3,913 rays from March 1985 to March 1987 from sites in those areas at rates ranging from 3-31 rays per hour. Rudlow (1989a) points out that "the rays were concentrated over an extremely limited area on each bar" and that "As little as several tens of meters change in position could determine whether there were two or twenty rays in the catch." Further, data indicate seasonal variation in their local distributions. Rudloe (1989a) suggested that "rays are localized in their habitats during the warm months at least, and move directly from one preferred locality to another or remain in one area over a period of weeks to months." The species is evidently migratory but its movements are poorly known. Existing information suggests at least some lesser electric ray seasonal migrations are likely associated with water temperature. Bigelow and Schroeder (1953) stated: "Captures of *Narcine brasiliensis* [*bancroftii*] off the Texas coast in the months of September, November, and March shows that it winters that far north and probably does likewise at least along the southern part of Florida. However, northward along the Atlantic Coast of the United States all of the records of it, except one, have been in summer." Similarly, Coles (1915) reported lesser electric rays are only present off the northern most part of their range during the summer. Rudloe (1989a) stated that within the GOM, rays were caught in the surf zone at Alligator Point, Florida, from March to December, and no rays were taken anywhere in the area from December to February. Funicelli (1975) reported that lesser electric rays are found at the deeper ends of their depth range during winter in the northern GOM, particularly from November-February.

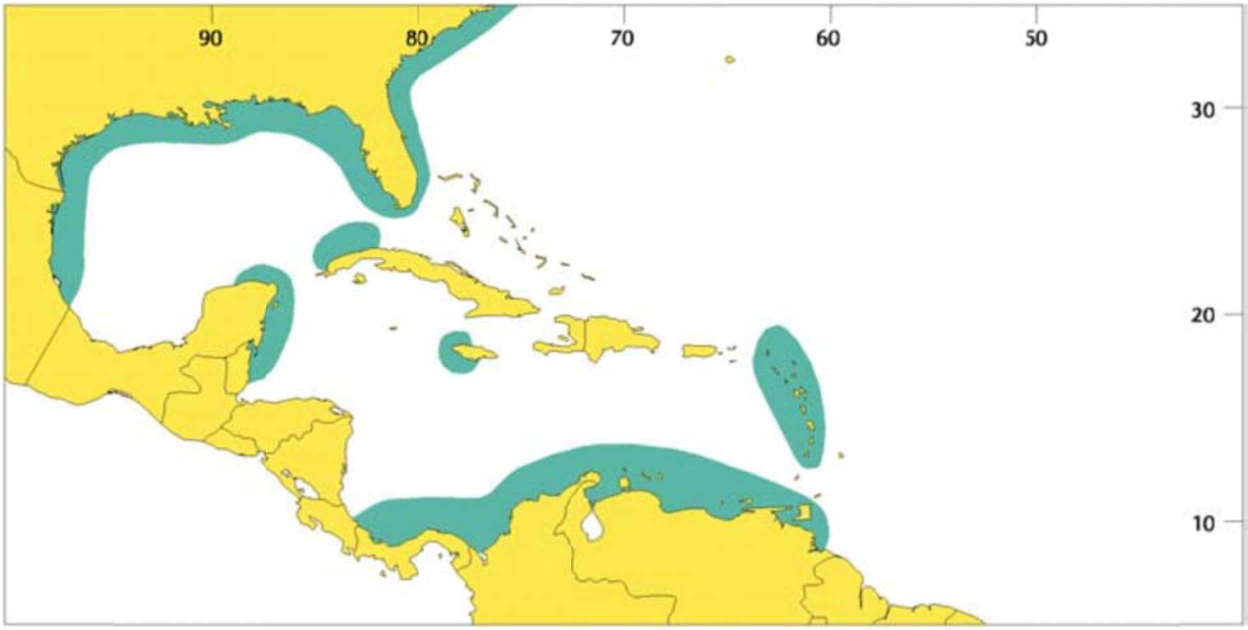

Figure 2. Lesser electric ray distribution in the western North Atlantic Ocean (McEachran and de Carvalho 2002)

2.4 Habitat Use

The lesser electric ray inhabits relatively shallow waters, often within the surf zone (Coles 1910; Fowler 1910; Bigelow and Schroeder 1953; Hoese and Moore 1998; Rudloe 1989a). Depths occupied by lesser electric rays range from the intertidal zone to 37 m (Bigelow and Schroeder 1953, Rudloe 1989a); however, there is at least one report of a lesser electric ray being captured in deeper waters at a depth of 340 m (Schwartz 2010). Fisheries-independent data collected by NMFS verify that the lesser electric ray is primarily a shallow water species. From 2002-2013, 5,137 trawls were conducted in the northern GOM at randomly selected stations ranging in depth from 4.7-326 m. A total of 127 lesser electric rays were collected, and the mean depth of capture was 9.29 m (range 5.20-17.50 m; S.D. 2.93). Environmental data were collected during these surveys demonstrating that this species inhabits waters ranging in temperature from 21.9-30.2 ^{o}C (mean = 27.18 ^{o}C; S.D. = 1.57), salinity from 27.7-36.9 ppt (mean = 34.10 ppt; S.D. 2.32), dissolved oxygen from 2.0-3.7 mg/l (mean = 2.85 mg/l; S.D. = 0.99) and turbidity from 0.6-94.0 % transmissivity (mean = 37.77 % transmissivity; S.D. = 28.23). These data are consistent with past reports of environmental conditions associated with the presence of lesser electric rays (e.g., Gunter 1945, Rudloe 1989a, Steiner et al. 2007).

Based on the best available information on the species, the species occurs predominately in sand bottom habitats. While lesser electric rays have a relatively broad distribution in the western Atlantic Ocean, the species is reported to occur almost exclusively on sand bottom habitats (Coles 1910, Bigelow and Schroeder 1953, Rudloe 1989a). For example, Rudloe (1989a) determined that “barrier beach surf zones and on [sand]bars adjacent to passes between barrier islands” are the preferred habitat for lesser electric rays. Both of these habitats are dominated by sand. Anecdotal reports also document lesser electric exclusively in high energy beach and sandbar habitats. Furthermore, NMFS fisheries-independent trawl survey data verify the findings of the aforementioned studies in that all lesser electric ray specimens collected in the

GOM were associated with sand bottom habitats. We only found one study lesser electric rays occurring in mud and fine silt habitats (i.e., Dean et al. (2005)).

Lesser electric rays are generally nocturnal and spend daylight hours buried under the sand. Rudloe (1989a) noted that his sampling was limited to night-time when the rays were active. There are numerous old and recent reports of lesser electric rays being most commonly found buried in the sand with only their spiracles revealing their presence.

2.5 Age and Growth

There are no age and growth studies for this species. However, the observations of Rudloe (1989a) suggest rapid growth: "In March the young born the previous August reappeared in the trawls and grew to the 20-29.9 cm range during the following spring and summer." McEachran and de Carvalho (2002) report size at birth at 9-10 cm with maximum growth to 58 cm total length (TL).

2.6 Reproductive Biology

Estimates of size at maturity for male lesser electric rays range from 20 – 26 cm TL (Bigelow and Schroeder 1953, Funicelli 1975, de Carvalho 1999, Moreno et al. 2010). Maturation in females occurs at a larger size with the smallest reported female with well-developed gonads being 26 cm TL (Funicelli 1975), and the smallest gravid female reported measured 27.1 cm TL (Bigelow and Schroeder 1953). Rudloe (1989a) observed that all the females larger than 29 cm, both in captivity and collected from the field off Florida, were gravid in July. This indicates that the reproductive cycle is annual, and adult females in the population are capable of reproducing each year. Annual reproduction by mature females was verified by Moreno et al. (2010). According to Rudloe (1989a), females give birth off Florida in August and September in the surf zone, and in November and December in more offshore locations. Rudloe (1989a) did not estimate the gestation period; however, in the Colombian Caribbean Sea, Moreno et al. (2010) found that the gestation period lasts approximately four months, with birth occurring from February to April. The brood size of female lesser electric rays has been given as 14 by Bean and Weed (1911), 4-15 by Bigelow and Schroeder (1953), 5-13 by de Carvalho (1999), and as 1-14 by Moreno et al. (2010).

2.7 Diet and Feeding

Lesser electric rays are reported to feed on small, benthic organisms (Moreno et al. 2010). Funicelli (1975) observed annelids in 84% of the lesser electric ray stomachs he examined from the northern GOM, which was in agreement with the limited data presented by Gudger (1912) and Bigelow and Schroeder (1953). Fishes within the order Anguilliformes were the next most abundant prey (30% of individuals), followed by arthropods and molluscs. Arthropods were the dominant prey type found in small individuals less than 300 mm TL (Funicelli 1975). Moreno et al. (2009) and Grijalba-Bendeck et al. (2012) reported similar findings for lesser electric rays collected in the Caribbean Sea off Colombia with annelids occurring in the majority of stomachs examined. However, both studies reported that arthropods constituted a larger portion of the diet than anguilliform fishes. A diet composed primarily of annelids has also been reported for the closely related Brazilian electric ray (Goitein et al. 1998).

Dean and Motta (2004a and b) characterize lesser electric ray feeding behavior and kinematics. The lesser electric ray is a benthic suction feeder with highly protrusible jaws. The lesser electric ray has the ability to protrude its jaws by nearly 100% of its head length to excavate buried polychaetes.

2.8 Predation and Disease

Almost nothing is known of natural predation on the lesser electric ray. Presumably its electric organs deter potential predators, such as sharks and dolphins. Rudloe (1989a) reported that tagged rays released off trawlers were repeatedly observed to be actively avoided by both sharks and porpoises that fed heavily on other rays and bony fishes as they were culled overboard. There is a single record of a shark attacking an electric ray during a “feeding frenzy” as bycatch was discarded back to the water (Rudloe 1988). Gulls observed feeding on fish in shrimp bycatch appeared to avoid electric rays released alive and only preyed upon dead individuals (Rudlow 1988). One researcher reported observed consumption of lesser electric rays by large red drum that were captured on bottom longlines and dissected. However, it was not clear to the researcher whether or not the rays were discarded bycatch that were opportunistically consumed (M. Ajemian, Texas A&M- Corpus Christi, pers. comm. to Jennifer Lee, NMFS, June 19, 2015).

Similarly, there is scant information on disease within the species. Electric rays retained in captivity for scientific purposes often exhibit monogenean infestations of the gills and are subject to bacterial infections and infestations of gill parasites. Captured lesser electric rays carry a range of parasites, such as external leeches (e.g., *Branchellion raveneli*) (Rudloe 1989b, Dr. Ash Bullard to J. Lee, NMFS SERO, August 2014) and copepods (e.g., *Caligus mutabilis*) (Bere 1936). Additionally, Tao (2013) reported that bacteria, such as *Vibrio* spp., are prevalent in the blood of healthy lesser electric rays captured from open beach habitat in the north-central GOM; though this condition is not uncommon among chondrichthyan fishes.

3. ABUNDANCE AND TRENDS

The International Union for the Conservation of Nature (IUCN) Red List Assessment indicates lesser electric ray is currently listed as Critically Endangered (de Carvalho et al. 2007). The IUCN Red List assessment notes that the species has declined 98% since 1972 in the northern GOM according to a study by Shepherd and Myers (2005) of trawl data from the Southeast Area Monitoring and Assessment Program (SEAMAP). The IUCN Red List assessment reports that declines of a similar high rates are evident in U.S. trawl surveys between 1989 and 2001 (a decline to 5% during this period, or, in other words , 95% fewer lesser electric rays documented in 2001 than in 1998) in U.S. coastal areas between Cape Canaveral, Florida, and Cape Hatteras, North Carolina. The IUCN Red List Assessment also states that diver survey data from the Reef Environmental Education Foundation (REEF) program show similar rates of decline between 1994 and 2004 off the coast of eastern Florida and the Florida Keys. The Red List Assessment formed the basis of the petition to list lesser electric ray under the ESA.

To fully evaluate the purported declines in abundance and rarity of the species as part of this status review, we attempted to find any and all abundance data related to the species. This included a review of the known scientific literature, internet searches, and communication with state and federal monitoring agencies. We acquired the original data sets utilized for the basis of the IUCN Red List assessment and petition and conducted an independent analysis of these data. In addition, we also considered a variety of other smaller datasets and encounter reports in forming our conclusions about trends in abundance of the species. While some of these other data were anecdotal in nature and couldn't be used to statistically assess trends in abundance, they were useful in illustrating recent encounters of the species its range.

3.1 Fishery Independent Data Sources

GOM SEAMAP Data
The Southeast Fisheries Science Center (SEFSC) Mississippi Laboratories have conducted trawl surveys in the northern GOM dating back to the 1950's. However, early work was exploratory and often only target species were recorded. In 1972 a standardized fall trawl survey began as a part of a resource assessment program. Then in 1982 a standardized summer trawl survey began under SEAMAP. Finally, in 1987, the SEAMAP program was adopted in the fall, thus unifying the two surveys. SEAMAP is a collaborative effort between federal, state and university programs designed to collect, manage and distribute fishery independent data throughout the region. The primary objective of this trawl survey is to collect data on the abundance and distribution of demersal organisms in the northern GOM. This survey, which is conducted semi-annually (summer and fall), provides an important source of fisheries independent information on many commercially and recreationally important species throughout the northern GOM (Pollack and Ingram 2014, Pollack and Ingram 2015). A full description of the historic and current surveys can be found in Nichols (2004) and Rester (2015).

Shepard and Myers (2005) examined trends in elasmobranch abundance from SEAMAP data using the longest continuous temporal coverage (1972–2002), for the areas between 10 and 110 m in depth near Alabama, Mississippi and Louisiana (i.e., statistical zones 11, 13-16, Figure 3). These authors correctly noted that Brazilian electric rays (*N. brasiliensis)* have been historically misidentified and are not known to inhabit the GOM. Thus, all *N. brasiliensis* and *Narcine sp.* identified within the trawl survey data were treated as *N. bancroftii* during the analysis. Using a generalized linear modeling approach to correct for factors unrelated to abundance, Shepard and Myers (2005) reported a decline of 98% since the baseline abundance of lesser electric rays in 1972 in the northern GOM, i.e., the number of lesser electric rays documented in the survey that year.

As part of our reanalysis of the data, we also utilized a generalized linear modeling approach in our analysis of the data. In statistics, a covariate is a variable that is possibly predictive of the outcome under study. Covariates considered in the analysis that may have affected abundance include year, area, water depth, and time-of-day. Because of major changes in survey design and survey coverage between 1972 – 1986 and 1987 – 2012 (Pollack and Ingram 2014), three separate time series were analyzed: Fall SEAMAP 1972-1986, Fall SEAMAP 1988-2013 and Summer SEAMAP 1982-2013. The Fall SEAMAP 1987 trawl survey was omitted from analysis because the cruise track differed from that of all the other surveys (counter-clockwise around the northern GOM and missed half of the area off Texas due to weather). Similar to Shepard and Myers (2005), all *N. brasiliensis* and *Narcine sp.* were treated as *N. bancroftii* for this analysis.

The abundance index constructed for Fall SEAMAP 1972-1986 was limited to NMFS statistical zones 11, 13, 14 and 15 (Figure 3). Sampling outside of these zones was inconsistent; therefore, the analysis was limited to this core area. In addition, all stations deeper than 40 fathoms were removed from the sample since there were no records of lesser electric ray occurring at those depths from any year of the survey. There are, in actuality, only two records in the entire SEAMAP data set of lesser electric ray occurring beyond 20 fathoms, one in 1972 at 23 fathoms and one in 1975 at 35 fathoms (depths for these stations were verified by the Coastal Relief Model[2]). It should be noted that the higher abundances in the early years of the survey might be inflated. During the survey, species can be marked as either ‘Sampled’ or ‘Select’. When marked ‘Select’, it indicates that each individual was removed from the overall catch and the count is the true number of individuals. Alternatively, when marked ‘Sampled’, the final count is extrapolated using the size of the subsample retained compared to the overall size of the catch. In the early years of the survey, many of the lesser electric rays were marked as ‘Sampled’ and their final counts were extrapolated, whereas later on in the surveys, they were marked ‘Select’ (Table 1).

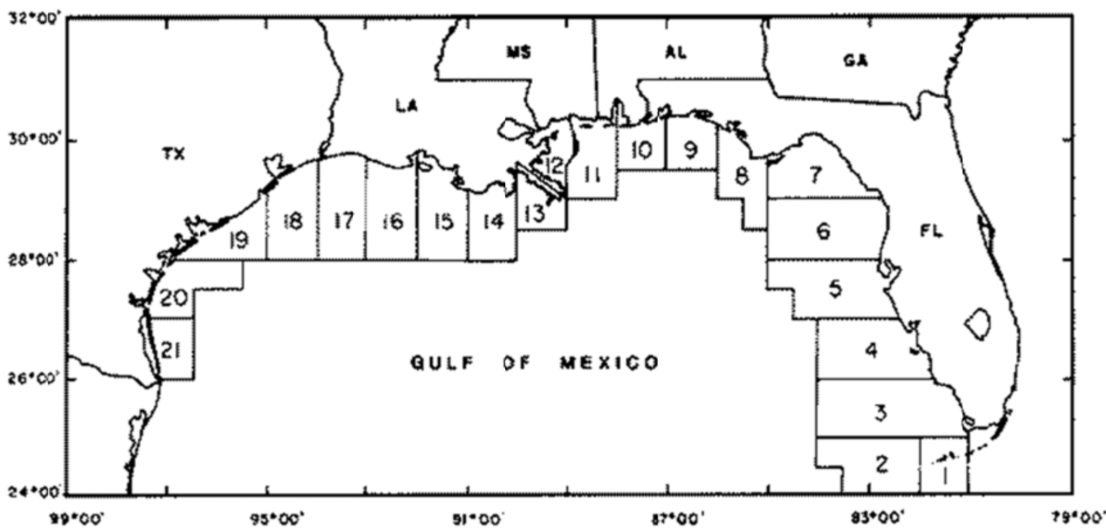

Figure 3. U.S. Gulf of Mexico Statistical Zones (http://www.sefsc.noaa.gov/images/stssn_statzone_gulf.gif)

The second index constructed was Fall SEAMAP 1988-2013. Data for this index was limited to NMFS statistical zones 10–21 (excluding 12), and at stations shallower than 17 fathoms. The third index constructed was Summer SEAMAP 1982-2013. Data for this index was also limited to NMFS statistical zones 10 – 21 (excluding 12), and stations shallower that 18 fathoms. Sampling outside of the specified zones was inconsistent or did not occur. Stations deeper than the maximum depth included in each index were removed from the sample since there were no records of lesser electric ray occurring at those depths from any year of the survey.

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[2] *NOAA National Geophysical Data Center, U.S. Coastal Relief Model, Retrieved date goes here,http://www.ngdc.noaa.gov/mgg/coastal/crm.html*

Table 1. Number of lesser electric rays that were marked as 'Sampled' and 'Select' during the SEAMAP Trawl Surveys. When the two numbers are equal it represents every lesser electric ray being pulled from the catches and counted.

Year	Sampled	Select
1972	17	46
1973	48	129
1974	33	47
1975	10	30
1976	21	21
1977		
1978	39	39
1979	13	37
1980		
1981		
1982	3	10
1983	3	3
1984		
1985	11	40
1986	1	4
1987	1	3
1988	1	1
1989	4	4
1990	8	12
1991	2	2
1992	1	1
1993	12	12
1994	5	5
1995	25	32
1996	12	12
1997	11	20
1998	3	3
1999		
2000	4	4
2001	8	10
2002	11	13
2003	7	10
2004	18	18
2005	1	2
2006	15	15
2007	13	13
2008	8	8
2009	11	12
2010	7	8
2011	14	14
2012	11	14
2013		

Within the northern GOM a total of 9,876 tows were included in the analysis with 624 lesser electric rays captured. Most captures occurred off the coasts of Louisiana and Texas (Figure 1). For the Fall SEAMAP 1972-1986 series, only year was retained as a covariate in the binomial submodel, while year and depth were retained in the lognormal submodel. Year, area, depth and time-of-day were the most significant covariates in the binomial submodel for the Fall SEAMAP 1988-2013 abundance series, while year and time-of-day were retained in the lognormal submodel. For the Summer SEAMAP 1982-2013 time series, year, area, depth and time-of-day were the most significant covariates in the binomial submodel, while year was retained for the lognormal submodel.

There were no discernible trends in relative abundance of lesser electric rays in any of the three GOM SEAMAP indices. All three time series were relatively flat with peaks in abundance scattered throughout the abundance trend (Figures 4-6). Within the northern GOM a total of 9,876 tows were included in the analysis with 624 lesser electric rays captured. Most captures occurred off the coasts of Louisan and Texas. Shepard and Myers (2005) indicated that only 78 individuals were captured from 1972-2002. However, from the data used for this analysis, there were 351 individuals recorded from the same time period. Shepherd and Myers (2005) exclusion of data off Texas explains partly the discrepancy and also reflects a lack of understanding of how the data were collected (sampled versus select). The distribution of lesser electric ray seems to be heavily concentrated along the barrier islands around south Texas and Mississippi and Louisiana (Figure 7). However, off the coasts of Mississippi and Louisiana the SEAMAP survey is conducted from the National Oceanic and Atmospheric Administration (NOAA) Ship *Oregon II* which cannot fish in waters shallower than 9 m due to the vessel's draft. Presently, efforts are being made to include waters as shallow as two fathoms in the sampling universe, but there are only a few research vessels that can sample that shallow. With the proportional allocation of stations by NMFS statistical zone, very few stations may end up in these shallow depths in future survey years. This could lead to a decrease in lesser electric rays captured by the survey in the future because SEAMAP is no longer sampling their habitat and therefore would not reflect abundance changes. Overall, lesser electric rays are rarely encountered during the trawl surveys due to the habitat it is found in and the inability of research vessels to sample that habitat.

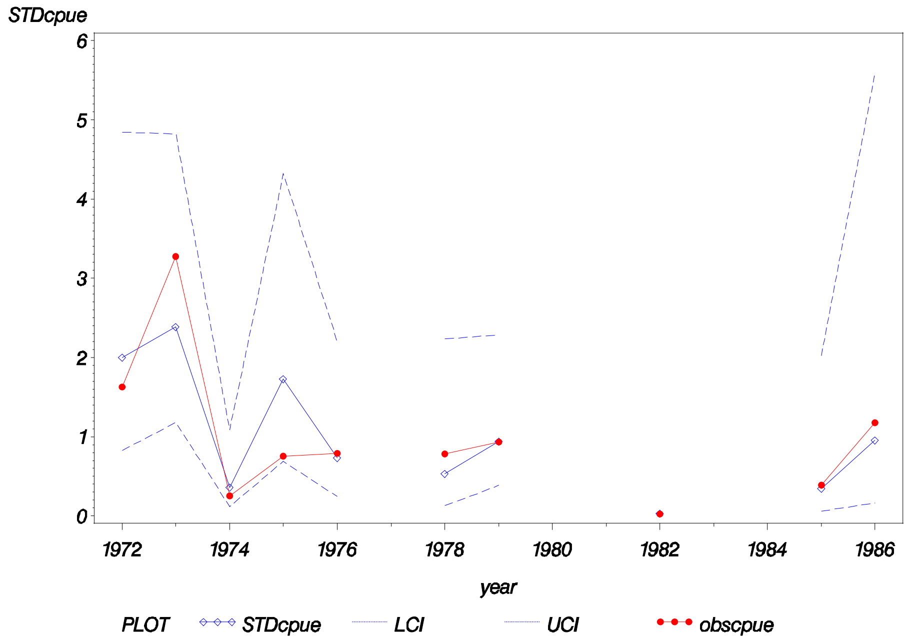

Figure 4. Annual index of abundance for lesser electric rays from the Fall SEAMAP Trawl Survey from 1972 – 1986, including observed catch per unit effort (obscpue) and standardized cpue (STDcpue) 95% confidence intervals (LCI= lower confidence interval, UCI=upper confidence interval) (Note that the survey has been conducted annually since 1972; in 1977, 1980, 1981, 1983, and 1984 no lesser electric rays were captured during the survey.)

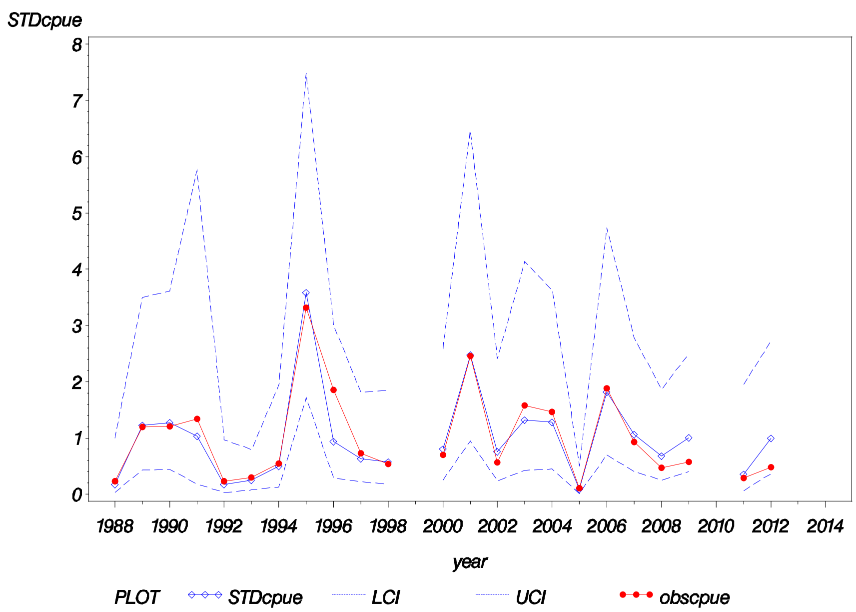

Figure 5. Annual index of abundance for lesser electric rays from the Fall SEAMAP Trawl Survey from 1988 – 2013, including obscpue and STDcpue 95% confidence intervals. (Note that the survey has been conducted annually since 1988; in 1999, 2010, and 2013 no lesser electric rays were captured during the survey.)

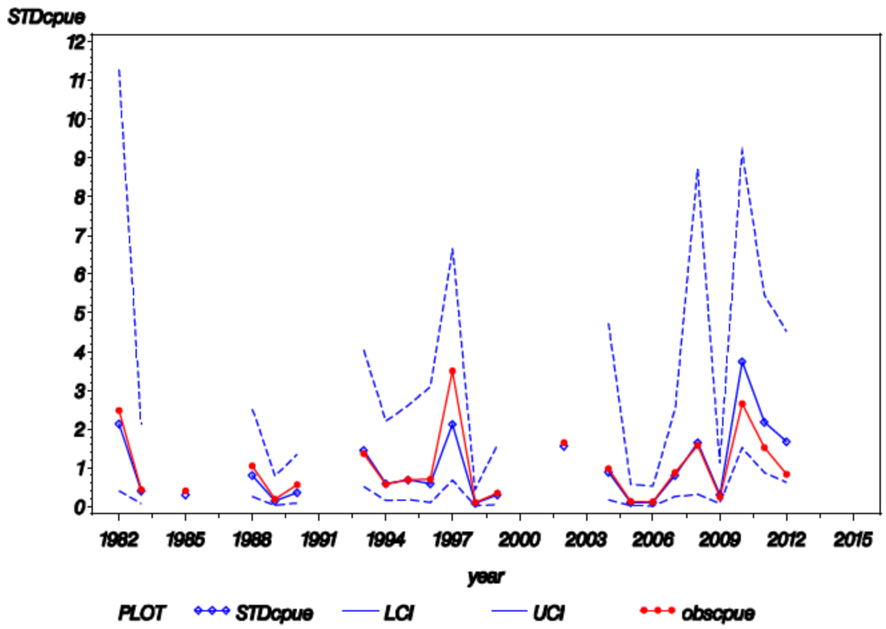

Figure 6. Annual index of abundance for lesser electric rays from the Summer SEAMAP Trawl Survey from 1982 – 2013, including observed catch per unit effort (obscpue) and standardized cpue (STDcpue) 95% confidence intervals (Note that the survey has been conducted annually since 1982; in 1984, 1986, 1987, 1991, 1992, 2000, 2001, 2003, and 2013 no lesser electric rays were captured during the survey.)

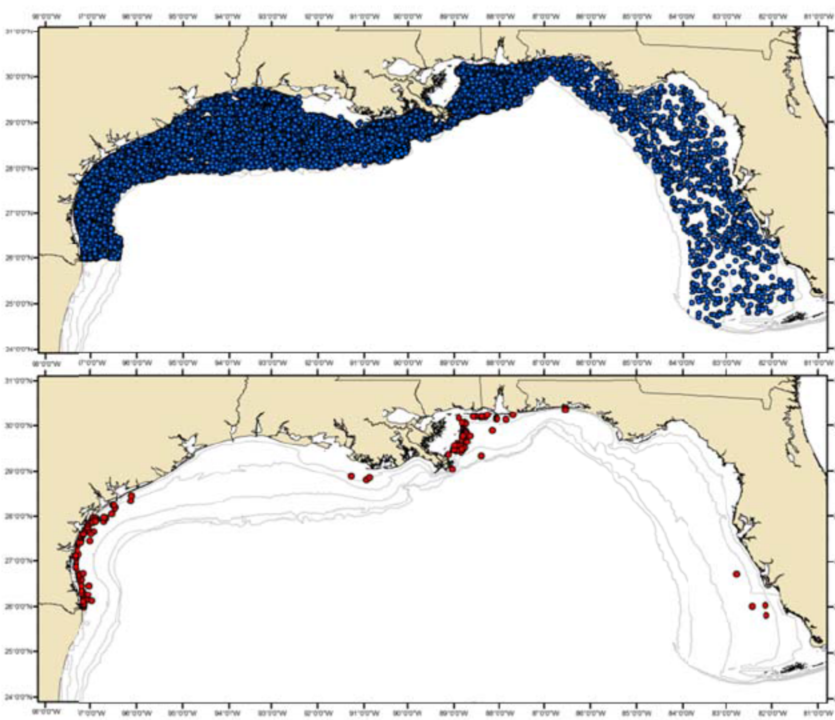

Figure 7. Location of SEAMAP summer and fall trawl survey stations (1972-2013) (top), with the stations with a positive capture of lesser electric ray. (bottom). Depth contours are 10, 20, 50, 100 and 150 m.

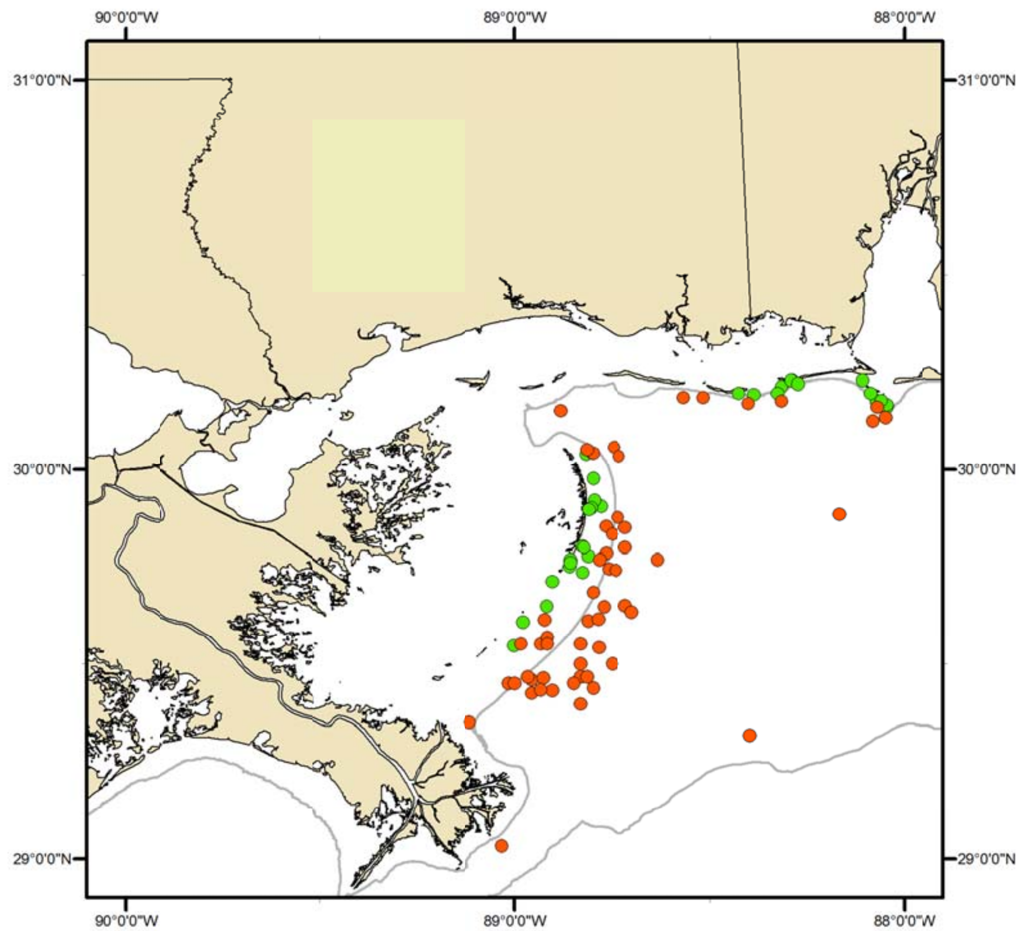

Figure 8. Positive occurrences of lesser electric rays off the coast of Alabama, Louisiana and Mississippi. Green circles are stations in waters less than 9 m deep; red circles are stations in waters 10-110 m deep according to depth collected on site, gray line is 9 m contour from Coastal Relief Model.

South Atlantic SEAMAP Data

A similar SEAMAP survey occurs in the Atlantic Ocean off the southeastern U.S. East Coast. Samples are collected by trawl from the coastal zone of the South Atlantic Bight (SAB) between Cape Hatteras, North Carolina, and Cape Canaveral, Florida. Multi-legged cruises are conducted in spring (early April - mid-May), summer (mid-July - early August), and fall (October - mid-November). Stations are randomly selected from a pool of stations within each stratum. The number of stations sampled in each stratum is determined by optimal allocation. From 1990-2000, the survey sampled 78 stations each season within twenty-four shallow water strata. Beginning in 2001, the number of stations sampled each season in the twenty-four shallow water strata increased to 102. Strata are delineated by the 4 m depth contour inshore and the 10 m depth contour offshore. In previous years (1990-2000), stations were sampled in deeper strata with station depths ranging from 10 to 19 m in order to gather data on the reproductive condition of commercially important penaeid shrimp. Those strata were abandoned in 2001 in order to intensify sampling in the shallower depth-zone. Further details are available in (Eldridge 1988).

A generalized linear modeling approach to correct for factors unrelated to abundance was also used to standardize these data following methods similar to the SEAMAP GOM data. Covariates considered in this analysis that may have affected abundance include year, season, area, and sampling statistical zone. Time of day was not included as a covariate because data were discontinuous due to most participating vessels not conducting 24 hour operations and instead trawling only during the day. Only daylight trawl samples were analyzed. The abundance trend for this time series was flat with peaks in abundance of different magnitudes found every 5-10 years (Figure 9). The data showed high inter-annual variability in lesser electric ray catches in the survey, and catches were very low throughout, but there was no trend in the catch rates suggestive of a decline in lesser electric rays.

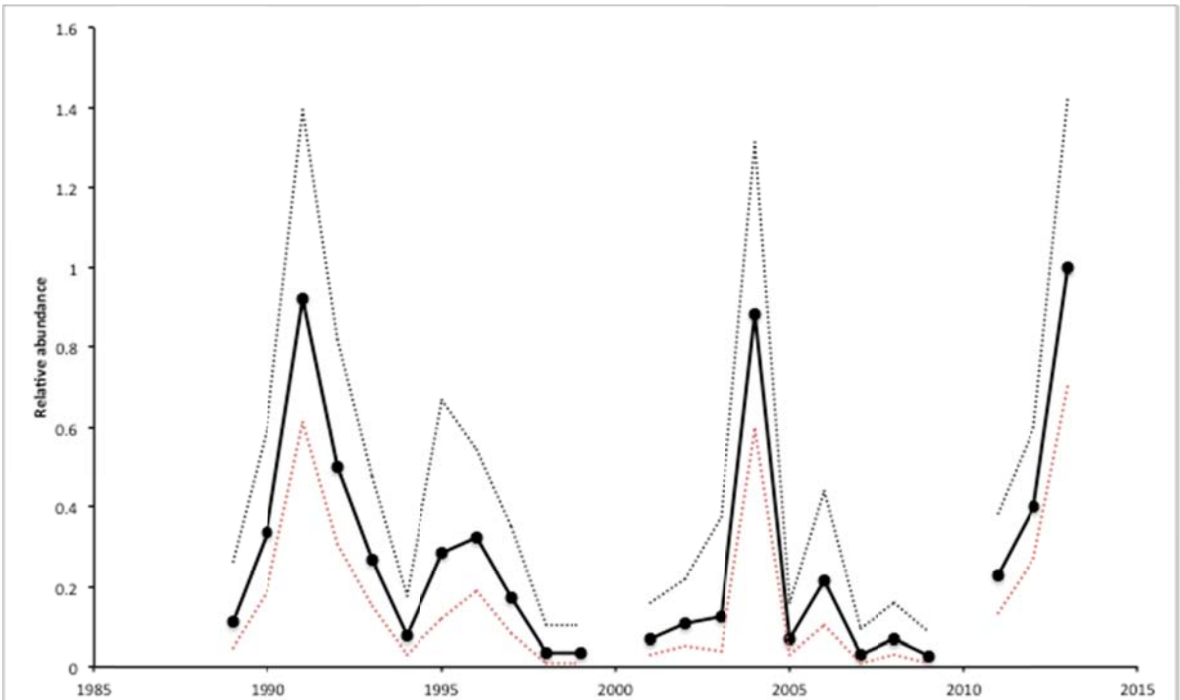

Figure 9. Annual index of relative abundance (yearly index divided by the maximum of the index) for lesser electric rays from the South Atlantic SEAMAP Trawl Survey from 1989 – 2013. Dotted lines represent upper and lower 95% confidence limits.

REEF Data

The Reef Environmental Education Foundation (REEF: www. reef.org) is a dataset that is composed of more than 100,000 visual surveys conducted by divers during their daily dive activities. This data set has been previously utilized for evaluating species abundance trends (e.g., Ward-Paige et al., 2010 and references therein) and was referenced in the petition as evidence of the low occurrence of lesser electric rays along the east coast of Florida, the GOM, and the northwestern Caribbean. The IUCN Red List assessment included a cursory review of 1994-2004 REEF data for apparent trends and no analysis was conducted.

Because these dives vary in duration, location and skill level (experience), the status review team also applied a generalized linear model to examine standardized rates of change in sighting frequency as an index of abundance. The team considered eight areas as a covariate based on major sampling areas from the REEF database: GOM, east coast of Florida, the Florida Keys, the Bahamas (including Turks and Caicos), the northwestern Caribbean (including Cuba, the Cayman Islands, Jamaica, Haiti/Dominican Republic), Greater Antilles (Puerto Rico to Grenada), Continental Caribbean (Belize-Panama), and Netherland Antilles. The team also considered skill level of the diver (experienced or novice), the bottom type, season, water temperature and water visibility as covariates.

In the REEF database, lesser electric rays were observed on 476 out of 119, 620 surveys (0.4% of surveys). Lesser electric rays were observed throughout the survey area with sighting records averaging 10-18% of the total in the Antilles, Bahamas, Florida, and Central America. Positive occurrences were lowest in the northwest Caribbean Sea and GOM. The average depth where diver sightings occurred was about 5 meters, generally over a habitat where a diver recorded a variety of individual habitats. The final model selected year, area and bottom type as covariates with the trend in occurrences relatively flat with the number of encounters rapidly fluctuating over the time series (Figure 10). Due to the low encounter rate, there was high uncertainty in the abundance trend.

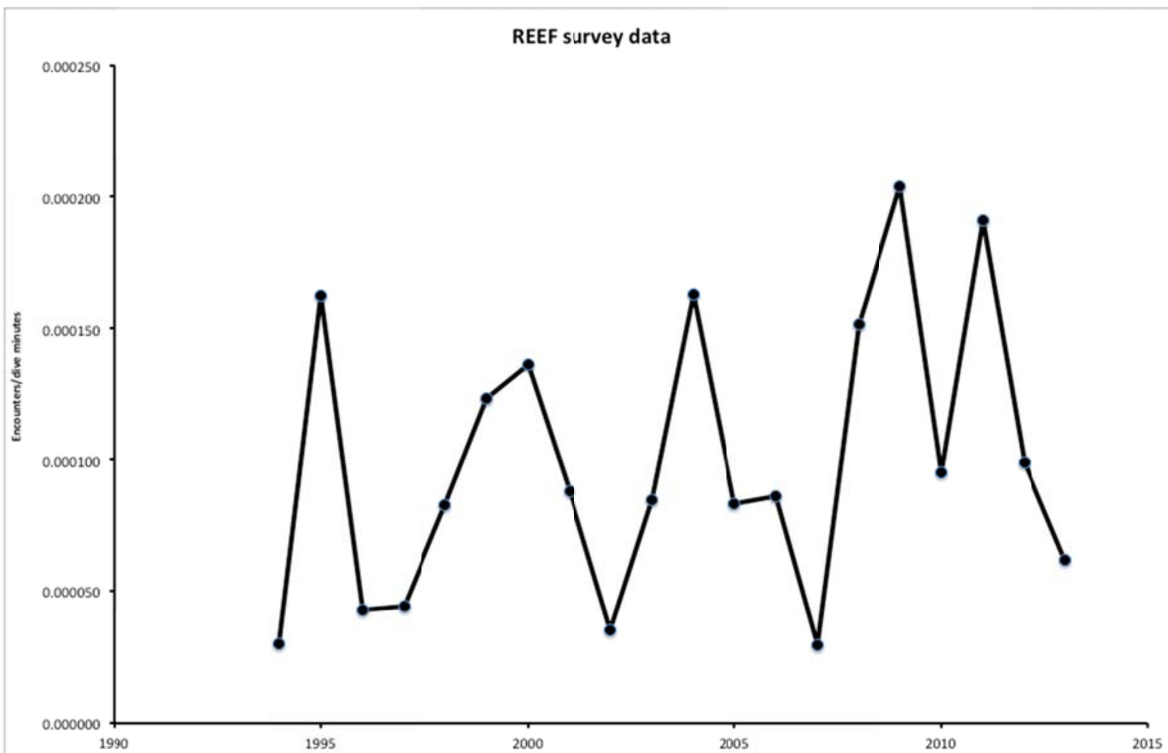

Figure 10. Annual index of relative encounters for lesser electric rays from the Reef Environmental Education Foundation.

Texas Parks and Wildlife Department (TPWD) Data
TPWD initiated two comprehensive sampling programs on the Texas coast in 1975. Gill nets and bag seines were used to monitor the relative abundance and size of all species caught in each gear in each bay system (Mambretti et al. 1990). Bag seine collections were made at six sites per month per bay until October 1981. Trawl collections did not begin coast-wide until 1982 in bays and 1985 in the GOM. The trawl sampling program began in the Texas Territorial Sea (i.e.,

within 16.7 km of shore) in 1984 off Port Aransas (24.1 km either side of each jetty) and was expanded to similar areas off the Sabine Pass, Galveston, Port O'Connor, and Port Isabel jetties in January 1986. Trawl sampling in Sabine Lake began in January 1986, and in East Matagorda Bay in April 1987 (Matlock 1992).

A review by TPWD revealed lesser electric rays were caught somewhat regularly only in their fishery-independent nearshore Gulf trawl survey; there were too few samples in the other gear types to assess. TPWD provided us with three data sets useful to assess trends in abundance based on trawl surveys in Aransas Pass, Matagorda, and Santiago Pass (Mark Fisher, TPFWD, pers. comm. to Jennifer Lee, NMFS SERO, July 31, 2014). Data from Aransas Pass and Matagorda show increases in abundance, especially since early 2000 (Figure 11a and b). The trend in abundance for Santiago Pass increases until the late 1990's, then decreases to its original level at the start of the time series (Figure 11c).

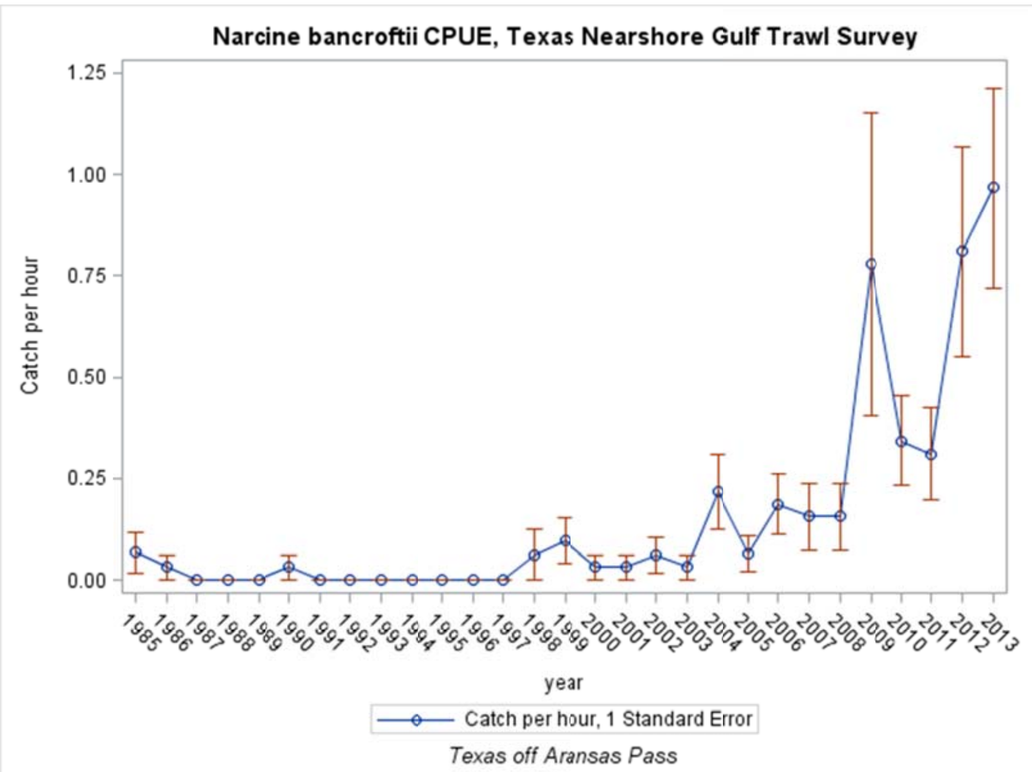

Figure 11a. Catch rates of lesser electric rays in nearshore trawl surveys along the Texas coast off Aransas Pass.

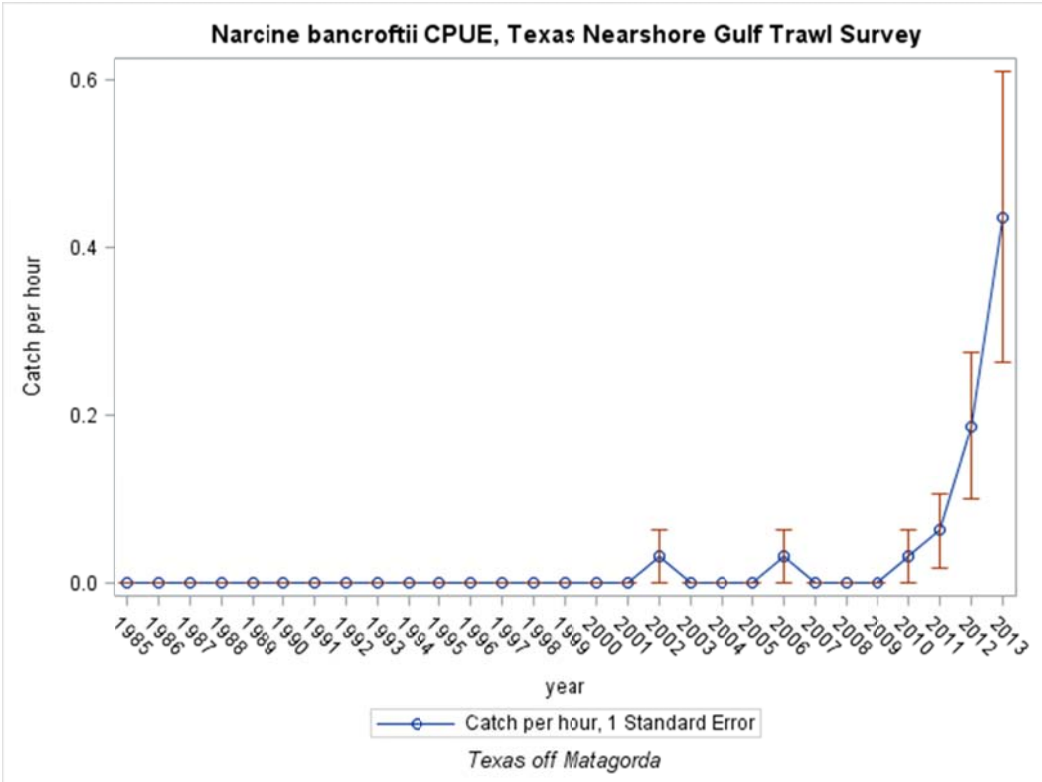

Figure 11b. Catch rates of lesser electric rays in nearshore trawl surveys along the Texas coast off Matagorda.

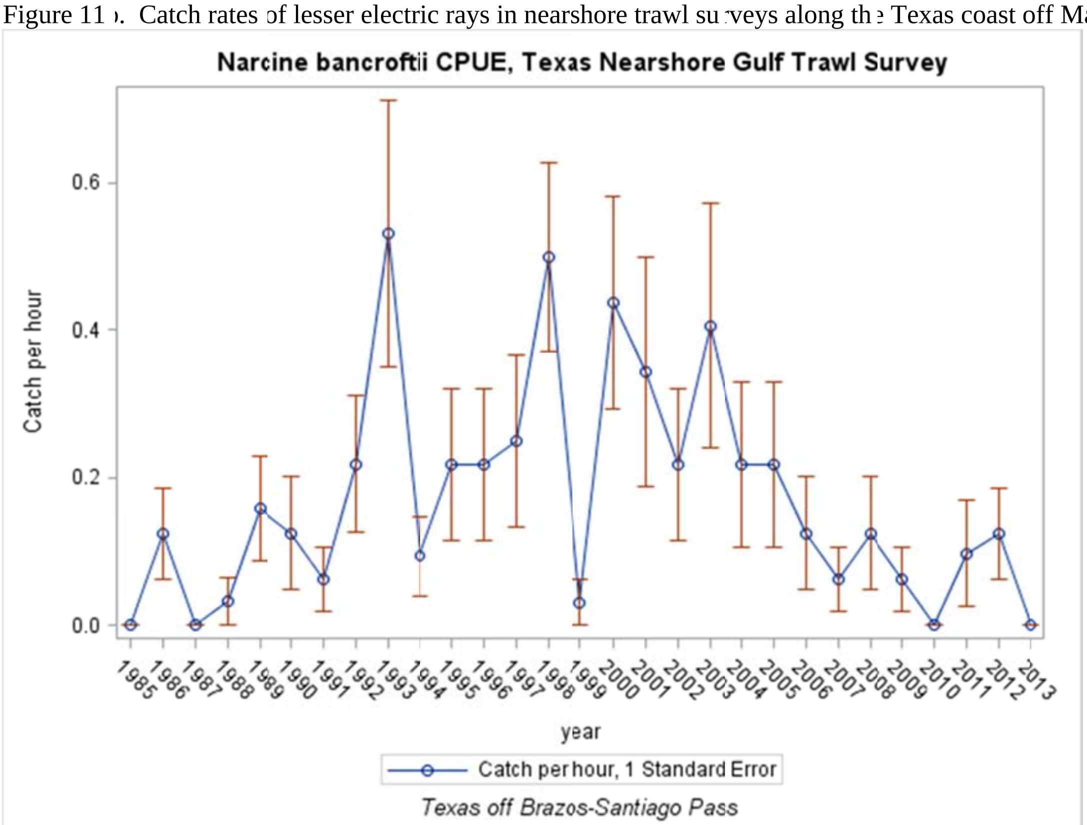

Figure 11c. Catch rates of lesser electric rays in nearshore trawl surveys along the Texas coast off Brazos-Santiago Pass.

Florida Fish and Wildlife Research Institute (FFWRI)

FFWRI's fisheries-independent monitoring (FIM) program uses a stratified-random sampling design to monitor fish populations of specific rivers and estuaries throughout the state. They use a variety of gears to sample, including small seines, large seines, and otter trawls. This program has long term data sets for Apalachicola (since 1998), Cedar Key (since 1996), Tampa Bay (since 1989), and Charlotte Harbor (since 1989) along the GOM and Tequesta (since 1997) and Indian River Lagoon (since 1990) on the Atlantic Coast. Despite the large geographic area sampled and the extensive sampling efforts over time, this program has collected very few lesser electric rays to date (34 specimens). FIM has collected 13 lesser electric rays from their Apalachicola location, 15 from Cedar Key, 4 from Tequesta, and 1 apiece from both Tampa Bay and Indian River Lagoon (Table 2). Due to the rarity of this species within their samples, we determined it was not appropriate to analyze these data points further.

Table 2. Summary of lesser electric rays collected by Florida Fish and Wildlife Research Institute's fisheries-independent monitoring program.

Gear	Number	Date	Estuary
Haul seine	1	7-6-1998	Apalachicola Bay
Haul seine	1	9-22-1998	Apalachicola Bay
Haul seine	1	3-9-2000	Apalachicola Bay
Purse seine	1	8-11-2001	Apalachicola Bay
Haul seine	1	8-4-2002	Apalachicola Bay
Haul seine	1	9-1-2004	Apalachicola Bay
Haul seine	1	11-4-2004	Apalachicola Bay
Haul seine	1	5-4-2006	Apalachicola Bay
Haul seine	1	10-10-2007	Apalachicola Bay
Haul seine	1	4-10-2008	Apalachicola Bay
Haul seine	1	7-13-2010	Apalachicola Bay
Haul seine	1	5-8-2012	Apalachicola Bay
Haul seine	1	9-10-2012	Apalachicola Bay
Otter trawl	1	4-8-2001	Cedar Key
Otter trawl	1	4-7-2002	Cedar Key
Otter trawl	5	11-5-2004	Cedar Key
Otter trawl	1	10-2-2008	Cedar Key
Otter trawl	1	6-1-2009	Cedar Key
Otter trawl	1	10-1-2009	Cedar Key
Otter trawl	1	8-7-2012	Cedar Key
Otter trawl	1	9-3-2012	Cedar Key
Otter trawl	1	1-1-2013	Cedar Key
Otter trawl	1	5-7-2013	Cedar Key
Otter trawl	1	10-6-2013	Cedar Key
Otter trawl	1	4-6-1994	Indian River Lagoon
Otter trawl	1	3-27-1990	Tampa Bay
Haul seine	2	12-22-1998	Tequesta
Haul seine	1	11-1-2009	Tequesta
Haul seine	1	11-2-2009	Tequesta

North Carolina Department of Environment and Natural Resources (NCDNR)

NCDNR reported to us that, in all of their fishery-dependent and –independent programs, there were only six occurrence records of lesser electric rays, and each occurrence record was from a different survey program. Only two of the occurrence records included a "count" of the species, i.e., the species was recorded as part of the enumerated collection (Table 3). The other occurrence records were documented only via comments section, where a specific count of animals is not included. Thus, as with the FFWRI data, we determined it was not appropriate to analyze these data due to the extreme rarity of this species' occurrence within their samples.

Table 3. Occurrences of lesser electric rays documented by NCDNR monitoring programs.

Record Date	Count or Occurrence only?	Monitoring Program
09/06/1969	Count (i.e., 1)	Demersal trawl survey
11/11/1975	Count (i.e., 3)	Clam survey
10/06/1981	Occurrence only	Scallop survey
11/31/1987	Occurrence only	Fishery-dependent calico scallop trawl
12/11/1991	Occurrence only	Fishery-dependent flounder trawl observer program
05/07/2008	Occurrence only	Commercial shrimp trawl fishery characterization

3.2 Fishery Dependent Data Sources

Shrimp Observer Program

Southeast Fisheries Science Center, Galveston Laboratory, began placing at-sea observers on commercial shrimping vessels in 1992 in the US southeastern region through a cooperative voluntary research effort. In July 2007, a mandatory federal observer program was implemented to characterize the U.S. GOM penaeid shrimp fishery, and in June 2008, the mandatory program expanded to include the U.S. South Atlantic penaeid and rock shrimp fisheries. This program was initiated to identify and minimize the impacts of shrimp trawling on federally managed species. The specific objectives are to (1) estimate catch rates during commercial shrimping operations for target and non-target species, including protected species by area, season and depth; and (2) evaluate bycatch reduction devices (BRDs) designed to eliminate or significantly reduce non-targeted catch. During the voluntary research effort, several different projects were enacted. One project, referred to as a characterization, involved identifying all species in a subsample from one randomly selected net. In the mandatory shrimp observer program, there are approximately 30 species (common, federally managed, etc.) that are selected and subsampled from every sampled net, but other species, including lesser electric rays, are only grouped into broad categories (e.g., crustaceans, inverts, finfish).

Data associated with commercial trawl bycatch of lesser electric rays in the eastern GOM and off the east coast of the United States were available from the the characterization project conducted in 2001, 2002, 2005, and 2007. A total of 1,150 trawls were observed and the catch was sorted in entirety to the species level (Figure 12). Across all years, 28 lesser electric rays were captured during 4016.6 hours of trawl effort with 387 and 763 trawls being observed off the east coast and in the northern GOM, respectively (see Figure 13-14 in Section 4.5.3). Due to the low occurrence of lesser electric rays, the team chose not to develop an index of abundace for this species. The low number of animals captured across all years would make the index relatively uniformative.

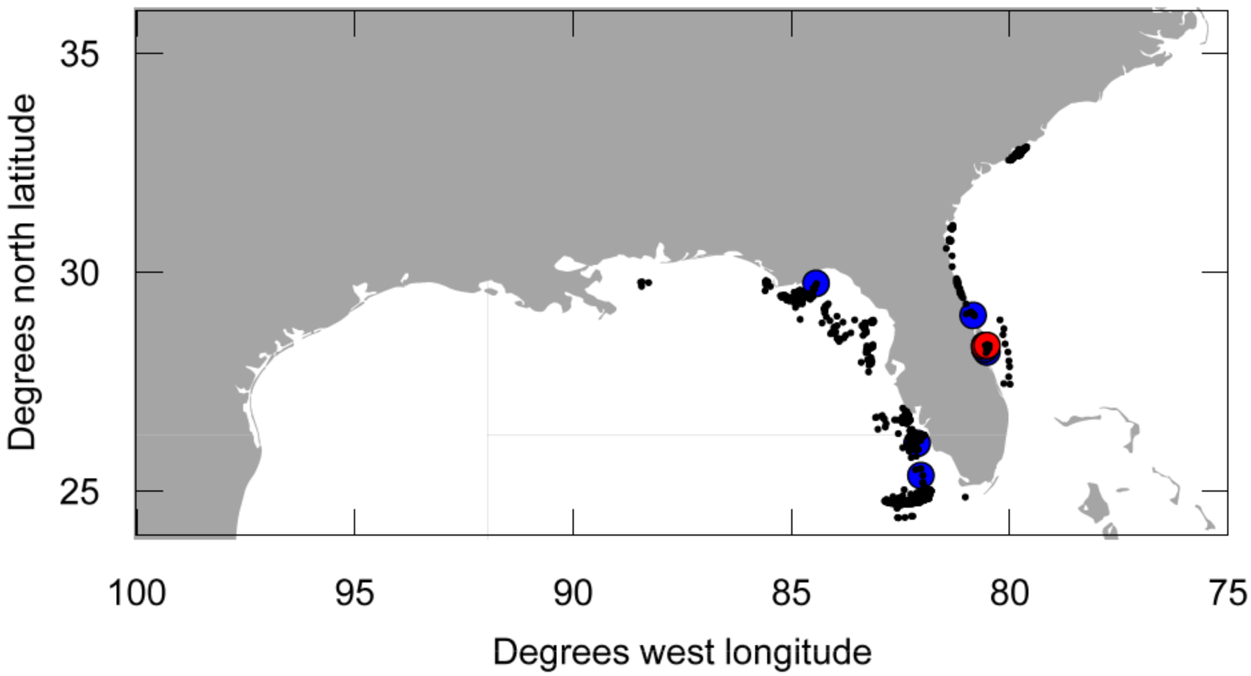

Figure 12. Observer documented bycatch of lesser electric rays in commercial trawls during 2001, 2002, 2005 and 2007. Black dots represent trawls where no individuals were observed within the catch. Colored circles indicate individual trawls where lesser electric rays were observed. Blue and red circles represent locations where 0.1-0.9 and 1.0-2.0 individuals were caught per hour, respectively.

3.3 Andectodal Reports

In addition to the datasets reviewed above, we found anecdotal accounts of lesser electric rays through various other sources. Many of these additional anecdotal accounts are from YouTube videos by beach goers or forum discussions by boaters and fishermen who encountered the species along the northern Gulf Coast. There are also anecdotal reports by divers around south Florida, along the Atlantic coast, and throughout parts of the Caribbean. A researcher at Auburn University provided anecdotal accounts of lesser electric rays along the Fort Morgan Peninsula in Alabama. The researcher observed large numbers of lesser electric rays during late summer to early fall over the past several years of sampling at this location (A. Bullard, to J. Lee, NMFS, pers. com). The most common anecdotal encounters are sightings. The sightings typically describe the number of lesser electric rays observed at one time as very abundant (e.g., “lots,” “everywhere”). One anecdote notes that when you know what to look for they can be seen everywhere. While these reports cannot be used to analyze trends in abundance, they illustrate that people continue to encounter the species in coastal areas around the GOM, South Atlantic, and Caribbean and that when they do the species appears to be locally abundant.

3.4 Summary

Based on the available data collected during this status review, we found no evidence of a decline in the relative abundance of lesser electric rays. Our analyses of the long-term datasets available indicate that the trend in abundance is relatively flat with the number of encounters dramatically fluctuating over each time series. This is not surprising based on the description of their habitat use as they appear to have a clumped but patchy distribution over shallow, sandy habitats as documented repeatedly in the literature. As additional support for this characterization, we note that recent encounters documented through anecdotes indicate lesser electric ray is abundant in specific habitats while consistently absent from others. We were unable to find any historical or current abundance information outside of U.S. waters for the lesser electric ray. As a non-commercial species, there are no statistics on commercial fishery catches of lesser electric rays or on effort that would enable an assessment of the population to be conducted. Given that declines have not been documented in U.S. waters where data are available, there is no reason to suspect that declines are occurring elsewhere in the species' range.

4. ANALYSIS OF LISTING FACTORS

The ESA requires NMFS to determine whether a species is endangered or threatened because of any of the five factors specified in section 4(a)(1) of the ESA. The following sections provide information on each of these five factors as they related to the current status of the lesser electric ray.

4.1. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

The ESA requires an evaluation of any present or threatened destruction, modification, or curtailment of habitat or range. In Section 2.3 and 2.4 we described the range and habitat use of lesser electric rays. The species is reported to occur almost exclusively on sand bottom habitats. Based on available records, barrier beach surf zones and sandbars adjacent to passes between barrier islands are believed to be the preferred habitat for lesser electric rays.

Man-made activities that have the potential to impact shallow sandy habitats include dredging, beach nourishment, and shoreline hardening projects (e.g., groins). These types of activities can negatively impact lesser electric rays by removing habitat features (e.g., alteration or destruction of sand bars) and affecting prey species. For example, annelids that lesser electric rays prey on are killed or otherwise directly or indirectly affected by large dredge-and-fill projects (Greene 2002).

Coastal habitats in the United States are being impacted by urbanization. Coastal habitats in the southern United States, including both the areas along the Atlantic and GOM, have experienced and continue to experience losses due to urbanization. For example, wetland losses in the GOM region of the U.S. averaged annual net losses of 60,000 acres of coastal and freshwater habitat from 1998 to 2004 (Stedman and Dahl 2008). Although wetland restoration activities are ongoing in this region of the U.S., the losses outweigh the gains, significantly (Stedman and Dahl 2008). These losses have been attributed to commercial and residential development, port construction (e.g., dredging, blasting, and filling activities), construction of water control structures, modification to freshwater inflows (e.g., Rio Grande River in Texas), and gas and oil related activities.

Oil and gas exploration is another anthropogenic activity that may adversely affect the marine environment. The oil and gas industry may affect marine resources in a variety of ways including increased vessel traffic, the discharge of pollutants, seismic surveys, and decommissioning charges. Although routine oil and gas activities generally occur outside of the known depth range of the species, miles of pipelines associated with oil and gas activities may run through lesser electric ray habitat. The effect or magnitude of effects on electric ray habitat is unknown. The largest threat is the release of oil from accidental spills. While safety precautions are in place to prevent the probability of spills and to decrease the duration of spills, these events still occur. In the GOM, the Deepwater Horizon oil spill was an unprecedented disaster, likely impacting the marine ecosystem in ways that may not be fully known for decades. While there has been no production of oil along the Atlantic coast of the United States to date, there remains the possibility of production in the future.

NOAA's Restoration Center is involved in ongoing coastal restoration activities throughout the southeastern United States. In 2010, NOAA funded coastal restoration activities in Texas and Louisiana using appropriations from The American Recovery and Investment Act of 2009. In Louisiana, where 25 square miles of wetlands are lost per year, funding from the Coastal Wetlands Planning, Protection and Restoration Act helps to implement large-scale wetlands restoration projects, including barrier island restoration and terrace and channel construction.

We anticipate an increase in large-scale restoration projects in the GOM to mitigate the adverse effects of the Deepwater Horizon oil spill. Numerous large coastal restoration projects in the GOM are expected to be funded by the Resources and Ecosystems Sustainability, Tourist Opportunities and Revived Economies of the Gulf Coast States Act, Natural Resource Damage Assessment and Clean Water Act settlement agreements related to the Deepwater Horizon Oil Spill. Many additional restoration projects will also be funded by the Gulf of Mexico Energy Security Act, beginning in FY17.

While fewer in number, restoration efforts are also expected along coastal areas of the southeastern U.S. For example, funding is expected to be available to support comprehensive and cooperative habitat conservation projects in Biscayne Bay located in south Florida, as one of NOAA's three Habitat Focus Areas.

In conclusion, the geographic areas in which the lesser electric ray occurs are being impacted by human activities. Despite ongoing and anticipated efforts to restore coastal habitats of the GOM and Atlantic off the Southeastern U.S., coastal habitat losses will continue to occur in these regions as well as throughout the lesser electric ray's entire range. However, we can find no information on the specific effects to lesser electric rays beyond broad statements on the impacts of coastal development and oil and gas exploration. Data are lacking on impacts to habitat features related to the lesser electric ray and/or threats that result in curtailment of the lesser electric ray's range. Predictions of how coastal habitat losses may impact the lesser ray in the foreseeable future would be largely speculative.

4.2. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Commercial and Recreational Harvest

McEachran and Carvalho (2002) reported for *Narcinidae* that "flesh of the tail region may be marketed after removal of the electric organs in the larger species, but is generally considered to be mediocre in quality. In the species-specific account for lesser electric ray, McEachran and Carvalho (2002) reported that that the tail region may be consumed as food and considered of good quality, but it is not targeted regularly by fisheries in our area [i.e., Western Central Atlantic].

Like our species petitioners, we found no evidence of commercial or recreational harvest of the species. Interest in the species to those who detect it in the surf zone is largely one of curiosity. As lesser electric rays are generally nocturnal and spend daylight hours buried under the sand, they likely go undetected by the general public. Recreational fishermen who are gigging for flounder at night are most likely to encounter this species. There are some anecdotal reports of recreational surf fishermen capturing them in dip-nets; however, available data indicate that captured individuals are released.

Collection for Scientific Research

Scientific research on lesser electric rays has been sparse. Rudloe (1989a) collected and studied the ecology of lesser electric rays from March 1985 to March 1987, to assess the feasibility of its use in biochemical and neurophysiological research. Rudloe (1989a) reported catching 3,913 rays at several stations from Cape San Blas to Alligator Point, Florida, during this time period. Of these, 3,229 were retained, 455 were tagged and released, and 229 were released untagged due to small size. Funding for research was discontinued after these 2 years of sampling.

Since the completion of the Rudloe study, we uncovered only a few additional studies (Dean and Motta 2004a, b, Dean *et al*. 2006, Tao 2013) involving the species. Dean led a study on lesser electric ray husbandry (Dean et al. 2005) and three studies on jaw morphology and feeding behavior (Dean and Motta 2004a, b, Dean et al. 2006). Dean collected the samples for these studies using a trawl off the coast of Cape Canaveral on the east coast of Florida (41 individuals) and in the northeast portion of the GOM (6 individuals). He also used preserved specimens from the Florida Museum of Natural History. Tao (2013), as a Ph.D. candidate at Auburn University, analyzed the blood vascular systems of ten lesser electric rays captured in the northern GOM off Alabama for bacteria. The Bullard Laboratory at Auburn University provided the samples for that study. They sampled the lesser electric rays and subsequently released them alive after collecting external parasites (Dr. Ash Bullard, Auburn University pers. comm. to J. Lee, NMFS, August 15, 2014). The Bullard Laboratory at Auburn University sampled an unknown number of additional lesser electric rays in accordance with their state collection permit; no record was kept of the number of lesser electric rays they observed in the field or the total number of individuals they examined. A few researchers from GOM expressed interest in studying the species in the future, but we are not aware of any directed studies on lesser electric rays at this time.

Collection for Aquaria/Education

Captive display of lesser electric rays in public aquaria is extremely rare. Due to their selective food habits (i.e., live polychaete worms) and feeding behavior, they are not easy to keep in aquaria (Rudloe 1989b, Dean et al. 2005). The 2008 American Elasmobranch Society International Captive Elasmobranch Census documented two male and one female electric rays, (both recorded as *Narcine brasiliensis)* that were in captivity at a single aquarium. We were unable to determine if these animals were still in captivity or the location of this aquarium. Nevertheless this serves as the only record of lesser electric rays in aquaria.

The Gulf Marine Specimens Laboratory sells 6-24 cm lesser electric rays for $126 (http://www.gulfspecimen.org/specimen/fish/sharks-and-rays/). No more than a few are sold annually and the cost of collection and delivery prohibits their use as student specimens (Jack Rudlow pers. comm. to J. Lee, NMFS, August 15, 2014).

Because the species has fidelity for specific, localized habitats, targeting lesser electric rays could adversely affect the population. However, there is no information to indicate that commercial, recreational, scientific, or educational overutilization of lesser electric rays has occurred or is occurring. Further, we don't expect overutilization by any specific industry in the foreseeable future.

4.3 Competition, Predation, and Disease

No information exists to indicate that competition for lesser electric ray prey species or other resources (e.g., sandy substrate habitat) is negatively affecting the lesser electric ray abundance or survival.

Predation of lesser electric rays is also not known to be a threat. As stated earlier, almost nothing is known of natural predation on the lesser electric ray. Presumably its electric organs deter potential predators, such as sharks and dolphins. As noted previously, Rudloe (1989a) reported that tagged rays released off otter trawlers were repeatedly observed to be actively avoided by both sharks and porpoises that fed heavily on other rays and bony fishes as they were culled overboard. However, there is a single record of a shark attacking an electric ray during a "feeding frenzy" as bycatch was discarded back to the water (Rudloe 1988). Gulls observed feeding on fish in shrimp bycatch appeared to avoid electric rays released alive and only preyed upon dead individuals (Rudlow 1988). A researcher reported observed consumption of lesser electric rays by large red drum that were captured on bottom longlines and dissected. However, it was not clear to the researcher whether or not the rays were discarded bycatch that were opportunistically consumed (M. Ajemian, Texas A&M- Corpus Christi, pers. comm. to Jennifer Lee, NMFS, June 19, 2015).

There is scant information on disease within the species. Electric rays retained in captivity for scientific purposes often exhibit monogenean infestations of the gills and are subject to bacterial infections and infestations of gill parasites. Captured lesser electric rays carry a range of parasites, such as external leeches (e.g., *Branchellion raveneli*) (Rudloe 1989b, Dr. Ash Bullard to J. Lee, NMFS SERO, August 2014) and copepods (e.g., *Caligus mutabilis*) (Bere 1936). Additionally, Tao (2013) reported that bacteria, such as *Vibrio* spp., are prevalent in the blood of healthy lesser electric rays captured from open beach habitat in the north-central GOM; though this condition is not uncommon among chondrichthyan fishes. However, we found no indication that disease is affecting lesser electric ray abundance and survival in the wild.

Predictions of whether competition, predation, or disease, may impact the lesser electric ray in the foreseeable future would be entirely speculative.

4.4 Existing Regulatory Authorities, Laws and Policies and Their Adequacy to Protect Lesser Electric Rays

The ESA requires an evaluation of existing regulatory mechanisms to determine whether they may be inadequate to address threats to lesser electric rays. Existing regulatory mechanisms include international, federal, and state regulations. Below is a description and evaluation of current domestic and international management mechanisms for marine species and activities impacting their habitats and their potential to protect lesser electric rays.

4.4.1. International Authorities

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
CITES regulates import, export, re-export, and introduction from the sea of certain animal and plant species. Species for which trade is controlled are included in one of three appendices. Appendix I includes species threatened with extinction that are or may be affected by international trade. Appendix II includes those species that may become threatened if their trade is not regulated and monitored, as well as species listed because of their similarity in appearance to other Appendix II species for which international trade may be a threat. Appendix III includes species that any party country identifies as being subject to regulation within its jurisdiction for purposes of preventing or restricting exploitation, and for which it needs the cooperation of other parties to control trade. The United States, as a party to CITES, may propose amendments to the appendices for consideration by the other Parties. There is no evidence or indication of lesser electric ray international trade so CITES has little utility for their protection at this time.

4.4.2. U.S. Interstate/Federal Authorities

Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et. Seq.)
The MSA provides regional fishery management councils with authority to prepare fishery management plans (FMPs) for fisheries in the U.S. Exclusive Economic Zone (EEZ) (i.e., waters out to 200 miles offshore, outside state waters boundaries). These FMPs are evaluated, approved and administered by NMFS for the Department of Commerce. Essential fish habitat is to be identified and described for species with approved federal FMPs; habitat conservation measures can and should be included in FMPs. There are no directed fisheries (i.e., commercial or recreational) for lesser electric rays to manage under a federal FMP. Federal waters subject to fishing closures under existing FMPs are further from shore than where lesser electric rays are commonly found, thus likely do not benefit this species. Current or future regulations addressing bycatch in federally managed fisheries are also unlikely to benefit lesser electric rays given this species inhabits relatively shallow waters, often within the surf zone.

Lacey Act of 1981 (16 U.S.C. 3371-3378)
The Lacey Act makes it a federal crime to import, export, or engage in interstate transport of any fish or wildlife taken in violation of a state law. By providing for federal prosecution of state fish and wildlife laws and more stringent penalties, the Lacey Act may deter interstate transport of illegally possessed species.

There are presently no state laws protecting lesser electric rays that would be subject to the Lacey Act. With no evidence or indication of import, export, or interstate transport of lesser electric rays, this law will not aid protection of lesser electric rays.

Endangered Species Act of 1973 (16 U.S.C. 1531-1543)
The ESA provides for the conservation of plant and animal species federally listed as threatened or endangered. It is illegal to take ("harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct"), import or export (from the United States), sell or offer for sale (in interstate or foreign commerce) endangered species and most threatened species. Federal agencies are directed, under section 7(a)(1) of the ESA, to utilize their authorities to carry out programs for the conservation of threatened and endangered species. Federal agencies must also consult with NMFS or the U.S. Fish and Wildlife (USFWS), under section 7(a)(2) of the ESA, on activities that may affect listed species and ensure their actions are not likely to jeopardize the continued existence of a species or destroy or adversely modify critical habitat.

The lesser electric ray may benefit slightly from the ESA indirectly via formal section 7 consultations conducted on actions that result in habitat protection or occurring in lesser electric ray habitat.

Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661-666)
The FWCA requires that wildlife, including fish, receive equal consideration with other aspects of water resource development. Under this Act, federal regulatory and construction agencies must give consideration to fish and wildlife resources in their project planning and in the review of applications for federal permits and licenses. These agencies must consult with state and federal fish and wildlife agencies regarding the possible impacts of proposed actions and obtain recommendations for fish and wildlife protection and enhancement measures. The FWCA consultation requirement applies to water-related activities proposed by non-federal entities for which a federal permit or license is required; the most significant of these respecting marine waters are Section 404 and discharge permits under the Clean Water Act and Section 10 permits under the Rivers and Harbors Act. The USFWS and NMFS review, report, and advise on proposed permit actions and make recommendations to permitting agencies to avoid or mitigate any potential adverse effects of federal water development projects on fish and wildlife habitat. Agency reports and recommendations, which require concurrence of the state fish and wildlife agencies involved, are to be given full consideration by the permitting agency, as well as accompany a construction agency's request for congressional authorization, but are not binding.

The FWCA may help to protect lesser electric rays. Although we are not aware of any direct applications of FWCA for lesser electric rays to date, FWCA may be applied to protect lesser electric rays in the future.

Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA), Titles I and III, the Shore Protection Act of 1988, and the Marine Protected Areas Executive Order 13158
The purpose of the MPRSA Title I is to prevent "unregulated dumping of material into the oceans, coastal, and other waters" that endanger "human health, welfare, amenities, and the marine environment, ecological systems and economic potentialities." Both this Act and the Shore Protection Act regulate ocean transportation and dumping of dredged material, sewage sludge, and other materials. Title III of the MPRSA, the National Marine Sanctuaries Act, also charged the Secretary of Commerce to identify, designate, and protect nationally significant marine areas within U.S. oceans and Great Lake waters based on their conservation, ecological,

recreational, historical, aesthetic, scientific or educational value. Sanctuaries, frequently compared to underwater parks, are managed according to Management Plans, prepared by NOAA on a site-by-site basis. Title III singles out endangered species for special attention. Since the act was enacted in 1972, it has been amended and reauthorized in 1980, 1984, 1988, 1992, 1996, and 2000. The 1988 amendments (Public Law 100-627, Title II) contained provisions for compensation for the destruction or loss of sanctuary resources. Reauthorization in 1992 (Public Law 102-587) required that federal agencies conducting activities likely to affect sanctuary resources consult with the Secretary of Commerce. If the Secretary finds a federal action is likely to destroy, cause the loss of, or injure a sanctuary resource, he or she must recommend reasonable and prudent alternatives that can be used by the agency, in implementing the action that will protect sanctuary resources.

The three designated National Marine Sanctuaries in the southeast (i.e. Grey's Reef, Florida Flower Banks, and Florida Keys) include three reef systems and were established to stem mounting threats to the health and ecological future of the coral reef and other marine ecosystems. Lesser electric rays are known to mainly inhabit sandy substrate and not the hard-bottoms of these protected areas, thus progress toward reducing fishing impacts, protecting habitat and restoring water quality in these sanctuaries would likely not significantly benefit the species.

Federal Water Pollution Control Act of 1972 (FWPCA) (33 U.S.C. 1251-1376)
Commonly known as the "Clean Water Act", the FWPCA is a broad statute with the goal of maintaining and restoring waters of the United States. The FWPCA, among other things, authorizes water quality and pollution research, provides grants for sewage treatment facilities, sets pollution discharge and water quality standards, and establishes permit programs for water quality, point source pollutant discharges, ocean pollution discharges, and dredging or filling of wetlands. Section 401 prevents destruction of aquatic ecosystems including wetlands, unless the action will not individually or cumulatively adversely affect the ecosystem. Section 402 requires permits from the EPA for the discharge of pollutants into navigable waters. Section 404 also provides for the Corps of Engineers to issue permits for the discharge of dredge or fill materials into navigable waters. NMFS and the FWS provide direct consultations to the EPA and the U.S. Army Corps of Engineers on the impacts to fish and wildlife of proposed activities and on methods for avoiding such impacts under provisions of the MSA, ESA, and FWCA.

National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321-4347)
NEPA is the basic national charter for protection of the environment. NEPA procedures must ensure that environmental information is available to public officials and citizens before federal actions are taken. The agencies use these findings in analyzing alternatives and making decisions, a process which allows for the consideration of a full range of options. One of the factors indicating whether a proposed action's impacts will be significant and require this detailed statement is the project's potential effects on the ESA- listed species. NMFS plays a significant role in the implementation of NEPA through its consultative functions relating to conservation of marine resource habitats. Any general recommendations implemented that reduce habitat impacts in shallow coastal areas may benefit lesser electric rays.

Coastal Zone Management Act (16 U.S.C. 1451-1464) and Estuarine Areas Act
Through these Acts, Congress established policy on the value of estuaries and coastal areas and set up comprehensive, state level planning programs to enhance, protect, and use coastal resources. Under these statutes, federal activities must comply with individual state programs. State planning and regulation of coastal development can thereby mitigate damage to sensitive coastal habitats. The Florida Coastal Management Program helps to coordinate actions of nine state agencies (including the Department of Environmental Protection and the FWC) and five water management districts using 23 statutes. These statutes can benefit lesser electric rays by curbing habitat degradation (particularly in shallow coastal areas) through careful, coordinated planning of coastal zone development and protection.

Federal Land Management and Other Protective Designations
Sound stewardship of lands and waters managed by federal agencies (as well as state park and wildlife authorities) contribute to the health of the aquatic systems that support lesser electric ray habitat. Commercial fishing is not permitted in the ENP; recreational spear guns, spear poles, seines and nets (except for dip nets, cast nets, and landing nets) are also prohibited. No fishing is allowed in several marine areas of the ENP, including Eco, Mrazek, and Coot Bay Ponds. In addition, three National Wildlife Refuges in the Florida Keys (the Key West National Wildlife Refuge, the National Key Deer Refuge, and the Great White Heron National Wildlife Refuge) may also afford some protection for lesser electric rays. While we don't have any direct observations, lesser electric rays are currently likely found in some of the protected areas noted, indicating that federal park and land management and other protective designations has the potential to benefit lesser electric rays to the extent such management reduces potential fisheries bycatch.

4.4.3. State Authorities

State fishery management agencies have the authority to manage fishing activity and fish impacted by fisheries in state waters (i.e, 0-3 miles in most cases; 0-9 miles off Texas and the Gulf coast of Florida). There are no fishing regulations or prohibitions on lesser electric rays. Manta rays (Genus *Manta* and *Mobula*) and spotted eagle rays (*Aetobatus narinari*) are the only rays regulated as prohibited species under state regulations. However, many states have regulations limiting what types of gear can be used, as well as where, and when they can be fished. Regulations aimed at fishing gears that lesser electric rays are potentially vulnerable to catch in (e.g., trawls) have the potential to indirectly benefit lesser electric ray bycatch in state fisheries.

4.4.4. Summary and Evaluation

International and federal laws, regulations and policies have some potential to affect the abundance and survival of lesser electric rays in U.S. waters. While many measures may lead to overall environmental enhancements indirectly aiding lesser electric rays abundance and survival, none have been applied specifically for the protection of lesser electric rays. To the best of our knowledge, the species remains unprotected by regulations in nations governing waters adjacent to the U.S. (such as Mexico, Cuba and the Bahamas). We found no evidence that the current lack of species-specific regulations is having a detrimental effect on lesser electric ray populations.

4.5 Other Natural or Manmade Factors Affecting Continued Existence

There are a variety of other natural and manmade factors that may affect the existence of lesser electric rays. These include the species' life history and habitat use, natural factors such as extreme tidal or red tide events, bycatch in commercial fisheries, and climate change.

4.5.1 Life History and Habitat Use

Rudloe (1989a) believed the lesser electric ray was potentially vulnerable to overharvest as a result of its low rate of reproduction and localized distribution. Given that the species reproduces annually (Rudloe 1989a, Moreno et al. 2010) with brood sizes ranging from 1-15 young (Bigelow and Schroeder 1953, de Carvalho et al. 1999, Moreno et al. 2010), it appears this species is fairly productive for an elasmobranch. Thus we do not agree that the lesser electric ray is vulnerable based on its rate of reproduction. We do believe the species' patchy distribution and fidelity for specific habitats increase vulnerability, but we did not find evidence of this vulnerability having detrimental effects on lesser electric ray populations.

4.5.2 Natural Events

Red Tide
Red tide (*Karenia brevis*) impacts many species of fish and wildlife in the GOM and along the Florida coast. *Karenia brevis* produces brevetoxins capable of killing fish, birds and other marine animals. While red tide events can cause deaths of aquatic species, we have no information on how and to what extent red tides may be affecting lesser electric rays. We did not find any reports of red tide resulting in lesser electric ray mortalities.

Extreme Low Tides
There are a couple reports of mass strandings of electric rays resulting from extremely low tides. National Park Service at Padre National Seashore reported documenting a dozen or so dead electric rays in the tidal zone of a 10 mile area between the 50 and 60 mile markers of Padre Island after an extremely low tide in the fall. Showing no signs of trauma or disease, they attributed the mortalities to the extremely low tides leaving them stranded. Such events have always occurred occasionally and are expected to continue to occur in the future without affecting overall population abundance.

4.5.3 Bycatch in Commercial Fisheries

Lesser electric rays have been incidentally captured by commercial fisheries targeting other species, specifically those fisheries using trawl gear. The likelihood and frequency of exposure to bycatch in fisheries is generally a function of (1) the extent of spatial and temporal overlap of the species and fishing effort, and (2) the likelihood of an interaction resulting in capture and the extent of injury from capture.

U.S. Fisheries

Data associated with commercial trawl bycatch of lesser elctric ray in the eastern GOM and off the east coast of the United States are available from the NMFS Observer Program. During 2001, 2002, 2005 and 2007 a total of 1,150 trawls were observed and the catch was sorted in entirety to the species level (Figure 12 in Section 3.2). Across all years, 28 lesser electric rays were captured during 4016.6 hours of trawl effort (Figure 12 in Section 3.2). NMFS conducted 387 trawls off the east coast and 763 trawls in the northern GOM over this time period (Figure 12 in Section 3.2). Trawl duration ranged from 0.1 to 11 hours (mean = 3.48 hours, S.D. = 1.41) (Figure 13) and occurred at depths ranging from 0.6 to 71.1 m (mean = 15.08, S.D. = 9.04) (Figures 14). In the combined areas there were 0.0070 individuals caught per hour of trawling. Examining area-specific lesser electric ray catch rates, there were 0.0171 and 0.0015 indivudals caught per hour off the east coast and in the GOM, respectively. For trawls with positive catch, there was no significant relationship between trawl duration and the number of individuals captured (F= 0.01, P = 0.92) (Figure 15), consistent with what would be expected for a species with a patchy distribution. Based on the number of trawls associated with lesser electric ray captures (n = 10) and the total number of trawls observed (n= 1150), the probability of capturing lesser electric rays is 0.0087 (C.V. = 0.3148).

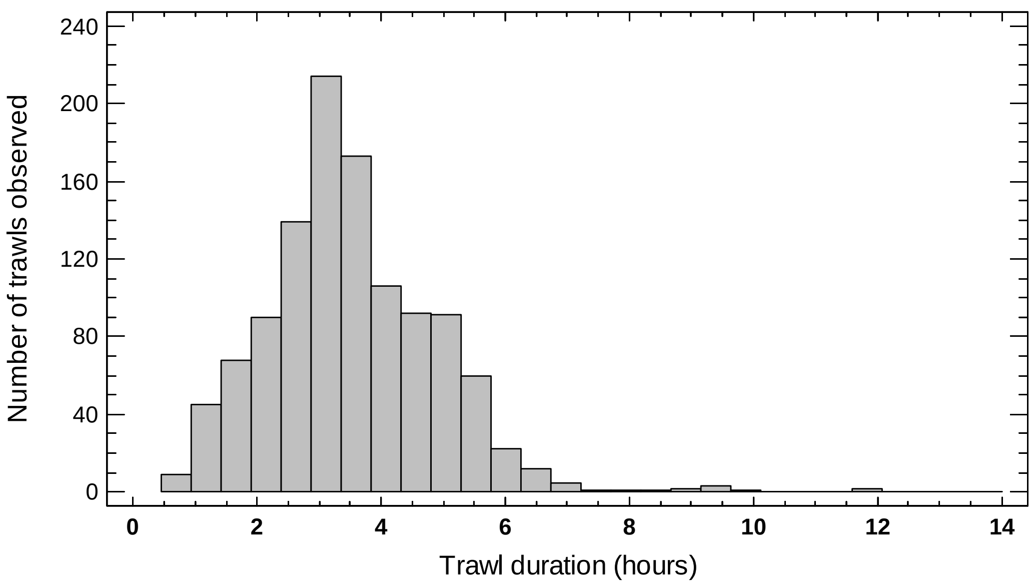

Figure 13. Histogram of effort associated with species-specific bycatch data collected by the National Marine Fisheries Service Observer Program off the east coast and in the Gulf of Mexico

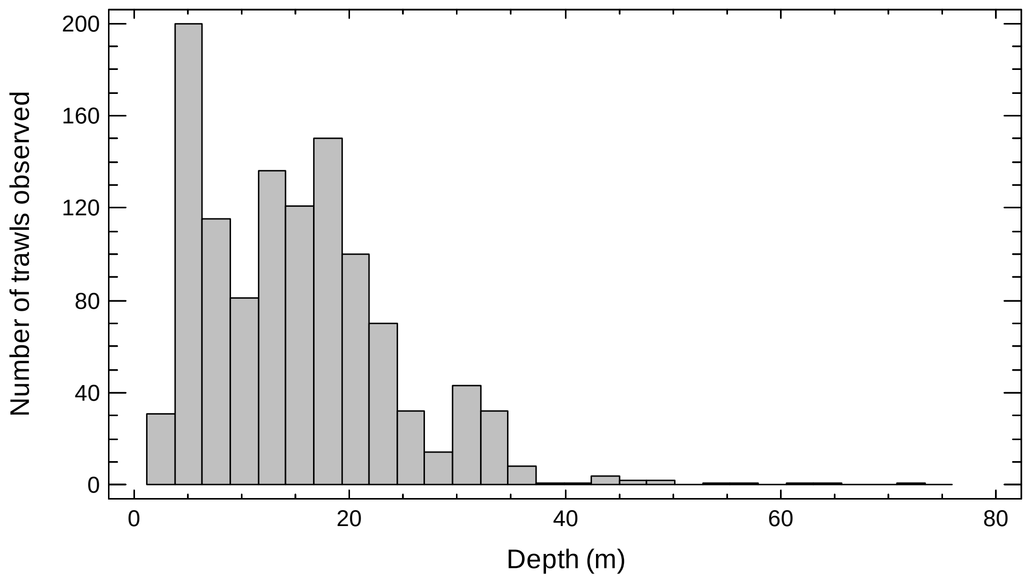

Figure 14. Histogram of trawl depths associated with species-specific bycatch data collected by the National Marine Fisheries Service Observer Program off the east coast and in the Gulf of Mexico

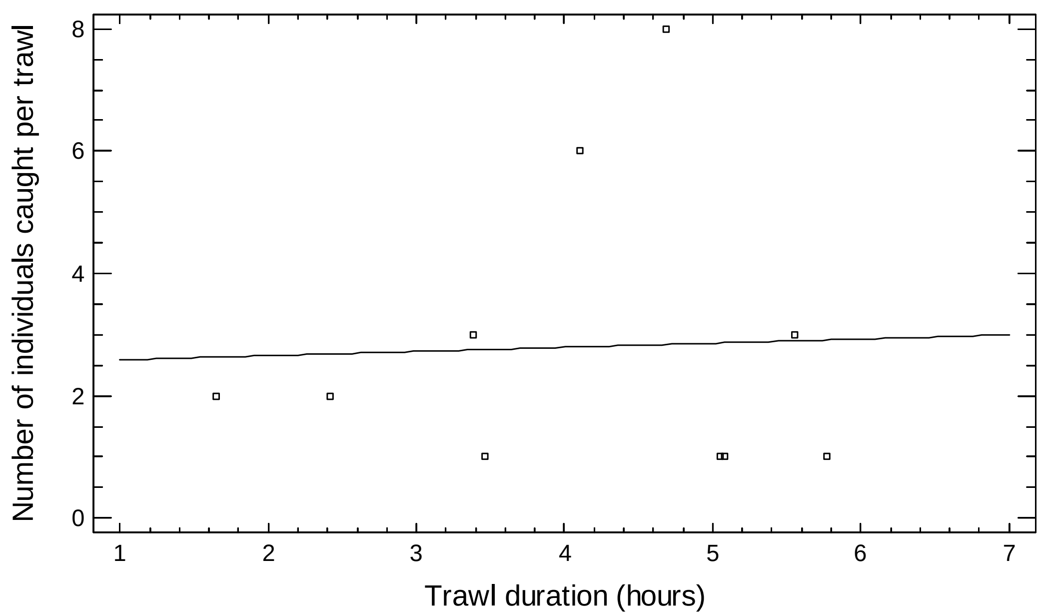

Figure 15. Relationship between trawl duration and number of Lesser electric rays captured in commercial trawls conducted off the east coast and in the GOM (F= 0.01, P = 0.92, r^2 = 0.15)

Foreign Fisheries

Acevedo et al. (2007) reported on 99 shrimp trawls in the Caribbean Sea off the northern coast of Colombia from August to November 2004. These trawls were conducted at depths ranging from 14-72 m. Elasmobranch fishes were captured in 30 of the 99 trawls, including 6 lesser electric rays. The 6 specimens were reported for the months of August and September, the only months in which the species was taken. The capture of 6 lesser electric rays is likely the result of their patchy distribution and not reflective of overall Columbian fleet annual cpue levels. There are few areas of suitable habitat for the species off northern Colombia because the bottoms are rocky or coralline. This also makes most areas unsuitable for trawling. Therefore, we do not believe the documented bycatch is particularly notable or cause for concern.

4.5.4 Climate Change

The Intergovernmental Panel on Climate Change has stated that global climate change is unequivocal (IPCC 2007) and its impacts to coastal resources may be significant. There is a large and growing body of literature on past, present, and future impacts of global climate change induced by human activities, i.e., global warming mostly driven by the burning of fossil fuels. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. NOAA's climate change web portal provides information on the climate-related variability and changes that are exacerbated by human activities (http://www.climate.gov/#understandingClimate). The EPA's climate change web page also provides basic background information on these and other measured or anticipated effects (see www.epa.gov/climatechange/index.html).

The impacts on lesser electric rays cannot currently be predicted with any degree of certainty. However, we predict that increased water levels and warmer water temperatures will have little impact on the species and, if anything, could possibly expand their range off the U.S. east coast. Given what we know about the species' current depth range, it is unlikely that sea level rise will have adverse effects. Similarly, because the range of lesser electric rays seems to be restricted to warm temperate to tropical water temperature, increased water temperatures are unlikely to negatively influence the species and could possibly expand their northern range.

5. EXTINCTION RISK ANALYSIS

The purpose of this section is to present what we believe are the overall risk of extinction faced by the lesser electric ray under present conditions and in the foreseeable future based on an evaluation of the species' demographic risks and assessment of risks.

According to Section 4 of the ESA, the Secretary of Commerce determines whether a species is threatened or endangered as a result of any (or combination) of the following factors: (A) destruction or modification of habitat, (B) overutilization, (C) disease or predation, (D) inadequacy of existing regulatory mechanisms, or (E) other natural or man-made factors. In addition to reviewing the best available data on threats to lesser electric rays, we considered demographic risks to the species similar to approaches described by Wainwright and Kope (1999) and McElhany et al. (2000). The approach of considering demographic risk factors to help frame the discussion of extinction risk has been used in many status reviews (http://www.nmfs.noaa.gov/pr/species). In this approach, the collective condition of individual populations is considered at the species level, typically according to four demographic viability risk criteria: abundance, population growth, spatial structure/connectivity, and diversity/resilience. These viability criteria reflect concepts that are well-founded in conservation biology and that individually and collectively provide strong indicators of extinction risk. Projected threats are considered those that we can reasonably predict. Because the information on lesser electric ray demographics and threats is largely non-quantitative and sparse, we used qualitative reference levels to the extent feasible with the best available information. The three qualitative ‘reference levels’ of extinction risk relative to the demographic criteria used were high risk, moderate risk, and low risk:

- High risk: A species or DPS with a high risk of extinction is at or near a level of abundance, productivity, spatial structure, and/or diversity that places its continued persistence in question. The demographics of a species or DPS at such a high level of risk may be highly uncertain and strongly influenced by stochastic or depensatory processes. Similarly, a species or DPS may be at high risk of extinction if it faces clear and present threats (e.g., confinement to a small geographic area; imminent destruction, modification, or curtailment of its habitat; or disease epidemic) that are likely to create present and substantial demographic risks.
- Moderate risk: A species or DPS is at moderate risk of extinction if it is on a trajectory that puts it at a high level of extinction risk in the foreseeable future (see description of “High risk” above). A species or DPS may be at moderate risk of extinction due to projected threats or declining trends in abundance, productivity, spatial structure, or diversity.
- Low risk: A species or DPS is at low risk of extinction if it is not at moderate or high level of extinction risk (see “Moderate risk” and “High risk” above). A species or DPS may be at low risk of extinction if it is not facing threats that result in declining trends in abundance, productivity, spatial structure, or diversity. A species or DPS at low risk of extinction is likely to show stable or increasing trends in abundance and productivity with connected, diverse populations.

We determined the current extent of extinction risk based on the lesser electric ray’s relative abundance trends data and how likely the species will respond to projected threats in the future. The foreseeable future is linked to the ability to forecast population trends. We considered the degree of certainty and foreseeability that could be gleaned concerning each threat, whether the threat was temporary or permanent in nature, how the various threats affected the life history of the species, and whether observations concerning the species’ response to the threat were adequate to establish a trend. In evaluating the foreseeable future, it is not just the foreseeability of the threats, but also the foreseeability of the impacts of the threats on the species that must be considered. Thus, the nature of the data concerning each threat and the degree to which reliable predictions about their impacts on the species could be made was assessed. Based on the nature of data currently available, the extent to which data could be extrapolated, grounded in data and logic and not speculation, we were generally unable to specify a definitive time frame. Ultimately, with no discernable relative abundance trends or other data showing that lesser electric rays have been impacted in the past, any predictions of how threats may impact lesser electric rays in the foreseeable future differently than they do now would be largely speculative. In other words, without data establishing that a threat has already been influencing the life history of the species negatively, the impacts of threats and factors generally were expected to remain unchanged in the future.

5.1 Qualitative Risk Analysis of Demographics

Our ability to analyze many of the specific criteria was limited. There are no reliable data available on age at maturity or natural mortality that would be necessary to determine population growth rates. Very little information is available on the life history of lesser electric rays. There are no age and growth studies for this species, but anecdotal studies suggest rapid growth. Size at maturity for females is estimated at about 26 cm TL (Funicelli 1975). Lesser electric rays are estimated to reach reproductive size by the end of their first year, and the reproductive cycle is annual (Rudloe 1989a). Brood size ranges from 1-15, depending on the study. While it is generally regarded that elasmobranchs exhibit life history traits that make them more susceptible to exploitation (e.g., low fecundity, late age of maturity, slow growth), the limited evidence suggests lesser electric rays exhibit life-history traits and population parameters that likely place them among those elasmobranchs that are more productive. Thus, this species likely will be able to withstand moderate anthropogenic mortality levels and have a higher potential to recover from exploitation and stochastic events. The species' life history characteristics suggest that the species' demographics currently represent a low risk of extinction and risks are unlikely to increase in the foreseeable future.

We determined that the current abundance of lesser electric rays represents a low risk to the species' continued existence now and in the foreseeable future. The lesser electric ray occurs in warm temperate to tropical waters of the western Atlantic from North Carolina to Florida (except for the Bahamas where its presence is unknown), the GOM and the Caribbean Sea to the northern coast of South America. Within its range, it has a patchy distribution in relatively shallow waters, often within the surf zone. There are no estimates of absolute population size over the species' range; however, analyses of multiple long-term datasets indicate that the trend in relative abundance is relatively flat with abundance dramatically fluctuating over each time series. This is not surprising given the patchy distribution over shallow, sandy habitats.

There is no evidence that lesser electric rays are at risk of extinction due to a substantial change or loss of variation in genetic characteristics or gene flow among populations currently or in the foreseeable future. This species is found over a broad range and appears to be well adapted and opportunistic. In addition, the risk of extinction due to spatial structure and connectivity for the lesser electric ray is low. Lesser electric rays have a relatively broad distribution in the western Atlantic Ocean generally in habitats dominated by sand bottom substrate. Sand substrate is not limiting throughout the range, and the limited data available on species movements indicate they do travel between areas with suitable habitat.

5.2 Qualitative Risk Analysis of Threats

Regarding habitat threats to the species, man-made activities that have the potential to impact shallow sandy habitats include dredging, oil and gas pipelines and pipeline development, beach nourishment, and shoreline hardening projects (e.g., groins). These types of activities can negatively impact lesser electric rays by removing habitat features they require. Although specific data are lacking on impacts to the lesser electric ray, it is reasonable to anticipate that coastal development will continue and may damage habitat within the species' range. However, the species does occur over a broad range and most impacts to the coastal zone have more significantly occurred to wetlands, coral reefs and mangrove ecosystems. Sand substrate is not limiting throughout the range, and the limited data available on species movements indicate they do travel between areas with suitable habitat. For these reasons, we concluded that the lesser electric ray is at low risk of extinction due to destruction and modification of habitat currently and in the foreseeable future.

Impacts from overutilization are unlikely to cause the species to be at risk of extinction. There is little to no direct harvest for the species and the levels of bycatch from the US shrimp trawl fishery is low primarily because the fishery operates in areas where lesser electric rays are not found. We also determined the threat from disease or predation is also low now and in the immediate future.

There are no fisheries regulations for lesser electric rays. Current or future regulations addressing bycatch in federally managed fisheries are unlikely to benefit lesser electric rays given this species inhabits relatively shallow waters, often within the surf zone. However, as previously stated, lesser electric rays are not subject to direct harvest and are very uncommon as bycatch in trawl and gillnet fisheries. Moreover, many states throughout their range (e.g., Florida, Texas, and Georgia) have banned gillnet fishing in state waters which will further reduce the likelihood of bycatch as a negative impact on the continued existence of lesser electric rays. Therefore, based on the best available information, we concluded that overutilization presented a low risk of extinction.

6. CURRENT CONSERVATION EFFORTS

There are no known conservation measures directed at lesser electric rays in place for this species. The IUCN has recommended monitoring of bycatch as a priority, and further research is needed to better define the distribution, population size and structure, life history, and taxonomy of this ray.

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