Application for an Individual Incidental Take Permit under the Endangered Species Act of 1973

August 15, 2011

(Revised)

Atlantic Sea Turtle Populations of:

Loggerhead (Caretta caretta)
Green (Chelonia mydas)
Kemp's ridley (Lepidochelys kempii)
Leatherback (Dermochelys coriacea)
Hawksbill (Eretmochelys imbricata)

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INTRODUCTION

The North Carolina Division of Marine Fisheries (NCDMF) requests an Incidental Take Permit (ITP) under Section 10 of the Endangered Species Act of 1973 (Public Law 93-205) (ESA). The requested ITP will authorize the implementation of management measures to protect threatened and endangered sea turtles and other ESA listed species, while allowing gill net fisheries for flounder and other species prosecuted by both commercial and recreational license holders to fish in the internal coastal waters of North Carolina. This request is prompted by notification from the National Marine Fisheries Service (NMFS) – Southeast Regional Office (SERO) in July and November 2009 indicating the need for the state of North Carolina to address unauthorized takes of sea turtles occurring in inshore gill net fisheries. The NCDMF desires to receive this ITP by September 2011 to implement a monitoring program and management measures that will ensure authorized sea turtle takes are not exceeded, while allowing North Carolina inshore gill net fisheries to operate.

SPECIES OF CONCERN

loggerhead turtle *Caretta caretta*
green turtle *Chelonia mydas*
leatherback turtle *Dermochelys coriacea*
hawksbill turtle *Eretmochelys imbricate*
Kemp's ridley turtle *Lepidochelys kempii*

On June 2, 1970, leatherback and hawksbill sea turtles were listed as endangered under the ESA throughout their ranges. Kemp's ridley sea turtles were listed as endangered on December 2, 1970. Green sea turtles were listed as threatened on July 28, 1978, except for the breeding populations of Florida and the Pacific coast of Mexico, which were listed as endangered. On July 28, 1978, loggerhead sea turtles were listed as threatened wherever they occur. Currently, loggerhead sea turtle populations are under review for potential listing as endangered and at risk for extinction (Conant et al. 2009).

The geographic distribution of loggerhead sea turtles includes the subtropical (and occasionally tropical) waters and Continental Shelves and estuaries along the margins of the Atlantic, Pacific, and Indian oceans. Loggerhead sea turtles are rare or absent far from mainland shores. In the Western

Hemisphere, loggerheads ranges extend as far north as Newfoundland and as far south as Argentina. Green sea turtles have a circumglobal distribution in tropical and subtropical waters. In U.S. Atlantic waters, green sea turtles occur around the Virgin Islands and Puerto Rico and from Texas to Massachusetts. Leatherback sea turtles occupy the open seas, although they are occasionally seen in coastal waters. Leatherbacks prefer warmer waters, however, they frequently appear in New England waters north to Newfoundland during the summer months. Hawksbill sea turtles are typically a tropical species found throughout the Caribbean. They are commonly observed in the Florida Keys, Bahamas, and southwestern Gulf of Mexico. Hawksbill stragglers have been reported as far north as Massachusetts and as far south as northern Argentina. This species is infrequently found in shallow coastal estuarine systems. Kemp's ridley sea turtles occur most frequently in the Gulf of Mexico, but they also occur along the Atlantic coast as far north as Long Island, NY and Martha's Vineyard, MA.

As water temperatures begin to rise during the spring months, sea turtles migrate northward along the coast and into estuarine waters (Shoop and Kenney, 1992; Thompson and Huang, 1993; Musick et al. 1994; Witzell and Azarovitz, 1996; Braun-McNeill and Epperly, 2004; Mansfield et al. 2009). When waters begin cooling during the fall, many sea turtles migrate southward out of the temperate latitudes to warmer waters. Others move offshore to warm waters in or near the Gulf Stream (McClellan and Read, 2007; Mansfield et al., 2009). This general pattern is reversed in the spring as they again migrate northward along the coast, repopulating estuarine waters and temperate latitudes. In 1988, researchers with the NMFS Laboratory in Beaufort, NC began monitoring the distribution of sea turtles in North Carolina estuarine and near-shore waters, employing three complementary methods to assess turtle distributions: aerial surveys, public sightings, and mark-recapture studies (Epperly et al 1995a; Epperly et al., 1995b). This research identified a distinct seasonal pattern of sea turtle distribution in the sounds and near-shore waters of North Carolina. In April, as coastal waters begin to warm, sea turtles enter the NC coastal sounds. During summer months, sea turtles may be found from the Albemarle Sound to the Cape Fear River and as far west as the lower reaches of the Neuse River estuary. The greatest densities of sea turtles occur in Core Sound and along the eastern shore of Pamlico Sound. In the fall, sea turtles leave the

sounds as water temperatures cool and are rarely seen inside the barrier islands from January to March. Sea turtles are observed in offshore waters throughout the year.

Females of all five species of sea turtles lay clutches of eggs in nests on coastal beaches. The adults aggregate off the nesting beaches during the spring to mate. After mating, females move onshore to lay eggs. Up to seven clutches may be laid during a single nesting season. After an incubation period of two months, the hatchlings dig to the surface and move toward the ocean. The young swim offshore and spend their early life in offshore waters. After several years at sea, most species enter the coastal waters or move into bays, river mouths, and estuaries where they spend their juvenile life. There appears to be an inshore movement as waters warm in the spring and followed by an offshore movement when waters begin to cool in the late fall and early winter (Epperly et al., 1995).

Reported sea turtle strandings in North Carolina increased from 1995 to 2000. Prior to 1995, annual stranding totals averaged less than 200. Strandings reached their highest level in 2000 with 831 reported statewide. North Carolina strandings from 2001 through 2009 averaged 455 per year. Total reported strandings in NC increased from 547 in 2008 to 638 in 2009. From 2001 to 2007, strandings were made up of 62% loggerhead and 19% green sea turtles. The species composition of strandings shifted in 2008-2009 to 33% loggerhead and 50% green (North Carolina Wildlife Resources Commission Sea Turtle Stranding Network Database 2009).

MANAGEMENT HISTORY

The NCDMF has addressed protected sea turtle issues in the coastal waters since the 1970s. This has been accomplished by cooperative agreements with the North Carolina Wildlife Resources Commission (NCWRC), establishment of a sea turtle sanctuary, proclamation authority delegated to the Director of NCDMF, additional queries on recreational surveys, management of the Pamlico Sound Gill Net Restricted Area (PSGNRA), formation of the NC Sea Turtle Advisory Committee (STAC), implementation of a large mesh gill net observer program, commercial bycatch reduction gear testing projects, outreach to the fishing industries, and collaboration with the NMFS.

Specifically, an agreement was established in 1979 with the NCWRC to exercise regulatory jurisdiction over all species of sea turtles, and their eggs and nests, consistent with designation of such species as endangered or threatened by USFWS. In 1980, the North Carolina Marine Fisheries Commission (NCMFC) established a Sea Turtle Sanctuary off the coast of North Carolina to protect nesting beaches through North Carolina Marine Fisheries Commission Rules (Fisheries Rule) 15A NCAC 03R. 0101). In1983, the NCMFC delegated proclamation authority to the NCDMF Director to close areas to protect endangered/threatened species (Fisheries Rule15A NCAC 03I. 0107). In 1989, an addition was made to the Marine Recreational Fisheries Statistics Survey (MRFSS) program to include a sea turtle sightings query on the survey form.

During the fall of 1999, increased sea turtle strandings were noted by the NCWRC – Sea Turtle Stranding and Salvage Network (NCSSTN) in the southeastern portion of Pamlico Sound. The NCDMF investigated fisheries operating in the area and determined that $\geq$ 5inch stretched mesh gill nets used to target flounder and< 5inch stretched mesh gill nets used to target spotted seatrout *Cynoscion nebulosus* were potential sources of the fishery interactions with sea turtles. This event and subsequent commercial fishery observations provided the justification for the PSGNRA, which expired December 31, 2010.

PSGNRA Management

Following stranding reports in 1999, immediate investigation of the fisheries activities in this area were conducted by the NCDMF and the NMFS. Observations revealed three gill net fisheries that were being prosecuted in NC internal coastal waters. A shallow water large mesh fishery along the Outer Banks, a deep water large mesh fishery further from shore, and a shallow water small mesh gill net fishery operating throughout Pamlico Sound. The large mesh fisheries targeted southern flounder *Paralicthys lethostigma*. The deep water fishery operated in depths ranging from 10 to 20 feet from September through December. The shallow water large mesh fishery generally operated in depths ranging from 3 to 10 feet in areas next to the barrier islands. The small mesh gill net fisheries were composed of runaround and set net fisheries. These fisheries generally target spotted seatrout, weakfish *C. regalis*, and bluefish *Pomatomus saltatrix*, (Gearhart 2003).

Initial monitoring of these fisheries in 1999 identified the large mesh gill net fishery as the probable source of sea turtle interactions in Pamlico Sound during the fall months. With this information, the NMFS initially issued an emergency rule closing the area to large mesh gill net fishing operations to protect threatened and endangered sea turtles (Figure 1, NMFS 1999).

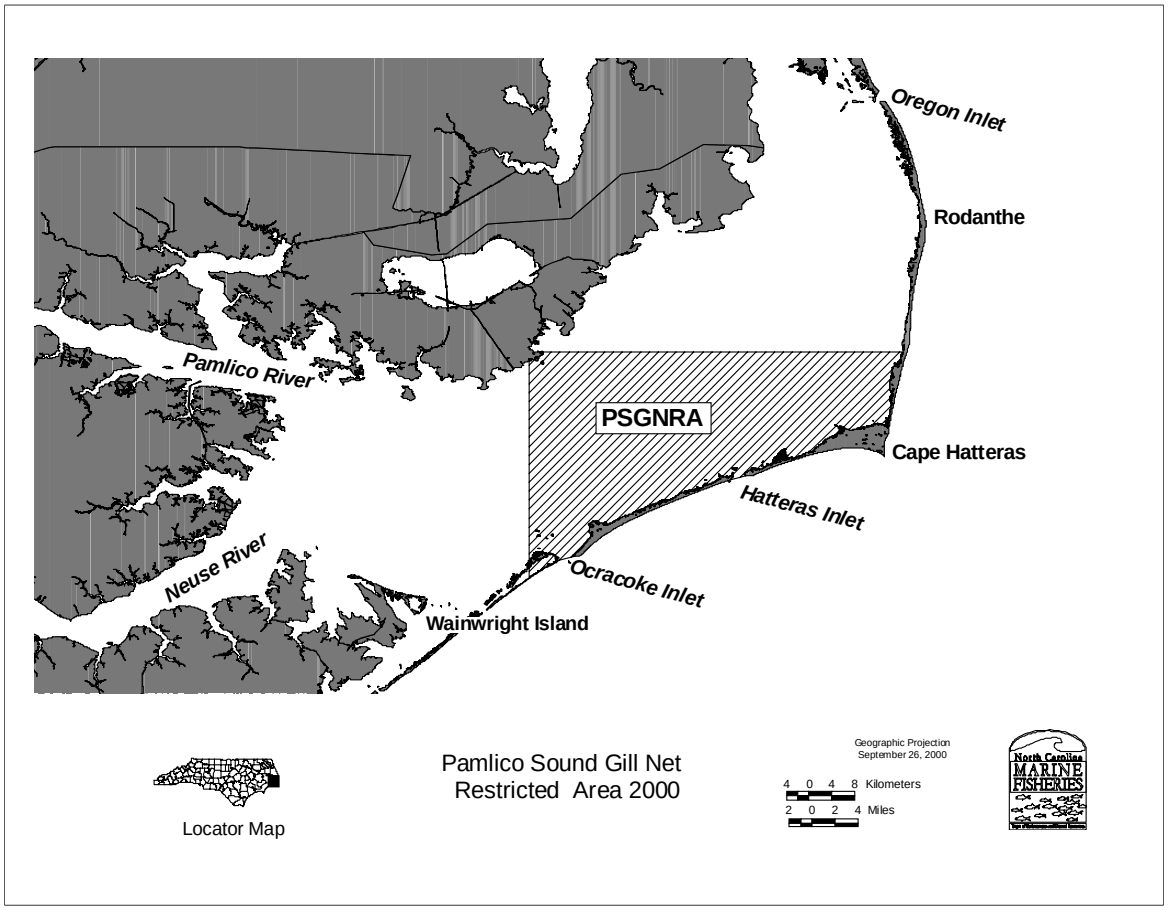

Figure 1. Map of southeastern Pamlico Sound depicting NMFS initial closure lines of Pamlico Sound in 1999.

To maintain this economically vital flounder fishery, the NCDMF applied for and received an ITP (#1259) in 2000 (Gearhart 2001). The ITP contained a comprehensive conservation plan designed to reduce sea turtle interactions by establishing authorized sea turtle take thresholds and intensive monitoring, while allowing traditional gill net fisheries to be prosecuted at reduced levels. Observations in 2000 under the ITP identified a deep water gill net fishery along the reef, and a shallow water gill net

fishery inside of the reef along the inshore waters of Pamlico Sound (Figure 2). The deep water region of Pamlico Sound was indicated as the primary source for sea turtle interactions and associated mortality.

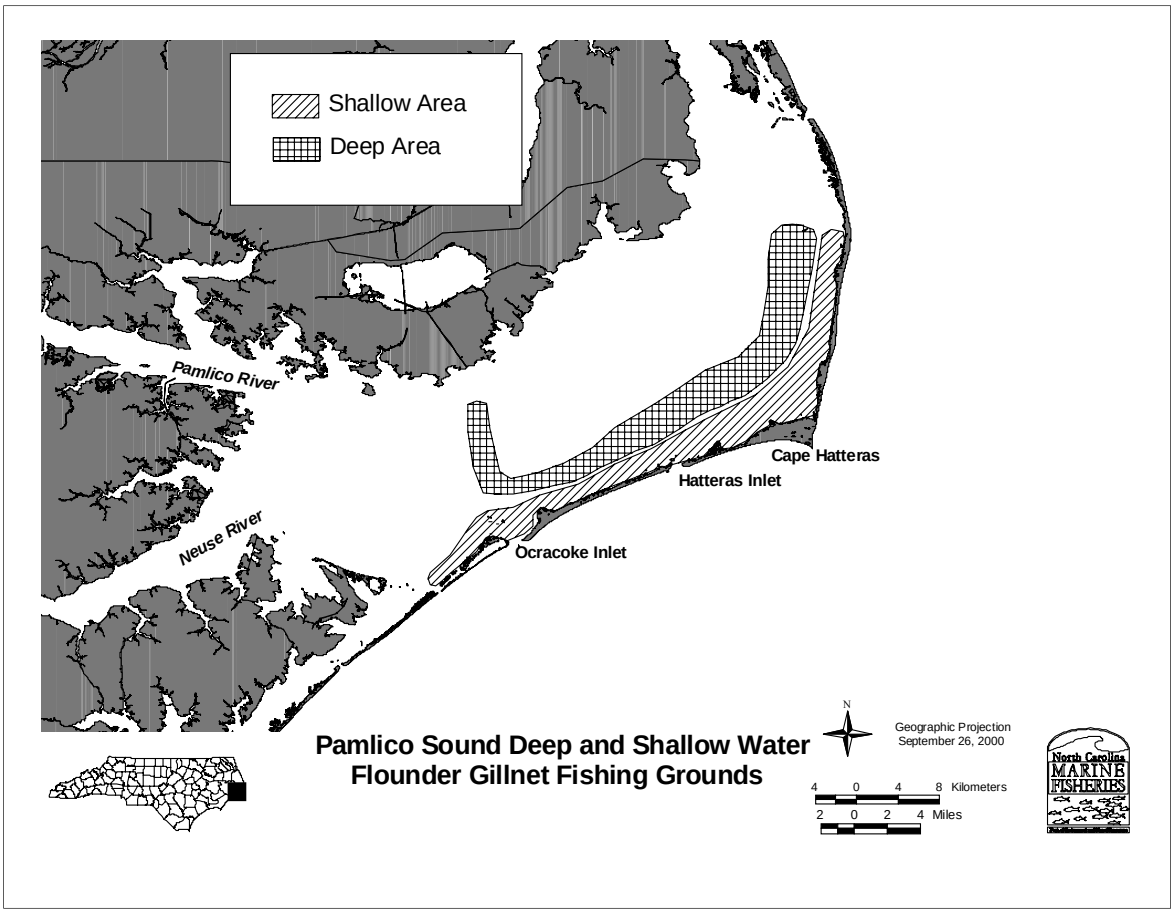

Figure 2. North Carolina estuarine flounder gill net fishing grounds in Southeastern Pamlico Sound in 2000.

Considering this, the NMFS established a permanent rule closing all potential fishing grounds utilized by the deep water large mesh gill net fisheries. In 2001, the NCDMF consulted with the NMFS and submitted an application for, and received ITP # 1348. This ITP mandated further restrictions for the 2001 fishing season by establishing prohibited fishing corridors and restricted areas in portions of the Pamlico Sound while fishermen were allowed to continue to prosecute the flounder fishery as stipulated in the ITP (Figure 3, Gearhart 2002). After the NCDMF designated the PSGNRA, the NMFS closed the remainder of Pamlico Sound to gill net gear larger than 4.25 inch stretched mesh size effective September 27, 2001 (Figure 3, 66 FR 42,845, August 15, 2001).

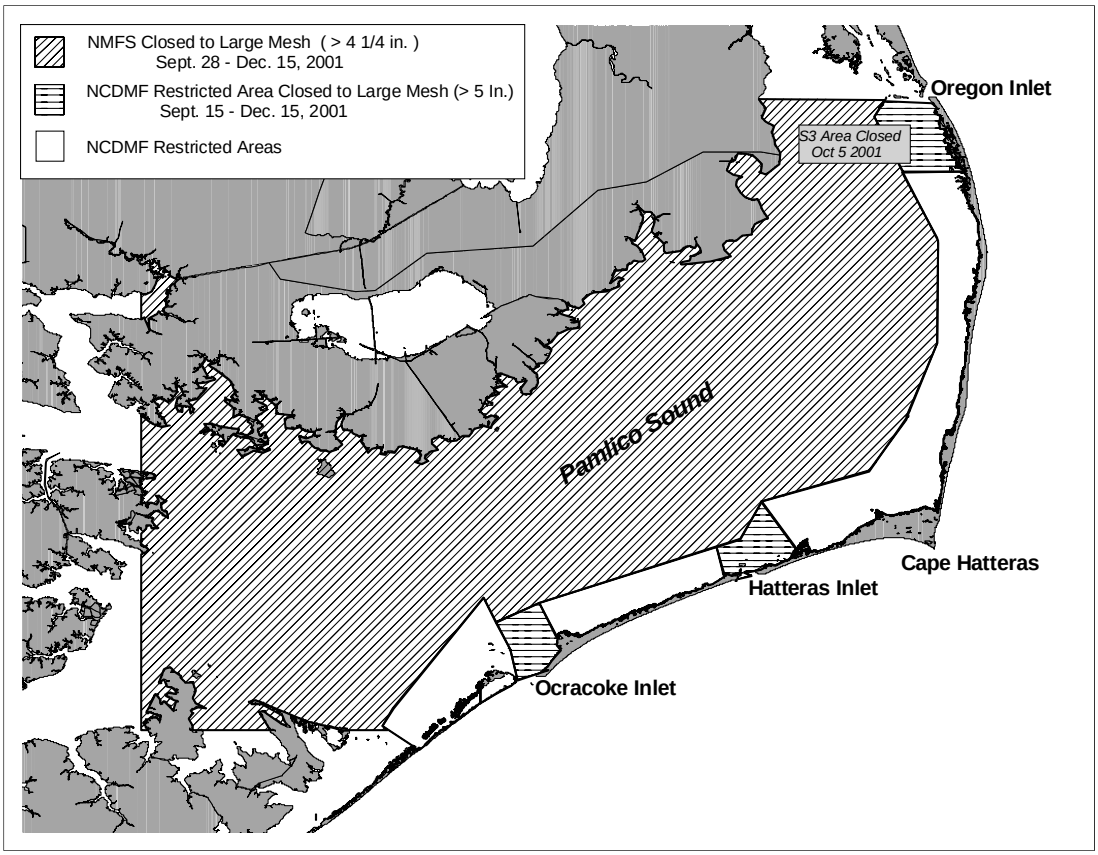

Figure 3. NCDMF 2001 Pamlico Sound Gill Net Restricted Area (PSGNRA) and NMFS closed area. S1=Shallow Water Gillnet Restricted Area 1; S2=Shallow Water Gillnet Restricted Area 2; S3=Shallow Water Gillnet Restricted Area 3; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor.

After considering 2001 monitoring data and consulting with the NMFS, the NCDMF applied for and received a three-year ITP (#1398) in 2002. This ITP contained a Habitat Conservation Plan (HCP), which required intensive sea turtle monitoring and a characterization program throughout restricted large mesh gill net fishing areas in the Pamlico Sound from September through December. From 2002 - 2004, the shape, size and location of restricted areas throughout the PSGNRA did not change (Figure 4). These areas were monitored on an annual basis from September 1 through December 15. Observed levels of sea turtle interactions in gill net fisheries were below the thresholds established by the ITP in 2002, 2003, and 2004 (Price 2005, Price 2004; Gearhart 2003).

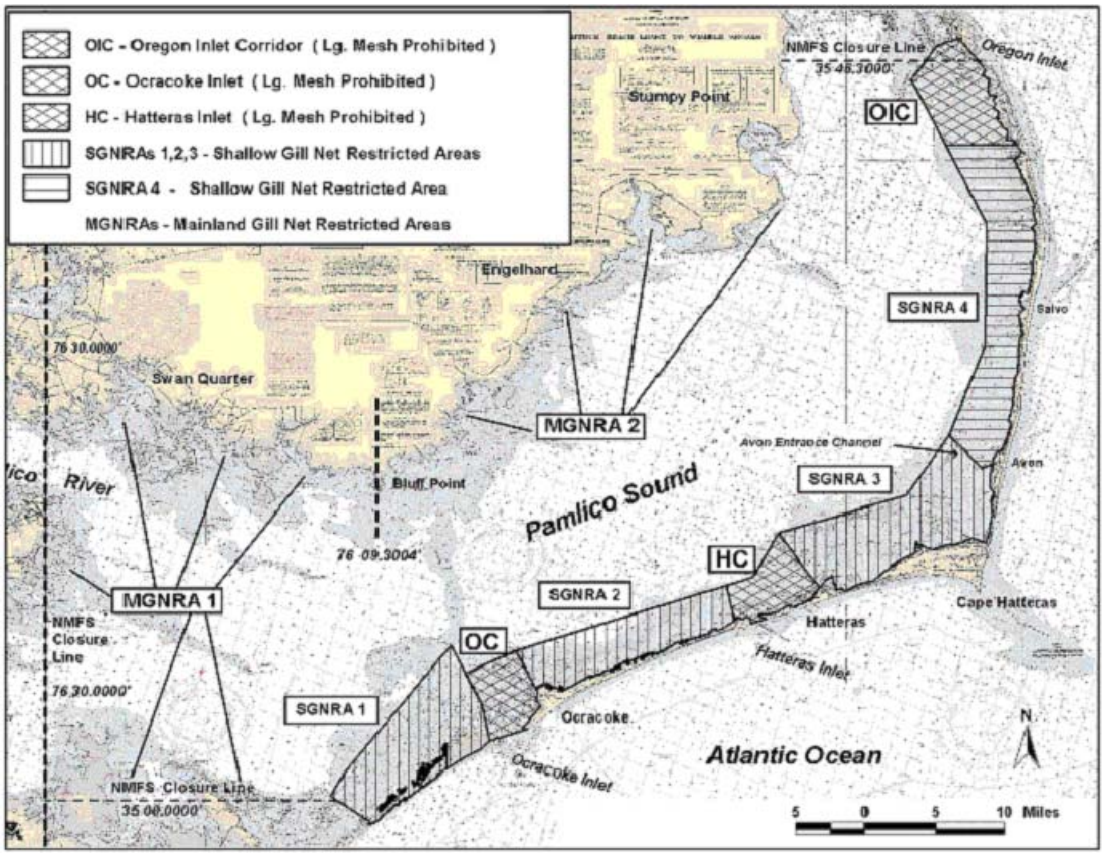

Figure 4. The Pamlico Sound Gill Net Restricted Area (PSGNRA) from 2002 through 2004 depicting restricted areas, and prohibited corridors for large mesh gillnet operations.

In 2005, the NCDMF consulted with the NMFS and applied for and received a six-year permit (ITP # 1528) in which management measures, restricted and prohibited areas, and monitoring efforts were similar to past management actions (Figure 5). There were a several changes in the PSGNRA in 2005 including: establishment of a state closure in addition to the federal closure in order to provide state jurisdiction and enforcement authority, modification in observer program procedures to better direct resources to times and areas of higher potential for sea turtle interactions; and elimination of the permit requirements along the mainland side of Pamlico Sound due to the small number of interactions in this area (ITP # 1528, Price 2006).

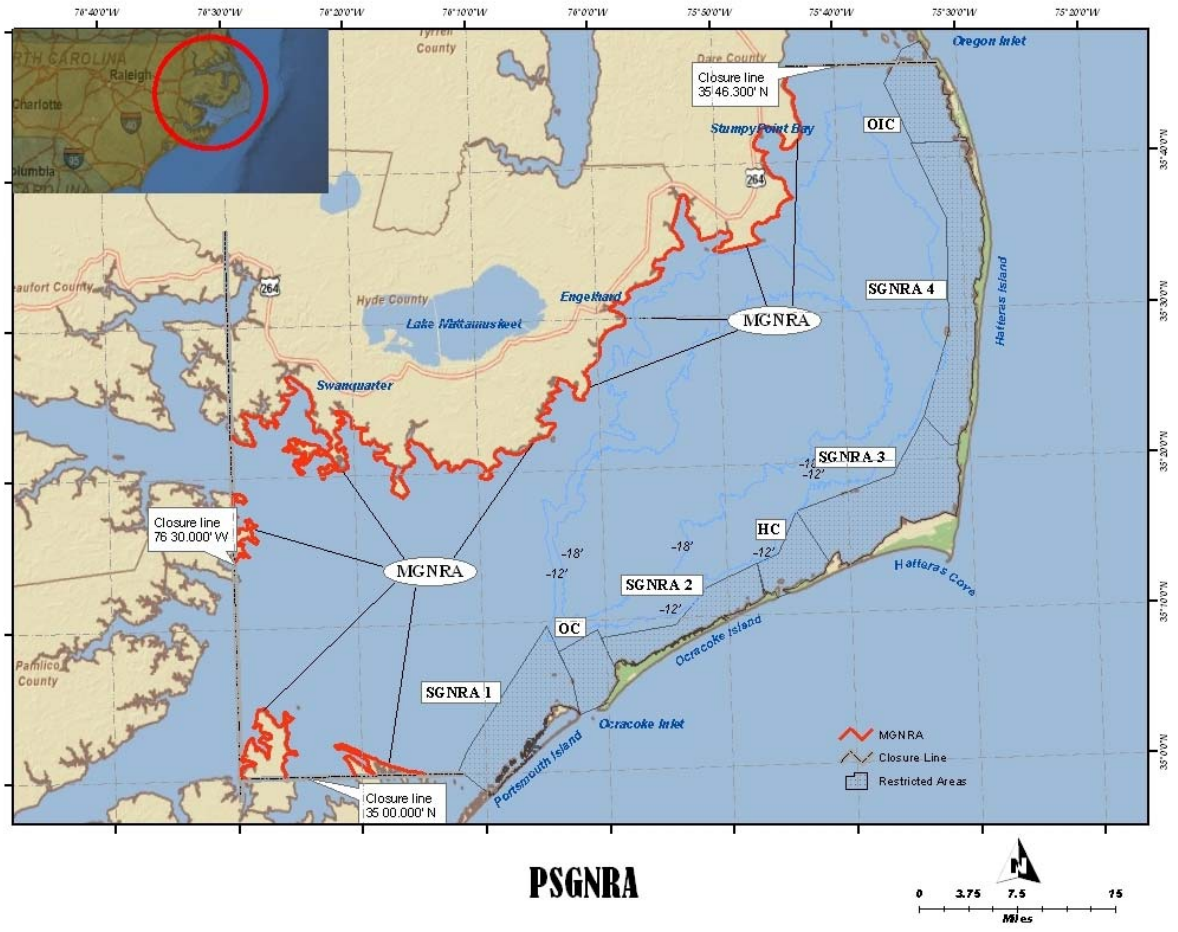

Figure 5. Map of the Pamlico Sound Gill Net Restricted Area (PSGNRA) from 2005 – December 2010.

Management of the PSGNRA from 2005 through 2010 was consistent and provided continued protection of sea turtles while allowing a shallow water gill net fishery to operate along the Outer Banks and mainland side of Pamlico Sound. However, beginning in 2007 observed and estimated sea turtle interactions increased significantly (Table 1). Seven sea turtle interactions were observed in 2005 and six interactions were observed in 2006 while 44 and 52 estimated takes were authorized for these years respectively (Price 2006, 2007a). In 2007, observed interactions increased dramatically to 20 which resulted in an estimate of 178 sea turtle interactions (all species combined). Due to the estimated interactions of live green sea turtles surpassing authorized thresholds, the 2007 PSGNRA season was closed approximately two weeks early (Price 2008). In 2008, observed and estimated interactions increased relative to years prior to 2007, but estimated sea turtle takes remained below authorized

thresholds and the season continued from September 1 through November 30 (Price 2009a). In 2009, another increase in observed and estimated sea turtle interactions occurred. The increase in interactions resulted in a closure of the 2009 PSGNRA on October 22 due to estimated live green sea turtle captures exceeding authorized thresholds of ITP # 1528 (Price 2010a).

Table 1. Observed and estimated sea turtle interactions by species and disposition inclusive with relative percent observer coverage by year throughout the PSGNRA from 2005 – 2009.

Year	Species	Dispostion	Obs. #	Total Obs. #	Est. #	Total Est. #	% Observer Cov.
2005	Green	Alive	4		28		
	Kemp's	Alive	1		4		
	Loggerhead	Alive	1		8		
	Loggerhead	Dead	1	7	4	**44**	**11.9**
2006	Green	Alive	2		20		
	Green	Dead	3		17		
	Loggerhead	Alive	1	6	15	**52**	**9.6**
2007	Green	Alive	14		125		
	Green	Dead	5		30		
	Loggerhead	Alive	1	20	23	**178**	**7.7**
2008	Green	Alive	8		59		
	Green	Dead	7		36		
	Kemp's	Dead	1		4		
	Loggerhead	Alive	1	17	4	**103**	**11.3**
2009 *	Green	Alive	21		229		
	Green	Dead	7		41		
	Kemp's	Alive	1		9		
	Kemp's	Dead	3		18		
	Loggerhead	Alive	1		11		
	Hawksbill	Dead	1	34	n/a	**308**	**12.1**
Totals **			84	**84**	685	**685**	**10.5**

*** 2009 estimates total 300 interactions; table reflects additional 8 interactions cumulative from 2008**
**** % observer coverage total is expressed as mean % from 2005 - 2009**

As a result of reports of increased sightings of sea turtles in previous years, the NCDMF considered delaying the opening of the 2010 PSGNRA until mid-September. Instead, the area was opened on September 1 for 17 days and the large mesh gill net fishery was closely monitored for sea turtle interactions. Few interactions were observed and the PSGNRA was subsequently opened from

September 20 until November 30. Collectively, these measures allowed the fishery to operate longer and ensure continued protection of endangered or threatened sea turtles.

Sea Turtle Advisory Committee (STAC)

During the summer of 2010, the NCMFC reestablished the STAC which had existed from 2003 to 2006 (STAC 2006). The STAC was originally intended to emulate the Atlantic Sea Turtle Strategy (NMFS agency-wide initiative since 2001) process at the state level. Specifically, the STAC's mission was to address sea turtle incidental catch (bycatch) in North Carolina inshore fisheries, identify problems areas, develop recommendations and submit a final report to the NCMFC detailing these efforts. This process involved the input and expertise of a number of stakeholders including standing committee members representing: NMFS, NCDMF, NCWRC, Duke University, Environmental Defense, commercial and recreational fishermen. In addition, informative presentations from the staff of several agencies: NCWRC, NCDMF, NMFS-Office of Protected Resources (OPR), NMFS-SERO, Atlantic States Marine Fishery Commission (ASMFC), and GA Dept. of Natural Resources were provided to the STAC and incorporated into the final report (STAC 2006).

The STAC identified four NC inshore fisheries that were primarily responsible for sea turtle interactions: gill nets, pound nets, shrimp trawls, and recreational hook and line. Multiple gears were also identified as gears of concern while many gears were identified as of no concern. The STAC recommendations were provided to the NCMFC through their final report and many of the recommended actions were adopted and are currently in place. Throughout the STAC process, recommendations were made for NCDMF to implement observer coverage for fisheries of primary concern to gather information on sea turtle bycatch.

NCDMF Observer Program

The NCDMF has obtained commercial gill net fishery observations outside of the PSGNRA, both spatially and temporally, since 2004 (Brown and Price 2005, Price 2007b, Price 2009b, Price 2010b, Conrad 2011). The purpose of these observations has been to initiate the process of characterizing effort, catch, and finfish bycatch by area and season. Additionally, these programs were established to monitor

fisheries for protected species interactions. The NCDMF has also conducted both inshore and near shore shrimp trawl observations (Brown 2009, 2010 *in press*) and obtained a limited number of pound net observations (Price 2007). In 2010, in addition to continued estuarine gill net observations, the NCDMF expanded the observer program to obtain observations in the recreational hook and line fishery. In 2011, the observer program was expanded to include the channel net fishery and the long haul seine fishery. The latter two monitoring programs are funded through an ESA Section 6 grant award to the states of NC, SC, and GA with the NCDMF functioning as a cooperator.

These programs have received funding from several sources including: state appropriations, the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA), the US Fish and Wildlife Service, the Atlantic Coast Cooperative Statistics Program (ACCSP), and the National Fish and Wildlife Foundation. The NCDMF will continue to seek funding for continuation of these vital fisheries monitoring programs. Information gathered from these programs is utilized when making management decisions, in stock assessments, in the development of Fishery Management Plans (FMP) and for identifying bycatch (finfish, protected species) problem areas.

The data that are collected in these monitoring efforts include the date, geographic location of gear, area fished, water temperature, salinity, vessel number and number of crew fishing. Gear type and gear parameters are also collected include: soak time, length of each net, stretched mesh net size, number of vertical meshes, ratio on which net is hung, net twine size, presence of tie downs and the distance the net is being fished from shore. Catch and effort data are collected through the identification, enumeration, weighing and measuring of each finfish species that is brought onboard the vessel from each net. Non-finfish species catch are also enumerated. Data for the catch, discard, regulatory discard and the alive/dead condition of each species upon release is recorded. With regard to protected species interactions, species, alive/dead, condition, curved carapace length and width, tag status, and pit-tag/e-tag data are recorded. All observer program data are available, by request, from the NC Division of Marine Fisheries (APPENDIX 1).

Gear Testing

Following the increased number of sea turtle strandings along the sound side of the Outer Banks in 1999 and the establishment of the PSGNRA, the NCDMF began testing modified gill nets for the purpose of developing gear that could reduce sea turtle bycatch and maintain acceptable catch levels of target species in gill net fisheries throughout the deep water portion of Pamlico Sound (Gearhart and Price 2003, Brown and Price 2005, Price and Salisbury 2007). These studies identified a low-profile gill net design that had potential for use in the deep water portion of Pamlico Sound to mitigate the bycatch of sea turtles. In addition, the 2006 study indicated the potential for application of this technology in other gill nets fisheries where similar conditions and sea turtle bycatch issues existed (Price and Salisbury 2007, Gilman et al. 2010).

Shrimp Trawl Tow Times – Southeastern NC

An area from Brown's Inlet to Rich's Inlet along the southern coast of North Carolina is often susceptible to high concentrations of marine algae. When present in high concentrations, the algae often foul shrimp trawl nets and Turtle Excluder Devices (TEDs) to the degree that they become inoperable. Since 1992, the NCDMF has worked with the NMFS to develop a management regime to address this problem. Specifically, an emergency rule promulgated by the NMFS from 1992 to 1995 and ITPs (# 1008 and # 1325) from 1996 to 2006 have allowed limited tow times to be implemented by the NCDMF through proclamations in lieu of TED use when algae concentrations are high.

Approximately 45 fishermen, with extensive knowledge of the local shrimp fishery, participate in this fishery. In some years, the fishermen were authorized under the ITPs to fish under tow time restrictions rather than with TEDs. From 1992-1999, between 14 and 43 vessels were issued permits for exemption from the use of TEDs. For the period 2001-2005, from 14 to 26 exemption permits were issued for this fishery. Tow times were not necessary in 2000 or in 2006 because low concentrations of algae allowed TEDs to work effectively. All of the provisions of the ITPs were implemented through proclamations issued by the NCDMF.

In 2006, the NCDMF applied for an ITP in this fishery. Based on low sea turtle interactions in the exempted fishery, NCDMF requested that the requirement for observer coverage be removed from the ITP. To date, NMFS has not responded to the request for an ITP without required observer coverage.

Large Mesh Gillnet Attendance – Cape Fear River, NC

In 2005, in response to high abundance of sea turtles in the lower Cape Fear River and associated takes in gill net gear, the NCDMF required attendance of large mesh gill nets from June 20 to August 31. The time period for required attendance has increased since 2005. In 2009, attendance of all gill nets in this region was required from May 23 to November 11. Since 2005, seasonal attendance has proven to be an effective method of reducing interactions with turtles and managing the gill net fishery in the lower portions of the Cape Fear River. Effort has been reduced by 66% when comparing landings data from 2007 to 2010 (Table 2). Discussions with NCDMF staff indicate that the attendance requirement allowed for timely detection and release of sea turtles from gill net gear and also resulted in reduced effort and participation due to the seasonal attendance requirement in the in the lower Cape Fear River flounder fishery.

Table 2. Southern flounder landings data from 2005-2010 for the Lower Cape Fear River.

YEAR	SPECIES	GEAR	WATERBDY	POUNDS
2005	SOUTHERN FLOUNDER	Gill Net Set, >= 5 in. mesh	Cape Fear River	13,636
2006	SOUTHERN FLOUNDER	Gill Net Set, >= 5 in. mesh	Cape Fear River	16,463
2007	SOUTHERN FLOUNDER	Gill Net Set, >= 5 in. mesh	Cape Fear River	9,374
2008	SOUTHERN FLOUNDER	Gill Net Set, >= 5 in. mesh	Cape Fear River	8,405
2009	SOUTHERN FLOUNDER	Gill Net Set, >= 5 in. mesh	Cape Fear River	11,132
2010	SOUTHERN FLOUNDER	Gill Net Set, >= 5 in. mesh	Cape Fear River	3,090

Outreach

Communicating management concerns and actions, including protected species bycatch issues, has always been an integral part of effective and adaptive fisheries management in North Carolina. The

implementation of the PSGNRA has necessitated industry involvement, participation and compliance since 2000. Informing and educating the industry about the ESA, the protection of species listed as either threatened or endangered and how this applies to the commercial fishing industry has been a major focus of the NCDMF outreach. Outreach efforts include public meetings, workshops, presentations, mail outs of summary information, public involvement (through advisory committees), and direct communications.

As a result of the NCDMF outreach efforts, the NC commercial fishing industry has become increasingly aware of the requirements of the ESA and the need for protected species conservation measures. The NCDMF will continue its efforts to conduct outreach to the industry concerning protected species bycatch. The NCDMF will benefit from the incorporation of the knowledge of fishermen concerning seasonal, annual, spatial and temporal variations in activities and distribution and abundance of protected species. Input from individuals who depend upon estuarine resources for a living and who observe the environment on a daily basis is a critical component of the NCDMF efforts to achieving sustainable fisheries resources. Outreach provisions included in this permit application will involve the relay of information between state and federal managers and fishing communities in addition to increasing public awareness of ESA mandates for protection of threatened or endangered species.

CURRENT EVENTS

In June 2009, the NMFS began an alternative platform (AP) observer program (observations via vessel) in Core Sound, NC. The NMFS observers documented sea turtle interactions in large mesh gill nets in this area beginning in late-June and notified the NCDMF of their concern for these unauthorized takes. The NCDMF consulted with the NMFS-SERO via conference calls and correspondence to discuss short and long-term actions to address sea turtle takes in gill nets in Core Sound as well as throughout the state. In the short term, the agencies agreed for the NCDMF to implement gear restrictions (yardage limits, mesh depth reduction, and net shot reductions) and increased observer coverage in Core Sound and adjacent water bodies (NCDMF Proclamation M-16-2009) . For the long-term, the NCDMF continued consultations with the NMFS-SERO (July 2009 to present) concerning the preparation of an ITP

application for internal coastal waters while compiling sea turtle interaction data from gill net surveys, research projects and direct observations.

As a result of continued sea turtle interactions in the Core Sound large mesh gill net fishery throughout the summer months and anecdotal reports from fishermen of increased sea turtle sightings along the Outer Banks in Pamlico Sound, the NCDMF delayed the opening of the 2009 PSGNRA until September 5. Monitoring efforts in the PSGNRA continued through October 22 when authorized thresholds of live green sea turtles were exceeded and the NCDMF closed the PSGNRA for the remainder of the season. On October 20, 2009, the day that authorized sea turtle takes were exceeded in the 2009 PSGNRA, a 60-day Notice of Intent (NOI) to sue the NCDMF and the NCMFC was received from the Duke Environmental Law and Policy Clinic on behalf of the Karen Beasley Sea Turtle Rescue and Rehabilitation Center Foundation (Beasley Center). The NOI stated that the NCDMF and the NCMFC violated Section 9 of the ESA by allowing gear that had unauthorized takes of threatened or endangered sea turtles.

The NCDMF consulted with the NMFS-SERO concerning this NOI while continuing to work toward the preparation of an application for a statewide ITP for gill net fisheries in internal coastal waters. In November 2009, the NCDMF received further correspondence from the NMFS-SERO reiterating the need to "satisfy the requirements of the ESA" relative to Core Sound sea turtle interactions. The NCDMF continued to compile sea turtle interaction data while developing an interim plan to address sea turtle interactions in gill net gear. As a result of discussions and correspondence with the NMFS-SERO, the NCDMF submitted an interim plan in January 2010 to address sea turtle interactions in gill net fisheries prosecuted in internal coastal waters. The plan proposed to close large mesh gill net fisheries throughout the majority of the estuarine waters of North Carolina from May to December 2010 (Figure 6).

On February 18, 2010 the NCDMF presented the interim proposal to the NCMFC and the public at an emergency NCMFC meeting in New Bern, NC. During the meeting, numerous commercial fishery representatives expressed concern with the proposed closure on the basis of the economic devastation that would result from such a closure. Representatives from the Coastal Conservation Association (CCA-NC)

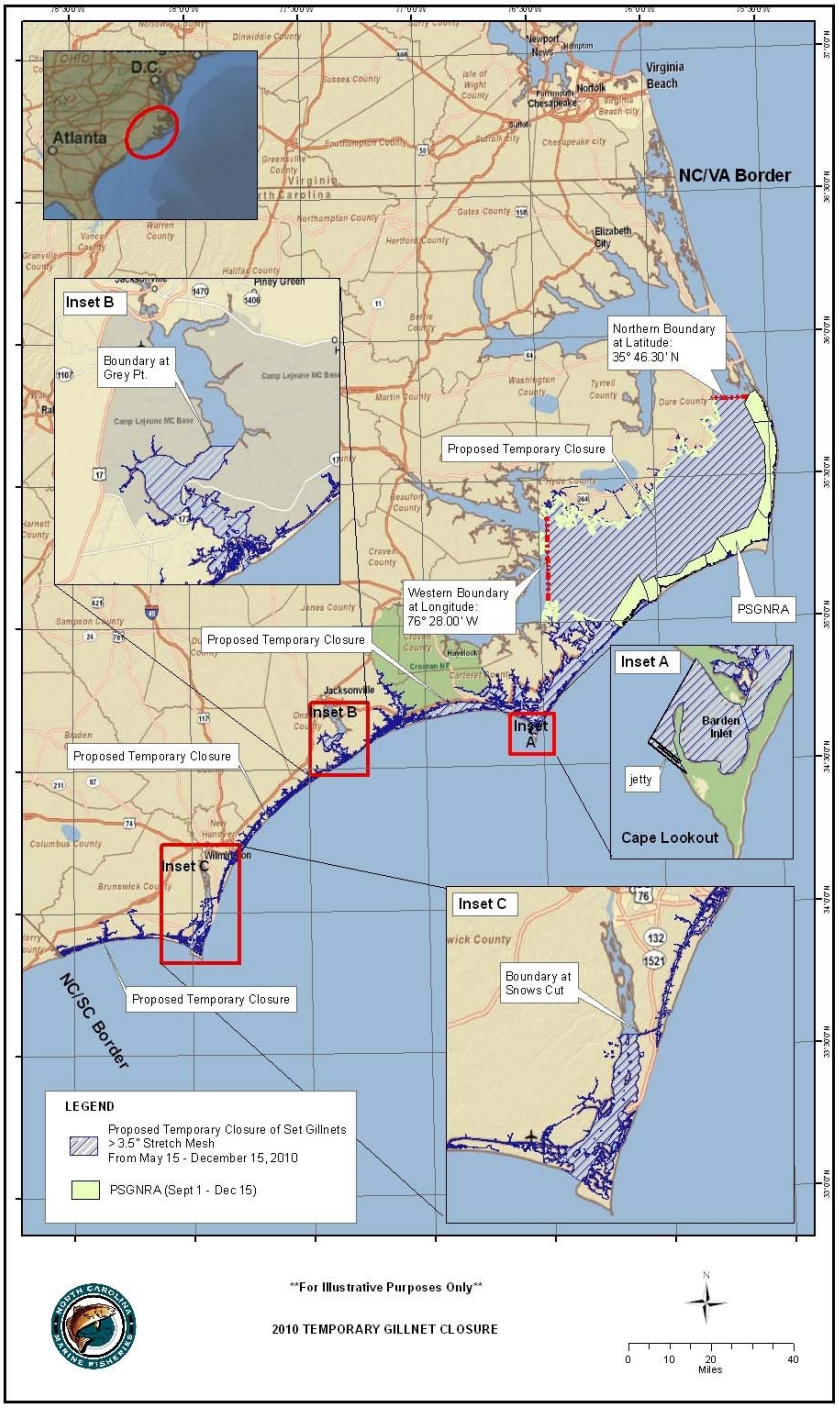

Figure 6. NCDMF proposed large mesh gill net closure for 2010 in coastal North Carolina.

did not support the interim closure stating the plan was too limited in scope. After thoroughly debating the issue, the NCMFC voted to direct the NCDMF to implement alternative measures that included reductions in the number of days per week that large mesh gill nets were allowed to be fished, restricted soak times, reductions in the length of individual nets (shots) and reductions in total yardage.

On 23 February 2010, the Duke Environmental Law and Policy Clinic filed suit against the NCDMF and the NCMFC on behalf of the Beasley Center. Negotiations between the parties occurred between late February and March 23, 2010, when the NCMFC met again. During the meeting, the NCMFC directed the Fisheries Director to issue a gill net proclamation effective May 15, 2010 restricting the number of days during the week that large mesh gill nets would be allowed, limiting soak time, establishing a maximum yardage limit, mandating maximum mesh depth, requiring net shot lengths, establishing spacing between net shots and eliminating the use of tie-downs and floats or corks along float lines. The NCDMF Director did not issue the proclamation because of ongoing negotiations with the Beasley Center and the Duke Environmental Law and Policy Clinic.

SETTLEMENT AGREEMENT

The NCMFC met May 12 through 14 and discussed the parameters of the final Settlement Agreement between the Beasley Center (plaintiff) and the NCDMF and the NCMFC (APPENDIX 2). At that meeting, the NCMFC reached an agreement concerning restrictions that would be implemented in the large mesh gill net fishery in NC internal coastal waters. As a result of the NCMFC action, the NCDMF issued Proclamation M-8-2010 (APPENDIX 3) effective May 15, 2010 implementing the provisions of the Settlement Agreement. Gillnet restrictions implemented by the proclamation included: a stretch mesh size range of 4 inch to, and including, 6 ½ inch for large mesh gill nets; soak times limited to an hour before sunset to an hour after sunrise, Monday evenings through Friday mornings; large mesh gillnets were restricted to a height of no more than 15 meshes, constructed with a lead core or leaded bottom line and without corks or floats other than needed for identification; a maximum of 2,000 yards of large mesh gill nets allowed to be used per vessel; maximum individual net (shot) length of 100 yards with a 25 yard

break between shots. Fishermen in the southern portion of the state were allowed to use floats on nets but were restricted to the use of a maximum of 1,000 yards of large mesh gill net per fishing operation.

Although gill nets are identified as small (< 5 inch stretch mesh) and large (_> 5 inch stretch mesh) in the NCDMF Trip Ticket Program (Trip Ticket), the Settlement Agreement includes gill nets from 4 inch to 5 inch stretch mesh in the large mesh category because of observed sea turtle takes in 4 inch and 4 ½ inch gill nets in the NCDMF Independent Gill Net Survey. The measures were modified slightly several times during 2010, with the concurrence of the Beasley Center, to improve gear efficiency or adjust fishing area boundaries without compromising the sea turtle conservation provisions of the Settlement Agreement.

Section 5(a) of the Settlement Agreement specifies: "The restrictions as listed in Paragraph 1, 2(e) and 2(i) are minimum requirements for the 2010 statewide ITP application." Paragraph 1 specifies the restrictions on large mesh gillnets, Section 2(e) pertains to different restrictions in the southern portion of the state as described above and Section 2(i) specifies that the restrictions apply to standard commercial fishing license holders and recreational commercial gear license holders.

However, Section 5(d) of the Settlement Agreement states "The restrictions as listed in Paragraphs 1, 2(e) and 2(i) are deemed solely interim measures and will be in effect within internal coastal waters, not otherwise exempt, until the NMFS issues the NCDMF an ITP for the affected areas. Furthermore, this Agreement shall not foreclose more lenient or more restrictive provisions in future ITP applications if warranted by biological data collected through reliable sources including but not limited to the NMFS and the NCDMF."

Section 2(b) of the Settlement Agreement makes note of the fact that the PSGNRA expired December 31, 2010 and specifies that that area will be subject to the Agreement. It is the intent of the NCDMF that management measures formerly implemented in the PSGNRA that proved to be effective for sea turtle conservation be carried forward in this ITP application for the shallow water portions of Management Unit B, Season 4 which were formerly designated as the PSGNRA.

GILL NET FISHERIES

North Carolina has a unique estuary system that is created by a chain of barrier islands along nearly the entire coast. Inlets within these barrier islands allow saline ocean water to mix with freshwater which is provided by a network of river systems flowing from the western portion of the state. This brackish water, coastal sound ecosystem is the third largest estuary in the world. This estuary provides prime habitat for numerous finfish species which are harvested by commercial and recreational fishing industries as well as residents and visitors to North Carolina.

Along the Atlantic Coast, gill nets are a legal gear and used for commercial and recreational purposes in all states, to some degree, with the exception of Pennsylvania and Florida (Table 3). Commercial and recreational fishermen deploy gill nets in much of North Carolina's coastal estuarine waters. Gill nets are highly regulated through the NCMFC adopted Fisheries Rules and by the NCDMF through proclamations. Regulations may include mandatory attendance, yardage limits, net shot limits, tie-down requirements, closed areas (primary nursery areas, PSGNRA), mesh size restrictions, minimum distance between fishing operations, marking requirements, permit mandates (PSGNRA), and observer requirements (PSGNRA, Core Sound 2009).

Gill net fisheries and related restrictions differ throughout the state depending on season, target species, location and physical characteristics of the water body being fished. In general, there are three primary set techniques: anchored set nets, floating drift nets, and strike or runaround nets. Anchored gill nets are passive sets deployed with an anchor or stake at one or both ends of the net shots or operation. These nets fish from the bottom upward into the water column. Drift nets are floated with the tides, are not anchored, and are typically used in deeper water areas such as near ocean inlets. With strike or runaround gill nets fisheries, the gear is set and quickly retrieved after surrounding a school of fish.

Gill nets may be used to target specific size ranges of fish due to the selectivity of different mesh sizes. Consequently, fishermen use gill nets of different mesh sizes to target different species. Commonly used mesh sizes in NC estuarine waters range from 2 ½ inch stretch to 6 ½ inch stretch mesh. Mesh sizes are frequently established by Fisheries Rules or NCDMF proclamation(s).

Table 3. Table summarizing current gill net fishery regulations by state along the Atlantic Coast.

State	Commercial								Recreational			
	Large Mesh				Small Mesh							
	Legal	Yardage Limit	Attendance	Limited Entry	Legal	Yardage Limit	Attendance	Limited Entry	Legal	Yardage Limit	Attendance	Limited Entry
Maine	yes	varies	yes	no	yes/bait	2000 ft	yes	no	No	n/a	n/a	n/a
New Hampshire*	yes	25 nets @ 300 ft	varies	no	yes	100 ft	yes	no	yes/bait	100 ft	yes	no
Massachusetts **	yes	800 yds.	no	no	yes	100 yds.	yes	no	yes	200 sq ft	yes	no
Rhode Island***	yes	no	no	yes	yes	no	no	yes	no	n/a	n/a	n/a
Connecticut******	yes	no	varies	yes	yes	no	no	yes	yes/bait	60 ft	yes	no
New York	yes	varies	varies	yes	yes	varies	varies	varies	no	n/a	n/a	n/a
New Jersey	yes	varies	varies	yes	yes	varies	varies	yes	no	n/a	n/a	n/a
Pennsylvania	no	n/a	n/a	n/a	no	n/a	n/a	n/a	no	n/a	n/a	n/a
Delaware	yes	varies	no	yes	yes	varies	no	yes	yes	100 ft.	no	no
Maryland	yes	3,500 yds.	no	yes	yes	no	no	yes	no	n/a	n/a	n/a
Virginia	yes	400 yds.	no	no	yes	200 yds.	no	no	yes	1 net @ 300 ft	yes	no
North Carolina	yes	3,000 yds.	no	yes	yes	no	varies	yes	yes	100 yards	yes	no
South Carolina	yes	varies	yes	no	yes	varies	yes	no	yes	100 ft.	no	no
Georgia ***	yes	no	no	no	yes	no	no	no	no	n/a	n/a	n/a
Florida	no	n/a	n/a	n/a	no	n/a	n/a	n/a	no	n/a	n/a	n/a

*Limited

** Approximately 500 gill net participants

*** Approximately 30 active participants

**** Approximately 40-50 active participants

***** Predominantly a shad fishery

Analyses of Trip Ticket data, commercial gill net observations, fish house sampling programs, and input from the commercial fishing industry enables estuarine gill net fisheries to be characterized by gear type, spatially and temporally (NCDMF 2008). Commercial landings are monitored through the Trip Ticket program which began in 1994. Under this program, only licensed commercial fishermen may sell catches to fish dealers who must be licensed by the NCDMF. Dealers are required to complete a trip ticket every time a commercial fishermen lands fish. Trip tickets capture data on gears used to harvest fish, area fished, species harvested, and total weight by species.

Commercial gill net fishing activity is also monitored through the NCDMF fishery dependent (fish house) sampling. The NCDMF Port Samplers collect data dockside as fish are landed. Commercial fishers are also interviewed dockside whenever possible. Data collected includes information on location, effort and gear characteristics, as well as information used to determine the size and age distribution of species landed (NCDMF 2008).

In addition to the monitoring efforts throughout the fall PSGNRA from 2000 through 2010, commercial estuarine gill net observer coverage has been expanded throughout the state since 2004. Information gathered during observer trips includes data on effort and mesh sizes used, as well as, data on the size and disposition of captured species (NCDMF 2008, Price 2007a, 2009a, Price 2010b).

Information gathered from the Trip Ticket program, fish house samples, and observations of commercial trips was used to characterize North Carolina's estuarine gill net fishery. Many commercially valuable species are targeted by gill nets throughout the year with no single size gill net (i.e. mesh size) being ideal for all species. Resulting information indicate that gill net fishermen utilize specific mesh size nets depending on the target species. While multiple species are most often landed for a single trip, a target species often comprises the majority of the catch.

By conducting these analyses and combining this information with direct commercial observations, distinct target species for small mesh and large mesh gill net fisheries may be identified spatially and temporally for NC estuarine waters. Large mesh fisheries consist primarily of five target species including southern flounder, striped bass *Morone saxatilis*, American shad *Alosa Americana*,

hickory shad *Polomolobus mediocris*, and catfishes *Ictalurus sp*. Large mesh gill net fisheries for flounder traditionally operated throughout the majority of the sounds and lower estuarine river systems with peaks in effort in the spring/summer months (April, May, June), and in the fall months (September–November). Fisheries for striped bass, which are managed as bycatch fisheries by the NCDMF, are more limited in time and space due to the anadromous migration pattern of this species. Striped bass gill net fisheries are prosecuted from late October through late April. Large mesh gill net fisheries are not allowed to target striped bass from May through early October. Consequently, the majority of striped bass effort occurs in the Albemarle Sound with seasonal effort occurring in the Pamlico Sound and the Pamlico and Neuse River systems. American and hickory shad fishing operations occur almost exclusively from January 1 through April 14 due to their anadromous migration patterns and distribution (season established by Fisheries Rule – 15A NCAC O3M .0519). Catfish are harvested with large mesh gillnets in the major river and Western Albemarle Sound with the majority of catches occurring during the winter to spring months. The most common mesh size mode for all large mesh gill net fisheries is 5 ½ inch stretch mesh.

Small mesh (< 4 inch stretch mesh) gillnet operations target a more diverse array of species relative to large mesh gillnet fisheries. Small mesh gillnet fisheries primarily target spot *Leiostomus xanthurus*, striped mullet *Mugil cephalus*, bluefish, spotted seatrout, weakfish, Atlantic menhaden *Brevoortia tyrannus*, Spanish mackerel *Scomberomorus maculates*, white perch *Morone Americana*, and kingfishes *Menticirrhus sp*. Peaks in spot landings occur in the spring/summer (April to June) and fall (October to November) months; spot are landed throughout the estuarine waters and river systems. Striped mullet are landed year round but peaks occur in the fall/winter months (October to January).

Bluefish are also landed year round throughout the estuarine and river systems with most landings occurring in the spring during April and May. Spotted seatrout and weakfish are targeted by small mesh gillnet operations primarily in the fall/winter (September to January) months. Weakfish landings may also peak in the spring during April and May. Atlantic menhaden are mostly targeted during the spring (February to May) with another peak in landings occurring in October. Spanish

mackerel are primarily targeted during the spring and fall months. White perch are almost exclusively targeted during the winter/spring months (December to April). Kingfishes are targeted primarily in the spring and the fall throughout the estuarine and river systems. Mesh sizes used in small mesh gill net operations vary more than those used in large mesh fisheries. However, the most commonly used small mesh sizes generally fall between 3 inch and 3 ¾ inch stretch mesh.

LANDINGS AND VALUES

Ex-vessel value is a measure of payment a fishermen receives from a fish dealer for landed product and provides an indicator of the value of a fishery. Total landings (all finfish and shellfish) throughout North Carolina were valued (ex-vessel) at approximately $77 million dollars in 2009. Estuarine landings accounted for 64% of the total and were valued at around $48 million dollars in 2009. From 1994 to 2009, the mean value of commercial fishing operations in North Carolina estuarine waters was almost $58 million dollars. Estuarine gill nets were responsible for landings valued at almost $6.4 million dollars in 2009 and averaged $6.2 million dollars in value from 1994 -2009.

The top ten valued species in 2009 from NC estuarine gill nets were southern flounder, striped mullet, spotted seatrout, red drum, Spanish mackerel, white perch, striped bass, spot, American shad, and bluefish. These species made up 92% of the total ex-vessel value for estuarine gill nets in NC for 2009. Gill net landings are responsible for greater than 50% of the total 2009 NC estuarine landings for all of the top ten species. In addition, for six of the top ten species landed from estuarine waters in 2009, gill nets were responsible for more than 80% of the total NC landings for each species. Large mesh ($\geq$ 5 in. stretch) gill net fisheries (e.g., southern flounder, red drum, striped bass, American shad) account for almost 62% of the total estuarine gill net value and the number of trips for 2009.

From 1994 to 2009, the total number of commercial fishing trips for all gears averaged more than 215,000 per year. The average number of annual commercial fishing trips for all gears in estuarine waters was around 198,000 between 1994 and 2009. Beginning in 2002, a decreasing trend in the total number of estuarine trips for all gears was noted with approximately 142,000 trips in 2009. By comparison, the average number of trips for all gears from 2002 to 2009 was approximately 155,000.

The number of annual estuarine gill net trips averaged nearly 41,000 from 1994 through 2009. The declining trend in total estuarine commercial fishing trips is also reflected in the number of estuarine gill net trips. Estuarine gill net trips declined from a high of around 51,000 in 1997 to approximately 36,000 trips per year in 2007 through 2009.

As fishermen spend their earnings in community stores, shipyards, offices and other businesses, additional economic impacts are generated. An analysis using the IMPLAN software package estimates that each $1 spent generates approximately $1.50 in economic impact before leaving the state's borders (IMPLAN version 3.0.5.2, 2010). Estuarine gill net landed species contribute to the businesses of primary dealers and processors and are estimated to have an economic impact of $255 million dollars to the state economy (Hadley and Crosson, 2010). These estimates do not include further "downstream" impacts of locally caught seafood that support owners and workers of most secondary dealers and processors,

restaurants, shipping companies, refrigeration companies and a multitude of other businesses.

SEA TURTLE INTERACTION TRENDS

In the last few years, observed and estimated sea turtle interactions in commercial large mesh gill net fisheries in the PSGNRA have increased (Price 2010a, Table 1). Interactions have also been observed outside of the PSGNRA through commercial gill net observations by the NCDMF and the 2009 NMFS alternative platform (AP) observer work in Core Sound. (Price 2007b, 2009b, NMFS unpublished alternative platform study).

An estimated total of 658 sea turtle interactions occurred in the PSGNRA from 2005 to 2009. Of these, 85% were green sea turtles, 10% were loggerhead sea turtles, and 5% were Kemp's ridley sea turtles. Also one hawksbill sea turtle interaction was observed in the 2009 PSGNRA (Price 2010a, Table 1). The majority (78%) of estimated sea turtle interactions in the PSGNRA were live individuals that were subsequently tagged and released.

A total of thirteen sea turtle interactions were observed outside of the PSGNRA from January 2004 to June 2010 in large mesh gill net operations in NC estuarine waters. (Brown and Price 2005, Price

2007b, Price 2009b, Price 2010b). The interactions were comprised of green turtles, (n = 8; 4 alive, 4 dead of which one was reported moderately decomposed), loggerhead turtles (n =1; alive) and Kemp's ridley turtles (n = 4; 2 alive, 2 dead which were both reported as moderately decomposed).

In the summer and fall of 2009, the NMFS AP observations in Core Sound indicated similar sea turtle mortality trends. The majority (55%) of observed interactions involved green sea turtles. Of the total interactions for all species combined, 73% involved live individuals (Table 4).

Observed sea turtle interactions in NCDMF and NMFS commercial large and small mesh gill net trips within and outside the PSGNRA have occurred exclusively in gill nets $\geq$ 5 inch stretch mesh. No sea turtle interactions have been observed in commercial gill nets < 5 inch stretch mesh through June 2010.

Table 4. Sea turtle's observed by species and disposition in the NMFS alternative platform gill net observer program in Core Sound, NC from June 2009 – November 2009.

Species	Alive	Dead	Totals
Green	8	4	12
Loggerhead	4	1	5
Kemp's	4	1	5
Totals	**16**	**6**	**22**

SUMMARIZED OBJECTIVES

The NCDMF requests an ITP authorizing annual estimated sea turtle takes in gill net operations in NC internal coastal waters from 2011 through 2013 for the purpose of providing continued protection for threatened and endangered species while allowing commercial gill net fishing to operate at regulated levels. The NCDMF has monitored gill net fisheries throughout Pamlico Sound since 2000 and has conducted numerous observations outside of this area since 2004. The information gathered from these direct observations allows the NCDMF to generate requested estimated take numbers and build a functional conservation plan. It is important to recognize that this conservation plan maintains flexibility

in design and management adaptations necessary to address potential changing finfish and sea turtle populations and distributions, varying fishing practices and data collections while providing for a better understanding of fishery bycatch issues and to more efficiently direct human resources.

The NCDMF is committed to providing protection for threatened and endangered species by managing fisheries in a responsible manner and basing management decisions upon the most current and comprehensive data sources. The implementation of conservation measures and authorization of requested estimated sea turtle takes described below are justified by the NCDMF's management history of the PSGNRA and compliance with the provisions of the Settlement Agreement.

HABITAT CONSERVATION PLAN

Under the requested ITP, the NCDMF will implement management measures in estuarine gill net fisheries in accordance with the Habitat Conservation Plan (HCP). A comprehensive monitoring program will be established through the HCP to ensure the functionality of management measures and allow timely adaptations to address sea turtle and other protected species conservation issues. In order to accomplish this, the NCDMF will divide the estuarine waters of North Carolina into five primary Management Units (Figure 7). Each of the units will be monitored seasonally and by fishery with weighted coverage derived from estimated sea turtle takes. If estimated takes exceed allowable thresholds in a Management Unit or sub-unit, the NCDMF will respond by issuing a proclamation closing the season for the responsible gill net gear in the applicable area. Proclamations involving gill net restrictions must be issued a minimum of 48 hours prior to the effective date and time..

Data from observed trips will serve as the primary source of information that will be used to identify the responsible gill net gear should authorized take levels be exceeded. However, information from other NCDMF biological sampling programs, Marine Patrol observations of gear, sea turtle sightings and reports from fishermen and the public will also be considered when available. Management flexibility through the HCP will allow necessary mitigation measures to be implemented and monitored in each area. Implementation of effective management measures will ensure the continued protection of threatened and endangered species and allow vital NC fisheries to be prosecuted at controlled levels.

Management Units

Management Units were delineated on the basis of three primary factors: similarity of fisheries and management; extent of known protected species interactions in commercial gill net fisheries; and unit size and the ability of the NCDMF to monitoring fishing effort (Figure 7).

Management Unit A will encompass all estuarine waters North of 35° 46.30'N to the North Carolina/Virginia state line. This includes all of Albemarle, Currituck, Croatan, and Roanoke sounds as well as the contributing river systems in this area. This area is currently defined as the Albemarle Sound Management Area (ASMA).

Management Unit B will encompass all estuarine waters South of 35° 46.30'N, East of 76° 28.00'W and North of 34° 48.27'N. This Management Unit will include all of Pamlico Sound and the Northern portion of Core Sound.

Management Unit C will include the Pamlico, Pungo and Neuse river drainages West of 76° 28.00'W.

Management Unit D is divided into two areas, D-1 and D-2, to allow the NCDMF to effectively address areas of high sea turtle abundance or "hot spots".

Management Unit D-1will encompass all estuarine waters South of 34° 48.27'N and East of a line running from 34° 40.70'N – 76° 22.50'W to 34° 42.48'N – 76° 36.70"W. Management Unit D-1 includes Southern Core Sound, Back Sound and North River.

Management Unit D-2 will encompass all estuarine waters west of a line running from 34° 40.70'N – 76° 22.50'W to 34° 42.48'N – 76° 36.70"W to the Western side of White Oak River. Management Unit D-2 includes Newport River, Bogue Sound and White Oak River.

Management Unit E will encompass all estuarine waters south and west of the Western side of the White Oak River to the North Carolina/South Carolina state line. This includes the Atlantic Intercoastal Waterway (ICW) and adjacent sounds, and the New, Cape Fear, Lockwood Folly and Shallotte rivers.

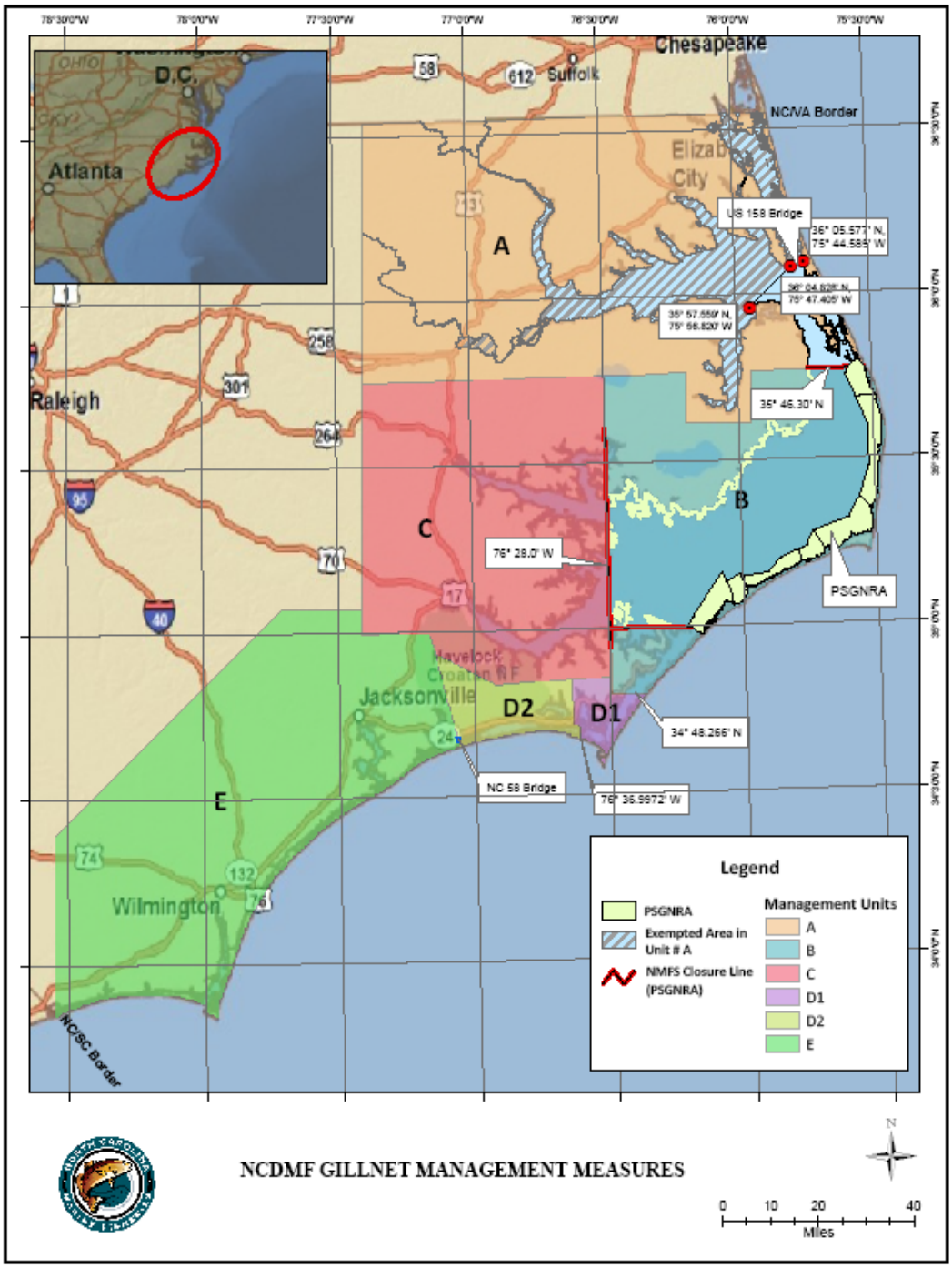

Figure 7. Map of Primary Management Units (A – E) throughout estuarine North Carolina for implementation of Habitat Conservation Plan from 2011 – 2013.

Management Measures

Large mesh gill net restrictions were implemented in internal coastal waters by NCDMF Proclamation M-8-2010 effective May 15, 2010. Restrictions included large mesh gill net use only from one hour before sunset Monday through Thursday evenings to one hour after sunrise Tuesday through Friday mornings. Large mesh gill nets were not allowed at any other time. A maximum of 2,000 yards per operation could be fished, except south of the NC Hwy 58 Bridge (Emerald Isle, NC Bridge) where a maximum of 1,000 yards could be used. Net shot lengths were restricted to a maximum of 100 yards with a 25 yard separation required between each net-shot. Large mesh gill nets could not exceed 15 meshes in depth and tie-downs were prohibited. Floats or corks were not allowed along the floatline of nets north of the NC Hwy 58 Bridge. These gear restrictions did not apply to the Western Albemarle Sound from a line from the East bank of the Alligator River to the East bank of the North River (Figure 7). Additionally, the NCDMF observer program was expanded to achieve a minimum of seven per cent observer coverage of large mesh gill net trips as required by the Settlement Agreement, with the exception of exempted areas.

For the three year life of the requested ITP, the NCDMF will issue proclamations implementing additional restrictions if necessary to provide increased protection of sea turtles and other ESA listed species or liberalizing gillnet or area restrictions if supported by NCDMF or NMFS biological data. Restrictions may include additional measures to reduce fishing effort, reduced yardage, attendance requirements or other gear limitations.

The NCDMF Marine Patrol (Marine Patrol) is responsible for enforcing Fisheries Rules and NCDMF proclamations. Enforcement of management measures will be a key component of the HCP. Marine Patrol officers are stationed within three coastal districts or in the vicinity of the NCDMF offices in Elizabeth City, Manteo, Washington, Morehead City and Wilmington. Weekly responsibilities for Marine Patrol officers include fish house inspections, aerial surveys, on the water fishing gear and license checks, fishermen interviews, enforcement of regulations and monitoring fishing activities. The tasking of Marine Patrol officers with gill net observer responsibilities is now an integral part of both the

NCDMF observer and enforcement programs. From May 18, 2010 through May 17, 2011 NCDMF Marine Patrol conducted 1,939 observed trips on which they observed 183, 221 yards of large mesh gill net (Table 5).

Table 5. NCDMF Marine Patrol gill net observations from May 18, 2010 – May 17, 2011

Unit	Trips	Yards of Large Mesh Gill Net Observed
A	430	16,653
B	374	34,740
C	272	40,250
D1	78	17,380
D2	208	21,615
D*	7	1,300
E	570	51,283

*Unable to determine trip's D1/D2 unit from original D management unit used in 2010.

Monitoring

Traditionally, the NCDMF has collected data from commercial gill net fisheries through an onboard observer program (Program 466) (Price 2007b, Price 2009b, Price 2010a). This program has allowed for the collection of data that are used for fishery management and monitoring protected species bycatch issues, the latter focused primarily throughout the PSGNRA. With the proposed expansion of the observer program, the NCDMF will continue traditional observer programs in which observers ride onboard vessels with commercial fishermen. The traditional observer program will be complemented by an AP program (Program 467) where operations are monitored at close proximity from state owned vessels. The infrastructure (i.e., database, personnel, equipment, etc.) necessary to implement the AP program has been achieved and approximately 50 percent of future NCDMF observations will by AP. The NCDMF monitored some estuarine gill net and recreational hook and line fisheries using alternative platforms in 2010. Program 467 was added to the NCDMF Biological Database to house AP data and the program is structured with flexibility to incorporate multiple fishery operations (e.g., gill net, haul seine and channel net fisheries). The data collected through the AP program will model data collected in the NMFS AP study conducted in the Core Sound gill net fishery during 2009. The NCDMF received copies

of the NMFS AP field forms and data sheets and staff incorporated elements of the forms in the NCDMF program to ensure transferability from state to state and state to federal programs.

The onboard observer program requires the observer to ride aboard the commercial fishermen's vessel. Protected species interactions, gear parameters, as well as detailed gill net catch and discard information for other species are recorded. The AP program requires two observers in a state owned vessel to monitor commercial fishermen hauling their gill nets from a state owned vessel. The AP observers document protected species interactions and also provide catch and discard estimates for information for other species that are observed. The data logs for the AP program differ slightly from the traditional observer program due to a reduction of the quantity of catch and bycatch species data collected in the AP program.

The Marine Patrol observer data is similar to that of the AP program, with the exception that the Marine Patrol does not collect fish catch, bycatch or weight estimates. The primary goal of the Marine Patrol observer program is to provide additional gill net fisheries coverage and to collect protected species interaction data. Marine Patrol officers are debriefed only if they witness a protected species interaction. The Sea Turtle Incidental Capture Report, which will be utilized by all observer programs, is the form used to debrief Marine Patrol officers.

The NCDMF staff created field data forms for Marine Patrol officers to use for observed trips, these forms are in the AP data format. The forms are specific to gill net observations and include location, effort, activity, violations, and protected species information. The Marine Patrol observer trip data will be identical to other NCDMF observer staff data collections, downloaded into the NCDMF biological database and used to improve fisheries observations by area and season and to provide prompt responses to protected species interactions.

The observer program will maintain statewide gill net fishery coverage in all management units while gill net fishing efforts are occurring, except in the exempted areas. Weekly observer coverage will be estimated for each management unit based upon fisheries effort data, sea turtle abundance, open management units and in areas where protected species have been reported. With coverage based upon

fisheries efforts, observer coverage will be relative to the fisheries efforts for that management unit, unless protected species reports indicate that an increase in coverage is needed within a management unit. Reports of increased numbers of protected species in an area will allow the NCDMF to increase observer coverage in areas where high concentrations of protected species populations may potentially interact with fishing gear. The observer program does not have allocated sea days associated with management units or sub-units.

In 2011, NCDMF began monitoring estuarine gill net operations using traditional on board observers operating under established data collection protocols which were supplemented by AP observations of gill net fisheries. Both programs are critical for NCDMF monitoring and management of gill net fisheries, conservation of protected species and for providing outreach opportunity to the fishing industry.

From May 17, 2010 through May 17, 2011, NCDMF staff conducted observations in large mesh gill net fisheries in the five areas described under Management Units and in Figure 7. Since May 15, 2011, Management Units have been observed on a seasonal basis. "Seasons" are defined as: (1) Winter (Dec – Feb); (2) Spring (Mar – May); (3) Summer (June – Aug); and (4) Fall (Sep – Nov). Observations have been concentrated in areas and during times of known or suspected sea turtle concentrations and ongoing gill net effort. Trip Ticket program data are used to estimate the number of large mesh gill net trips by area and season when weighting coverage. In addition, NCDMF observations from onboard gill net observations (2000 to 2010) and independent gill net sampling programs (1990 through 2010) will be used to direct coverage to known areas of increased sea turtle interactions (Table 6 and Figure 8). In 2011 and following years, observations by DMF biological staff will be supplemented by the incorporation of Marine Patrol AP observations. This will not only allow for sea turtle distributions and interaction concerns to be more comprehensively characterized, but will also assist in shaping future conservation efforts. NCDMF will continue to seek additional funding to hire additional biological staff for the traditional and AP programs. Increases in the biological observer staff may reduce the need for weekly observations by Marine Patrol officers.

Table 6. Sea Turtle Incidents By Area, May 17, 2010- May 17, 2011

NCDMF SEA TURTLE INCIDENTS BY AREA
(5/17/2010-5/17/2011)

Area	Date	Season	Live Kemp's ridley	Dead Kemp's ridley	Live Green	Dead Green	Live Logger head	Dead Logger head
B	5/25/2010	SPRING	1					
B	6/9/2010	SUMMER			1			
B	6/11/2010	SUMMER			1			
B	6/16/2010	SUMMER			1			
B	9/22/2010	AUTUMN			1			
B	9/28/2010	AUTUMN			1			
B	10/6/2010	AUTUMN			1			
B	10/14/2010	AUTUMN			1			
B	10/18/2010	AUTUMN					1	
B	10/18/2010	AUTUMN			2			
B	10/30/2010	AUTUMN			1			
B	11/2/2010	WINTER			1			
B	11/3/2010	WINTER			1			
B	11/8/2010	WINTER			1			
B	11/9/2010	WINTER			1			
C	9/8/2010	AUTUMN						1
D1	6/2/2010	SUMMER	2		1		1	
D1	6/10/2010	SUMMER	3	1				
D1	6/17/2010	SUMMER	1					
D1	6/18/2010	SUMMER				1		
D1	6/18/2010	SUMMER	1					
D1	6/22/2010	SUMMER		1	1			
D1	6/24/2010	SUMMER				1		
D1	7/2/2010	SUMMER	1					
D1	7/9/2010	SUMMER	1					
D1	7/14/2010	SUMMER	3					
D1	7/20/2010	SUMMER	1					
D1	7/27/2010	SUMMER				1		
D1	9/1/2010	AUTUMN	1				1	
D1	9/1/2010	AUTUMN	1					
D1	9/8/2010	AUTUMN			2	1		
D1	9/8/2010	AUTUMN	1					
D1	11/9/2010	WINTER			1			
D1	11/10/2010	WINTER			1			
D1	5/6/2011	SPRING	1					
D1	5/6/2011	SPRING					1	
D1	5/6/2011	SPRING	1					
D1	5/17/2011	SPRING		1				
D1	5/17/2011	SPRING		1				
E	5/21/2010	SPRING	1					
E	6/23/2010	SUMMER			1			
E	6/24/2010	SUMMER			1			
E	7/29/2010	SUMMER			1			
E	7/30/2010	SUMMER			1			
E	8/5/2010	AUTUMN			1			
E	8/26/2010	AUTUMN	1					
E	9/7/2010	AUTUMN	1					
E	9/9/2010	AUTUMN			2			
E	9/21/2010	AUTUMN			1			
E	10/27/2010	AUTUMN		1				
TOTALS			22	4	28	4	4	1
Total Sea Turtle Incidental Captures: 17 May 2010 -17 May 2011								63

6/16/2011

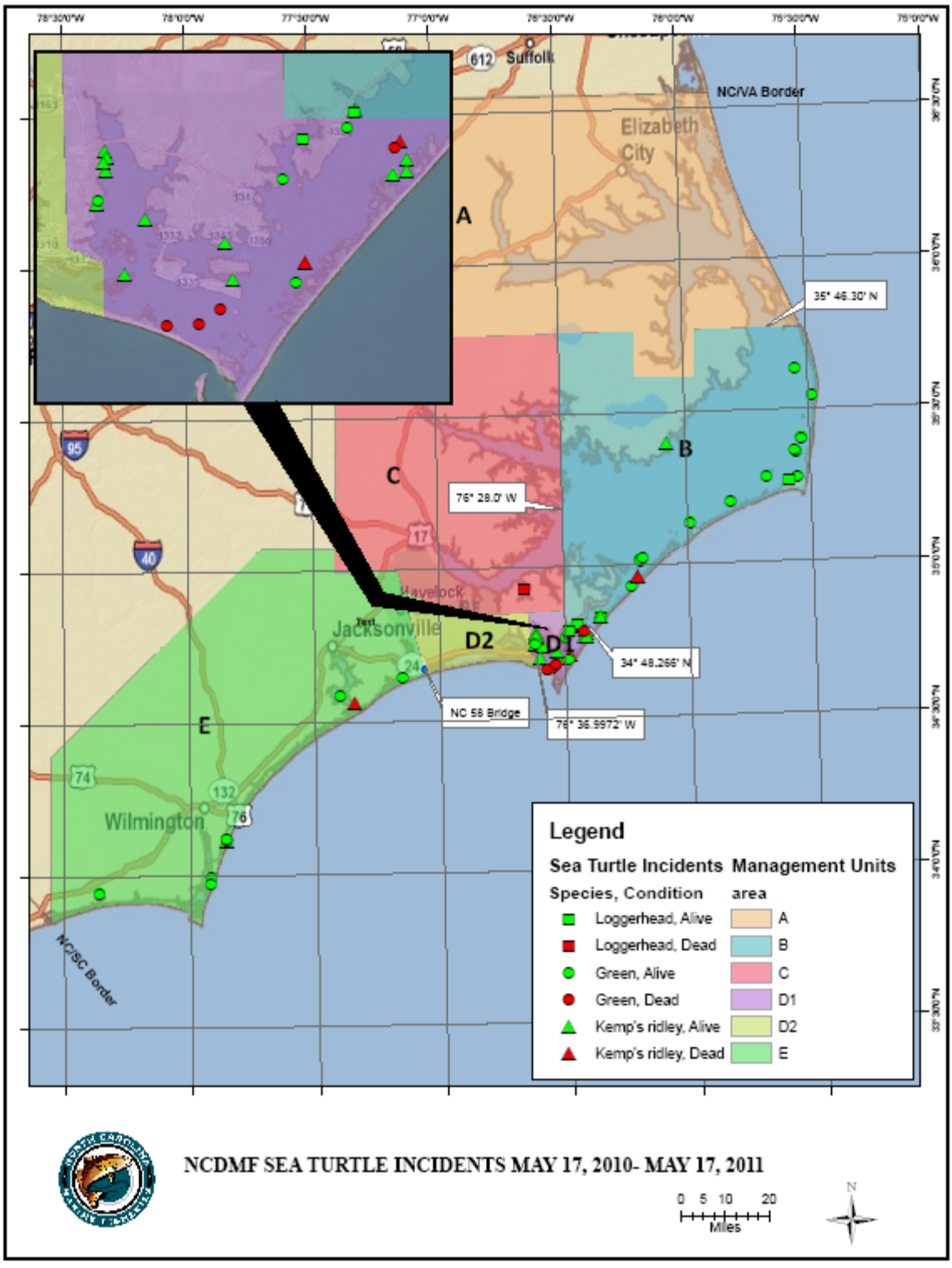

Figure 8. NCDMF Observed Sea Turtle Incidents in Gill Net Fisheries, May 17, 2010 – May 17, 2011

Observers have been trained by NCDMF staff on all data collection protocols. PSGNRA observers were trained to handle, transport, identify, resuscitate, tag and release sea turtles in accordance with the NMFS standards by NCDMF staff or personnel with the NMFS Laboratory in Beaufort, NC. Most of these individuals are still serving as observers in the NCDMF Protected Resources Section. Marine Patrol officers were trained in late April 2010 by staff on all data collection protocols and were provided field and final data sheets for weekly observations. Marine Patrol officers also participated in sea turtle identification, resuscitation, handling and tagging training with the NMFS-Beaufort Lab in late April 2010. As other biological staff and Marine Patrol officers are hired, similar training will take place.

Data collections from observer trips includes: date, location, unit, time, season, gill net description (net length, number of net shots, mesh size, presence/absence of tie downs, vertical mesh height, hang ratio), soak time and water depth. Additionally, environmental parameter data (wind, tide stage and water quality) is collected when feasible. Total catches of target species is estimated and final disposition (kept or discarded) is recorded. Sea turtle interaction information includes species, condition, tag numbers, and final disposition. Sea turtle interactions are photo documented when possible. Gill net interactions involving other protected species are documented. All observers are required to adhere to these data collection parameters. Observers are debriefed by phone daily and submit weekly debrief reports at the end of each week. At the end of each day, observers contact the observer coordinator and provide the following trip information: the fisher's name, area fished, all protected species interactions, quantity and species of fish caught, fishing effort in the area, other vessels in the area, as well as any other information which will assist in the determination of ongoing observer effort required at that location.

NCDMF has not used volunteer observers to date primarily due to a lack of expressed interest on the part of the public and logistics of observers having to contact fishermen in the evening to arrange trips for the next day and predawn rendezvous for trips with fishermen at docks or boat ramps. Additionally, NCDMF is concerned about possible liability issues, limited availability of NCDMF required safety equipment (US Coast Guard approved cold weather survival gear, personal EPRBs) and limited staff to train and supervise volunteers.

The NCDMF AP program utilizes vessels that may vary in model, but will range in size from approximately 19' to 25'. The NCDMF has procured vessels suitable for use in the AP program that are located at each field office for use by observer program personnel. All boats are equipped and maintained in accordance with US Coast Guard safety regulations and NCDMF safety policies. The NCDMF anticipates that a minimum of 1,250 traditional and 1,250 AP large mesh gill net observer trips will be conducted annually throughout the coastal waters of North Carolina. This amount of effort is expected to achieve a minimum of 7% observer coverage of the annual large mesh gill net trips in internal coastal waters. The number of trips to be observed for 7 % observer coverage is based upon NCDMF Trip Ticket data which indicate that approximately 36,000 large mesh gill net trips were made in 2009.

Observer data is coded into the NCDMF Biological Database Program 467 immediately following the completion of an observed trip. Standard interaction reports are submitted to the NCWRC STSSN within 24 hrs of an observed interaction. Observers are debriefed by supervisory staff via telephone, email and/or in person within 24 hrs of observed trips. Summary reports are provided monthly to the NMFS-OPR and the NMFS-SERO with estimates of total sea turtle takes by management unit, season, species and disposition (alive or dead). Sea turtle take estimates will be cumulative in each management unit and season by species and disposition**. Should sea turtle takes for one species exceed allowable thresholds, the NCDMF will issue a proclamation closing the remaining portion of the season for the responsible gill net gear in the Management Unit(s) or Sub-Unit where thresholds were surpassed.**

Mitigation Measures

Mitigation measures in the HCP and continued monitoring of the fishery will provide managers with the tools necessary to modify fisheries practices in a timely fashion**. NORTH CAROLINA MARINE FISHERIES COMMISSION RULE 15A NCAC 03I .0107(b) ENDANGERED OR THREATENED SPECIES** states, in part, “The Fisheries Director may close or restrict by proclamation any coastal waters with respect to taking or attempting to take any or all kinds of marine resources when the method (equipment) used is a serious threat to an endangered or threatened species listed pursuant to

16 USC 1533(c)". Such actions may include time/area closures, attendance requirements, gear restrictions and increased monitoring efforts. However, if information collected by the NCDMF observer program indicates that no interactions have been observed or estimated takes are well below authorized thresholds, relaxation of restrictions during some seasons or in some areas may be in order. The HCP and subsequent monitoring will provide management flexibility and protection of ESA listed species and the most efficient use of management resources.

Mitigation measures will be implemented by the NCDMF to minimize and reduce sea turtle and other protected species interactions in gill net fisheries. These measures may include extensive outreach, timely response to "hotspots", an adaptive observer program and implementation of further restrictions through Fisheries Rules or NCDMF proclamations. These measures will have the potential to minimize sea turtle interactions, reduce sea turtle mortality and offer protection to other threatened and/or endangered species.

Hotspots

A key component of an adaptive monitoring program is the identification of areas of high potential for bycatch of protected species in gill net fisheries through observed interactions and on the water sightings of sea turtles by the NCDMF observers, biological staff, Marine Mammal Stranding Program, Marine Patrol, reports from commercial and recreational fishermen and the general public (Figure 8). These areas will be referred to as "hotspots" and will provide managers the opportunity to address bycatch concerns through timely implementation of conservation measures such as increased observer and Marine Patrol coverage, additional gear restrictions and temporary and/or seasonal closures. In the PSGNRA, identification of hotspots helped characterize bycatch and facilitated the implementation of effective conservation measures (e.g., delineation of restricted areas, prohibited areas, direction of resources) necessary to minimize sea turtle takes and reduce mortality.

Adaptive Observations

Outreach, extensive monitoring and identification of areas of concern will allow the NCDMF observer program to efficiently direct resources on a seasonal and area basis. Variations in finfish distribution and abundance, changes in commercial fishing behavior, and variable protected species distribution and migration will direct monitoring efforts in gill net fisheries. Since these factors do not remain static, it will be paramount for NCDMF observer programs to be adaptable and flexible in order to respond to changing conditions in fisheries and distributions of protected species. Adaptive responses and flexibility in this program are necessary for increased understanding of protected species behavior patterns and to have the ability to respond to the changes associated with protected species conservation.

REQUESTED TAKES

To develop requested ITP sea turtle takes, the NCDMF used multiple data sources and contracted with Dr. Don Holbert, a retired biostatistician from East Carolina University in Greenville, NC, to conduct analyses on a step by step basis. The goal of these analyses was to estimate a range of anticipated annual sea turtle takes by species, disposition, management unit and season in gill net fisheries. These ranges are based on (1) no reduction in fishing effort, (2) 20% reduction in fishing effort, (3) 30% reduction in fishing effort; and (4) 50% reduction in fishing effort. Reductions in fishing effort have occurred since the implementation of the Settlement Agreement. The data sources used and estimates generated are based upon data collected from 1990 – 2010. Specifically, the NCDMF compiled known sea turtle interaction in gill net fishing gear and Trip Ticket information from: (1) the NCDMF independent gill net survey (1999 – 2010); (2) the NCDMF independent gillnet survey in the Albemarle Sound (1990-2010); (3) the NCDMF independent gillnet survey in the Cape Fear River (2002-2006); (4) the NCDMF commercial gill net observer program (2001 – 2010); (5) NC Sea Grant Fishery Resource Grants – commercially dependent research (2000, 2001, 2004, 2007, 2008); (6) NCDMF fish house sampling data (1999 – 2010); (7) the NCDMF Trip Ticket program (1994 – 2010); and (8) the NMFS Alternative Platform gill net observer data in Core Sound from June 2009 – November 2009 and (9) the

NCDMF Alternative Platform observer data from May 2010-December 2010 (Holbert 2010), (Holbert 2011), (APPENDIX 4).

Methodology

Estimating total turtle takes for this ITP was a three stage strategy including: (1) calculating turtle CPUE, by year-unit-season-method-mesh, (2) calculating fleet effort to which the above CPUE estimates were applied; and (3) applying these CPUE estimates to the fleet data and smooth with a model fit (Poisson Regression). Data from each source was standardized by management unit, year, season, method, and mesh size. "Management Unit" refers to areas delineated for management in this ITP as depicted in Figure 7. "Year" encompassed the years 2001-2010 from data sources and "Seasons" were designated as: Winter (Dec – Feb); Spring (Mar – May); Summer (June – Aug); and Fall (Sept –Nov). "Gill Net Mesh Sizes" were classified as small (< 4 inch stretch mesh) and large ($\geq$4 inch stretch mesh). Gill net fishing methods are "Active" (runaround or strike gill net operations), where gear is "actively" set and retrieved; or "Passive" (set or anchored gill net operations), where gear is deployed for a certain period of time and then retrieved, generally the following day. "Soak Times" in all data sources and final analyses were standardized to one day. By combining files, all data sources were compiled into a database with like parameters. For each data set and for each record, unique catch and effort data existed.

Stage one of the analyses involved obtaining overall catch per unit effort (CPUE) data by pooling all available summary files that contained data on both effort and turtle takes. This was done by combining the data sets and the resulting file contained pooled estimates of CPUE for sea turtles by unit, year, season, method and mesh. Stage two of the analysis involved estimating fleet effort by first collapsing the trip ticket data by summing the pounds harvested over all species (target species) for a given unit, year, season, method and mesh. Then the biological data from the commercial fish house sampling and at-sea sampling was pooled to determine the effort (net length/soak time for a given unit, year, season, method and mesh. The two data sets were merged to produce a measure of total effort for each unit, year, season, method and mesh.

The third stage in these analyses involved using the pooled CPUE data obtained earlier and merging with the fleet effort data to obtain point estimates of turtle takes for each record. While sea turtle CPUE estimates could be based upon bycatch rate and pounds landed, CPUE was estimated based upon bycatch rate and effort with effort being defined as the total amount of gill net yards fished multiplied by the soak time. Sea Turtle CPUE based upon net length and soak time considers the time the net is in the water regardless of pounds of fish caught. This calculation results in a lower variability of the CPUE when compared to effort based upon pounds of fish landed.

Records were then deleted that corresponded to the "active" method so that only "passive" gear was analyzed from 2001 through 2010. Take estimates were then calculated by multiplying total effort by CPUE. When no CPUE was available for a particular UNIT*YEAR*SEASON*MESH combination, a pooled CPUE, pooling across years for the given UNIT*SEASON*MESH combination was used.

It was estimated that approximately 15,000 turtle interactions occurred in passive gillnet gear in internal coastal waters over the 10 year period from 2001 to 2010. Interactions in large mesh outnumbered those in small mesh approximately 28:1. Interactions in the summer outnumbered those in all other seasons combined by approximately 2 ½ : 1. The predominant Management Units where interactions occurred were B, D1, and E, representing 97% of all interactions; for these three Management Units, the interaction ratio was approximately 2:1:1 (for B:D1:E). Interactions occurred uniformly through the years, with 2003 and 2005 being the 2 lowest years (about 500 interactions each), and 2004 and 2009 the 2 highest years (about 2200 interactions each).

Modeling Turtle Interactions as a Function of Unit, Year, Season, and Mesh

Poisson regression can be used to model turtle interaction rates (count per unit of effort) as a function of management unit, year, season and mesh. This method is designed to handle situations in which the response variable represents a count of events corresponding to some specified level of exposure. In our setting, the "event" is a turtle interaction, and the "exposure" is the amount of fishing effort that produced this number of events (i.e. this number of turtle interactions). In this model, the

response is the expected (natural) logged count. The exposure variable (often called the "offset") goes into the model as log (exposure). The fitted equation is:

log (rate) = b0 + b1*UNIT +b2*YEAR +b3*SEASON +b4*MESH

For any given UNIT*YEAR*SEASON*MESH, once a fitted value is obtained for "log (rate)", the actual rate is then estimated by exponentiation (i.e. <Estimated rate = exp {estimated log (rate)}). The effect is to "smooth" the data, in order that the fitted (i.e. "smoothed") values for cases that had unusually high counts will be pulled downward, while fitted (i.e. "smoothed") values for cases that had unusually low counts will be pulled upwards. In fitting the Poisson regression model, the deviance scale was used to allow for the possibility of over dispersion. Resulting data included the point estimates, model fits, and 90% lower and upper confidence limits for expected turtle take by unit, year group, and season and are found in detail in APPENDIX 4.

Calculations

One must consider that these data represent a sparse data set. Among the 478 combinations of UNIT*YEAR*SEASON*MESH, 405 (85%) did not have an interaction. Therefore little weight should be given to the confidence limits for those cases with zero turtle interactions. Changes in fishing effort must also be considered while trying to make reasonable projections. Therefore, projections were based on different scenarios that may be influencing fishing effort (no reduction, 20% reduction, 30% reduction and 50% reduction). Based on pooled CPUEs for each year for large mesh, where catch and effort data were pooled over seasons and units, in the last four years (2007-2010) there have been two relatively high years and two relatively low years. A confidence level of 90% was selected over a 95% confidence level in order to account for uncertainty in the data so that projections are more reasonable. Using the upper boundary of the 95% confidence limits is unnecessarily conservative. Using just the point estimates is justifiable since when totaled, outlying data points will be evident.

Projections are broken out by species and status (live/dead) based on 320 turtle interactions recorded in the data utilized for CPUE by species and status of which 21 were unknown species. Within these data, the ratio of live turtles to dead turtles is 2:1 based on actual interaction counts. Post interaction

mortality data for North Carolina were not available, nor used within this initial model, though adjustments could be made to the model in the future to incorporate post interaction data for North Carolina, if available . This ratio was applied to the relative percent species composition of known interactions for computation of final species counts and mortalities. The proportion of green turtle, kemps turtle, loggerhead turtle and hawksbill turtle was 72%, 19%, 8.3% and 0.67% respectively.

Estimates of sea turtle takes in Table 7 follow results from the Poisson regression model for large mesh gill net operations based on a 50% reduction in fishing effort. Numbers generated in this model are acceptable and are used to request a threshold of takes that is reasonable while providing a safeguard threshold for protected sea turtles. Finally, applying mortality estimates by species allows for 902 takes requested for large mesh gill nets by management unit, season, species and disposition annually for 2011 through 2013 (Table 7). No leatherback sea turtle interactions were documented in NC commercial gill net operations from 2001 to 2010 (Gearhart 2002, Price 2010b, NCDMF unpublished data). It is unlikely that increased takes of this species will occur, however to provide a safeguard in the event of interaction with leatherback sea turtles, one directly observed take in any combination of disposition, unit and season is requested to address a possible interaction with large mesh gill net operations.

There was only one sea turtle recorded in a small mesh net deployment. This green turtle was recorded in a 5,745 yard deployment in Management Unit B during the summer season. While interactions in small mesh (<4inch) gill net gear are unlikely, small mesh trips will be observed to document whether or not interactions are problematic in small mesh gear. Therefore, the NCDMF requests a total of 68 estimated takes in small mesh gill net gear (Table 8). Requested takes are based upon no reduction in fishing effort and the use of the same available data sources from 2007 to 2010 at a 90% confidence level which represents a reasonable estimate in each unit, season and disposition for each species. The expansion of the observer program is expected to provide a minimum of 2,500 observed gill net trips annually and is anticipated to be equal to or greater than 7% coverage of the total fishing effort in internal coastal waters of North Carolina. In the event of increased interactions, the NCDMF Fisheries Director has the ability to implement further restrictions by proclamation (e.g., gear restrictions, closures)

within each Management Unit with a minimum of 48 hours advanced public notice. Take estimates will be computed monthly for each Management Unit by Season.

REQUESTED TAKE SUMMARY

The requested takes in this application (Tables 7 & 8) reflect annual estimated takes in large and small gill net fisheries from 2011 through 2013 and represents a reasonable scenario based upon a 50% reduction of commercial large mesh gillnet effort since May 15, 2010. Specifically, the gill net restrictions implemented under the Settlement Agreement limit both net length and soak times significantly. In areas where sea turtles normally occur, large mesh gill net gear may be set Monday through Thursday nights only. The gear is allowed to be set one hour before sunset and must be out of the water one hour after sunrise.

Trip Ticket program data for May 17 through December 27, 2009 indicate that 18,990 large mesh trips were made in internal coastal waters. The number of trips during the same period in 2010 was 11,908, a 37% reduction in the number of trips. However, the NCDMF believes that when the reduced number of trips from Trip Ticket data and the Settlement Agreement provisions (which reduced the maximum yardage and eliminated daytime soaks) are combined, total 2010 large mesh effort is, at a minimum, 50% below previous years. The NCDMF is confident that the management measures described herein will be adequate for conservation of sea turtles in North Carolina's internal coastal waters. The NCDMF has a staff of trained and experienced observers and Marine Patrol officers who will monitor gill net fisheries and collect the information necessary to revise take estimates if deemed necessary in the future.

Between 2000 and 2010, a number of changes were made in the PSGNRA such as: adjustments to allowable fishing areas, restrictions modified (e.g., state closure, net length restriction) and allowable take levels reduced (Gearhart 2003, Price 2010a). These adaptations were made feasible as a result of the extensive monitoring program conducted by the NCDMF in the PSGNRA from 2000 through 2010.

Table 7. Estimated annual sea turtle takes requested by species, disposition, unit, and season annually for 2011 – 2013 in the NC large mesh estuarine gill net fishery. Note: Requested takes for leatherback (any combination of disposition, unit or season) is not anticipated, but requested for safeguard.

	A				B				C				D1				D2				E				
Species	**Wint**	**Spr**	**Sum**	**Fall**	**Wint**	**Spr**	**Sum**	**Fall**	**Wint**	**Spr**	**Sum**	**Fall**	**Wint**	**Spr**	**Sum**	**Fall**	**Wint**	**Spr**	**Sum**	**Fall**	**Wint**	**Spri**	**Sum**	**Fall**	**Totals**
Green	**0**	**0**	**0**	**0**	**0**	**9**	**242**	**93**	**0**	**0**	**3**	**2**	**0**	**5**	**113**	**28**	**0**	**0**	**8**	**6**	**0**	**4**	**90**	**49**	**652****
Live	0	0	0	0	0	6	162	62	0	0	2	1	0	3	76	19	0	0	5	4	0	3	60	33	436
Dead	0	0	0	0	0	3	80	31	0	0	1	1	0	2	37	9	0	0	3	2	0	1	30	16	216
Kemp's	**0**	**0**	**0**	**0**	**0**	**3**	**64**	**24**	**0**	**0**	**1**	**0**	**0**	**1**	**30**	**7**	**0**	**0**	**2**	**1**	**0**	**1**	**24**	**13**	**171****
Live	0	0	0	0	0	2	43	16	0	0	1	0	0	1	20	5	0	0	1	1	0	1	16	9	116
Dead	0	0	0	0	0	1	21	8	0	0	0	0	0	0	10	2	0	0	1	0	0	0	8	4	55
Loggerhead	**0**	**0**	**0**	**0**	**0**	**1**	**28**	**11**	**0**	**0**	**0**	**0**	**0**	**0**	**13**	**3**	**0**	**0**	**1**	**0**	**0**	**0**	**10**	**6**	**73****
Live	0	0	0	0	0	1	19	7	0	0	0	0	0	0	9	2	0	0	1	0	0	0	7	4	50
Dead	0	0	0	0	0	0	9	4	0	0	0	0	0	0	4	1	0	0	0	0	0	0	3	2	23
Hawksbill	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**6****
Live	0	0	0	0	0	0	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	**5**
Dead	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Leatherback*	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	**1**

*** Leatherback are rare in NC waters. No takes of these species are anticipated, however a request for 1 (any combination of unit, season and disposition) throughout the state and year is being made to ensure authorization in the unlikely event of interaction.**

**** Total requested estimated takes of green, kemp's, loggerhead and hawksbill sea turtles - 902.**

Table 8. Estimated annual sea turtle takes requested by species, disposition, unit, and season annually for 2011 – 2013 in the NC small mesh estuarine gill net fishery. Note: Requested takes for leatherback (any combination of disposition, unit or season) is not anticipated, but requested for safeguard.

	A				B				C				D1				D2				E				
Species	**Wint**	**Spr**	**Sum**	**Fall**	**Wint**	**Spr**	**Sum**	**Fall**	**Wint**	**Spr**	**Sum**	**Fall**	**Wint**	**Spr**	**Sum**	**Fall**	**Wint**	**Spr**	**Sum**	**Fall**	**Wint**	**Spri**	**Sum**	**Fall**	**Totals**
Green	**0**	**0**	**0**	**0**	**0**	**2**	**27**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**4**	**52****
Live	0	0	0	0	0	1	18	4	0	0	0	0	0	0	5	2	0	0	0	0	0	0	2	3	35
Dead	0	0	0	0	0	1	9	2	0	0	0	0	0	0	2	1	0	0	0	0	0	0	1	1	17
Kemp's	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**12****
Live	0	0	0	0	0	0	5	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	9
Dead	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3
Loggerhead	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4****
Live	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3
Dead	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hawksbill	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0****
Live	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Leatherback*	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	**1**

*** Leatherback are rare in NC waters. No takes of these species are anticipated, however a request for 1 (any combination of unit, season and disposition) throughout the state and year is being made to ensure authorization in the unlikely event of interaction.**

**** Total requested estimated takes of green, kemp's, loggerhead and hawksbill sea turtles - 68.**

Section 3(b) of the Settlement Agreement requires that the NCDMF achieve a minimum of 7% observer coverage of large mesh gill net trips per week in internal coastal waters. The primary focus of the observer program will be on large mesh gill nets in internal coastal waters. In the future, data from the expanded observer program may allow the NCDMF to request adjustments to the take levels proposed in this ITP application.

Until a statewide ITP is obtained, sea turtle conservation measures implemented in accordance with the Settlement Agreement and the NCDMF's ability to promptly implement additional adaptive management measures (e.g., further gear restrictions, area closures and seasons) through proclamations will serve as a safeguard for conservation of protected species while allowing large mesh gill net fisheries to be prosecuted in internal coastal waters.

ANTICIPATED IMPACT

The provisions proposed in this ITP application and the expanded NCDMF observer program will provide data that can be used to characterize interaction trends by gear, season and area and allow for implementation of management measures to reduce takes. The resulting data may lead to management measures, fishing practices and gear modifications that will ultimately conserve many more sea turtles than the requested 972 estimated annual takes (903 in large mesh gill nets and 69 takes in small mesh gill nets) requested in this application for the three year period of 2011 through 2013. The NCDMF believes that the gill net restrictions implemented May 15, 2010 and subsequently modified, with the concurrence of the Duke Environmental Law and Policy Clinic and the Beasley Center, will be effective in reducing sea turtle interactions with gill net gear. Reports from onboard and alternative platform observations and the NC Stranding Network database will allow sea turtle gill net interactions to be closely monitored and provide for the timely implementation of additional mitigation measures should estimated take thresholds be approached. This proposed activity will have no impact on the habitat of sea turtles and no restoration of the affected habitat is proposed.

ALTERNATIVES CONSIDERED

An alternative action considered, but rejected, by the NCDMF was not to apply for an ITP and to close estuarine waters to all gill net fisheries. While this action would provide the greatest protection for sea turtles, it would not allow for collection of long-term comprehensive data that might assist in the identification of sources responsible for many of the sea turtle strandings in North Carolina internal coastal waters. A full closure of estuarine gill net fisheries in North Carolina would have a severe and unprecedented economic impact on participating fishermen, the local and regional economy and would be directly contradictory to the NCDMF's mission of: "Ensuring sustaining marine and estuarine fisheries and habitats for the benefit of the people of North Carolina."

ADAPTIVE MANAGEMENT

The NCDMF will use proclamation authority to implement management measures necessary to reduce sea turtle takes in estuarine gill net fisheries in North Carolina. This flexibility is a necessary component of an ITP as increased knowledge will be acquired through extensive monitoring, outreach and data collections. Proclamation authority allows the NCDMF to implement timely responses which may provide increased protection of sea turtles. The need for additional management measures or better direction of resources will be determined by the NCDMF in consultation with the NMFS-OPR and the NMFS-SERO throughout the ITP process.

Appropriate restrictions may include gear or area restrictions, attendance requirements, modifications in observer coverage and/or increased enforcement. The NCDMF will consult regularly with the NMFS-SERO and the NMFS-OPR to ensure that monitoring and management programs maintain the flexibility for the NCDMF to monitor, anticipate, respond and implement needed action. This flexibility was a vital component of the NCDMF management of the PSGNRA and will apply to our monitoring and management strategy for gill net fisheries prosecuted in internal coastal waters of the state. A long-term adaptive approach will provide for the protection and conservation of sea turtles and other protected species.

FUNDING OPPORTUNITIES

In 2010, NCDMF management and monitoring of estuarine gill net fisheries operated under state appropriations and federal awards totaling more than $500,000. Beginning in 2011, NCDMF will monitor gill net operations in each management unit and season with state appropriated funds and with funds remaining from current grants and with existing staff and personnel. Observer program funding is also available through an ESA Section 6 Joint Cooperative Award (NCWRC, SC, GA), however, these funds may not be used for observing gill net trips mandated by an ITP, but they may be used for observing other gears for sea turtle interactions. On July 1, 2010, NCDMF received increased state funding of approximately $257,000 for five new observer positions, support equipment and operations. The state funded observer positions have replaced one-half of the temporary services observer positions that were formerly funded through federal grants.

APPLICATION

The North Carolina Division of Marine Fisheries acknowledges the magnitude of the requested 972 annual takes of sea turtles proposed in this ITP application. The requested estimated take numbers represent a worst-case scenario**. It is highly unlikely that the total authorized take level will be approached or exceeded in a season or a year because the NCDMF will close a Management Unit or Sub-Unit for the remainder of that Season if takes exceed the authorized level for one of the five species, not the authorized level for all species.** The NCDMF believes that the gear restrictions, adaptive management, extensive monitoring, delineation of Management Units and estimate of takes 60 times per year (monthly in each of the five Management Units) will ensure continued protection for endangered or threatened sea turtle populations.

North Carolina fishermen and communities depend greatly upon the fisheries resources of this state. The industry remains committed to working with managers to address bycatch problems in gill net fisheries. The NCDMF will continue to address protected species bycatch issues through timely management actions, development of bycatch reducing gears, and outreach to the fishing industry.

The requested three-year ITP will allow for the establishment of a comprehensive conservation plan with a monitoring infrastructure to provide for management measures to be implemented for protection of sea turtles and other protected species in North Carolina internal coastal waters. The monitoring program will allow for characterization of the gill net fisheries and sea turtle distributions and interactions in these waters. This information will provide managers with the tools to address concerns in the short-term, and the information needed to plan and manage resources in the long term both for the conservation of protected species and the opportunity for various user groups to access to North Carolina fisheries resources. This program will remain adaptive and flexible throughout its course as the NCDMF will continue to work with the NMFS to address protected species issues in North Carolina fisheries.

The North Carolina Division of Marine Fisheries, PO Box 769, Morehead City, NC 28557, (Phone 252-726-7021) makes application for an Individual Incidental Take Permit under Section 10 of the Endangered Species Act authorizing implementation of management measures for protection of threatened and endangered sea turtles and other ESA listed species while allowing gill net fisheries to be prosecuted in the estuarine waters of North Carolina. This request is being made to cover activities described herein from September 1, 2011 through December 31, 2013.

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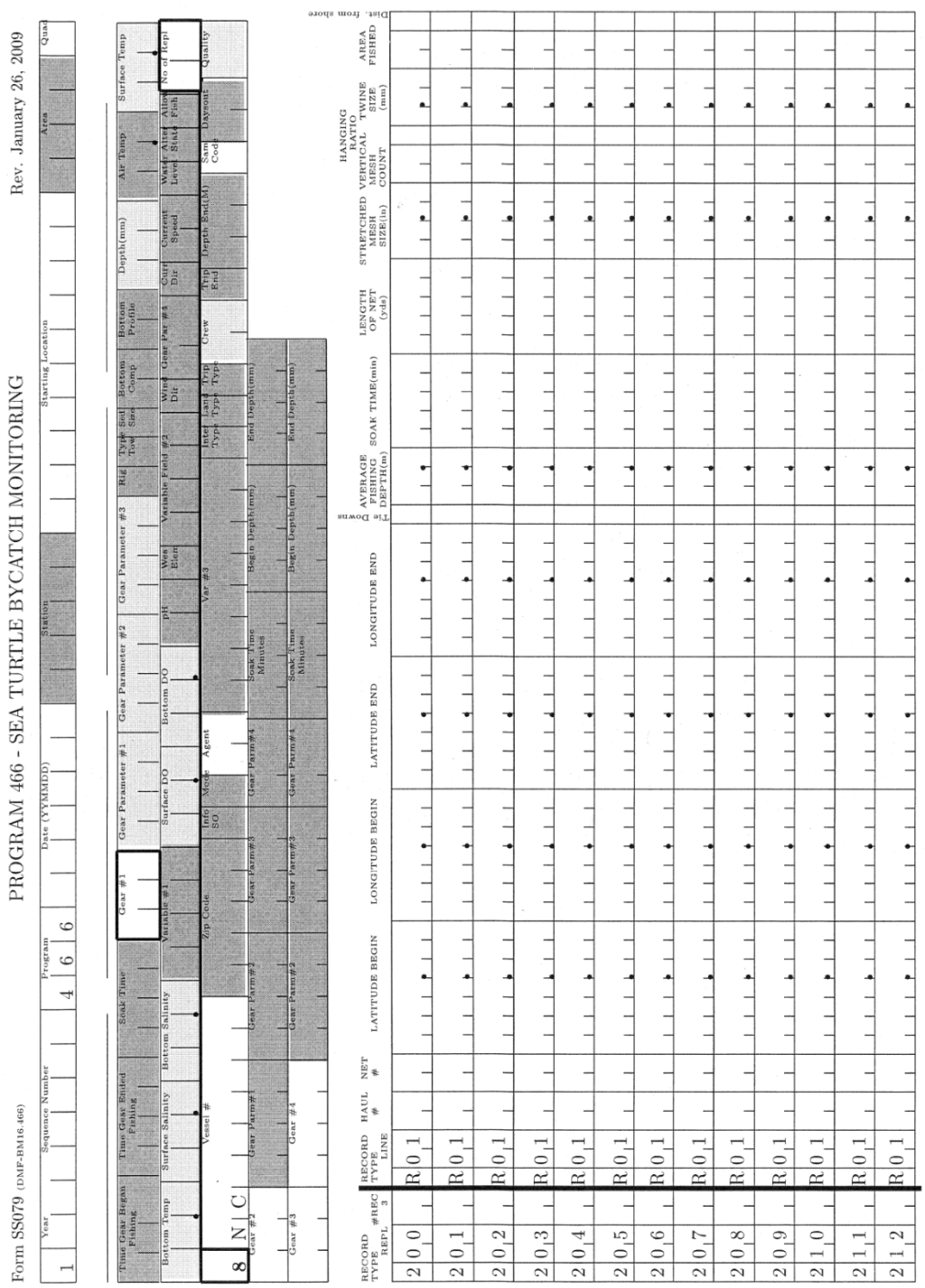
APPENDIX 1, DATA LOGS

Program 466 Data Logs: Onboard Observer



Form SS080 (DMF-BM16.466)

PROGRAM 466 - SEA TURTLE BYCATCH MONITORING

Rev. February 2, 2009

RECORD TYPE REPL	#REC 3	RECORD TYPE LINE	HAUL #	NET #	LATITUDE BEGIN	LONGITUDE BEGIN	LATITUDE END	LONGITUDE END	TIE DOWNS ↓	AVERAGE FISHING DEPTH(m)	SOAK TIME(min)	LENGTH OF NET (yds)	STRETCHED MESH SIZE(in)	HANGING RATIO VERTICAL MESH COUNT ↓	TWINE SIZE (mm)	DIST. FROM SHORE AREA FISHED ↓
213		R01														
214		R01														
215		R01														
216		R01														
217		R01														
218		R01														
219		R01														
220		R01														
221		R01														
222		R01														
223		R01														
224		R01														
225		R01														
226		R01														
227		R01														
228		R01														
229		R01														
230		R01														
231		R01														
232		R01														
233		R01														

Form SS080 (DMF-BM16.466)

PROGRAM 466 - SEA TURTLE BYCATCH MONITORING

Rev. February 2, 2009

RECORD TYPE REPL	#REC 3	RECORD TYPE LINE	HAUL #	NET #	LATITUDE BEGIN	LONGITUDE BEGIN	LATITUDE END	LONGITUDE END	TIE DOWNS ↓	AVERAGE FISHING DEPTH(m)	SOAK TIME(min)	LENGTH OF NET (yds)	STRETCHED MESH SIZE(in)	HANGING RATIO VERTICAL MESH COUNT ↓	TWINE SIZE (mm)	DIST. FROM SHORE AREA FISHED ↓
213		R01														
214		R01														
215		R01														
216		R01														
217		R01														
218		R01														
219		R01														
220		R01														
221		R01														
222		R01														
223		R01														
224		R01														
225		R01														
226		R01														
227		R01														
228		R01														
229		R01														
230		R01														
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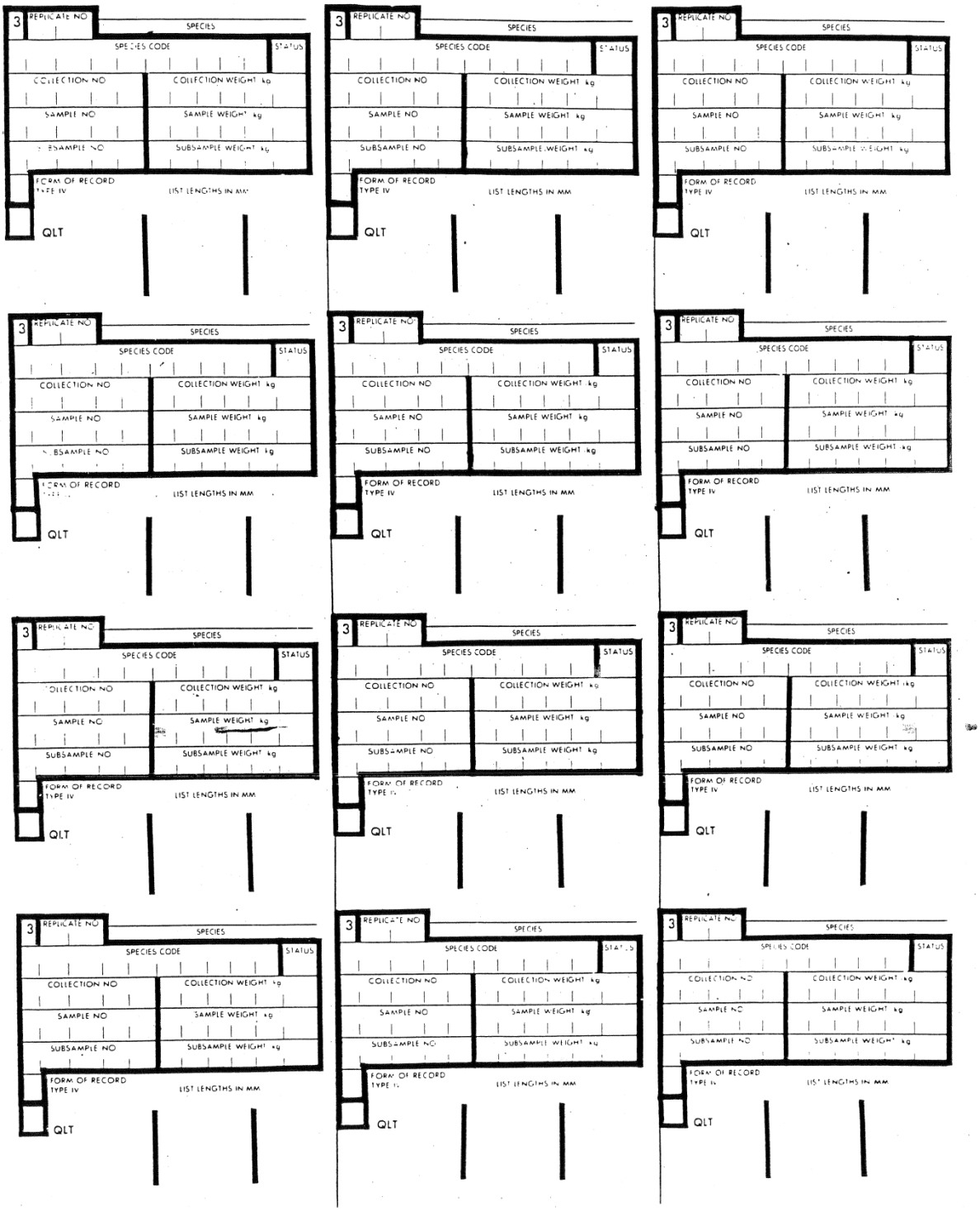
232		R01														
233		R01														

Form DMF—BM14

Rev.05/05/86

Program | Sequence No. | Location | Date



Form SS112 (DMF–BM04.PAR)

Rev. December 6, 2010

SPECIES BIOLOGICAL DATA

3 | Repl No | Species

Species Code | Status

Collection No | Collection Weight(kg)

Sample No | Sample Weight(kg)

Subsample No | Subsample Weight(kg)

Form of Record | Tag Type | Number Tagged

Quality | Tag Type | Number Tagged

Program 466

Location

Date

Sequence No.

Record Type	Line Num	Frequency	Curved Carapace Length (mm) *Length*	Weight (kg)	Sex	Maturity	Parameter A	Parameter B	Curved Carapace Width *Parameter C*	Parameter D	Inconel Tag #1 *Parameter E*	Inconel Tag #2 *Parameter F*	Alive/Dead *Egg/Larval Stage*	Tag Status	Etag
4															
4															
4															
4															
4															
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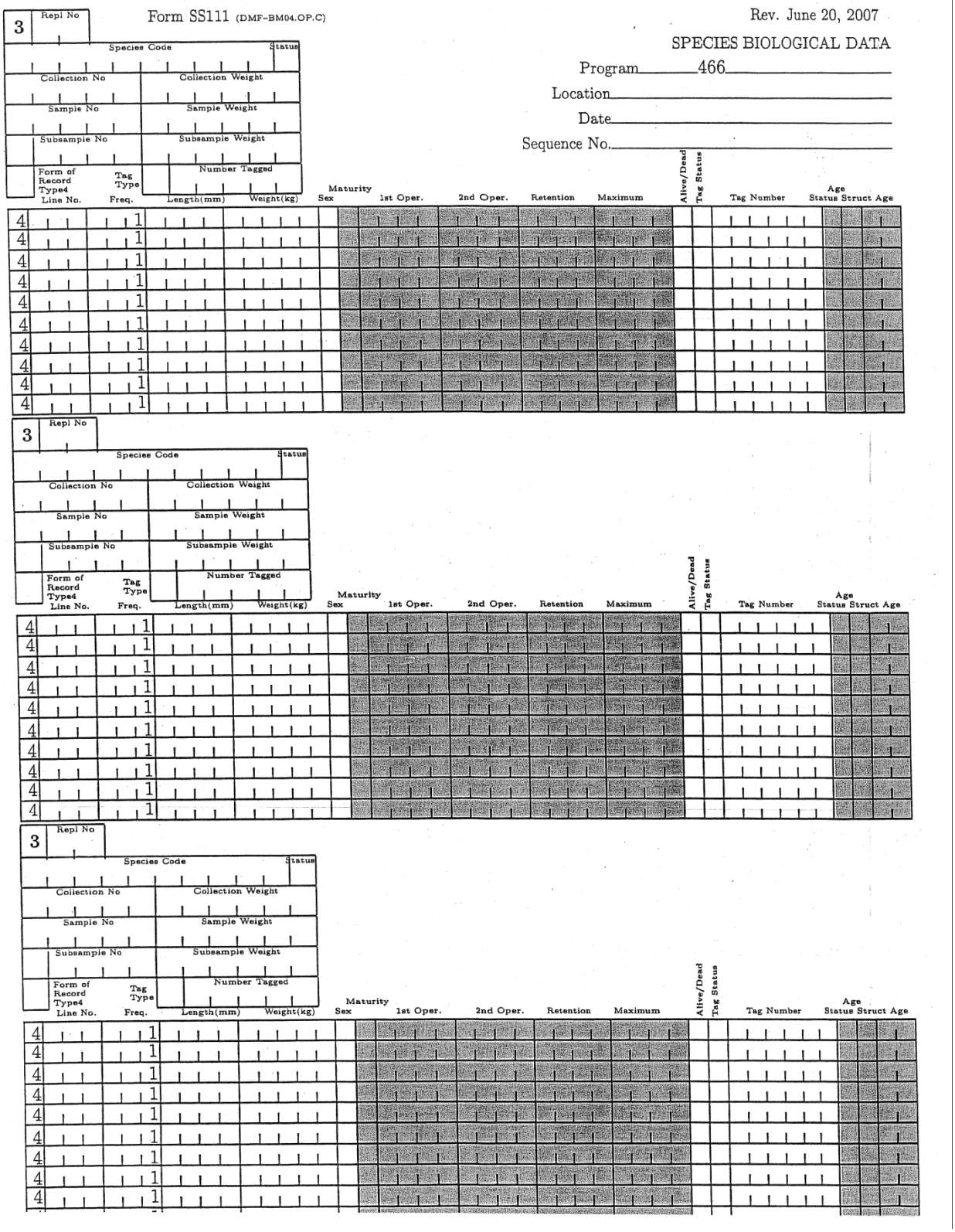
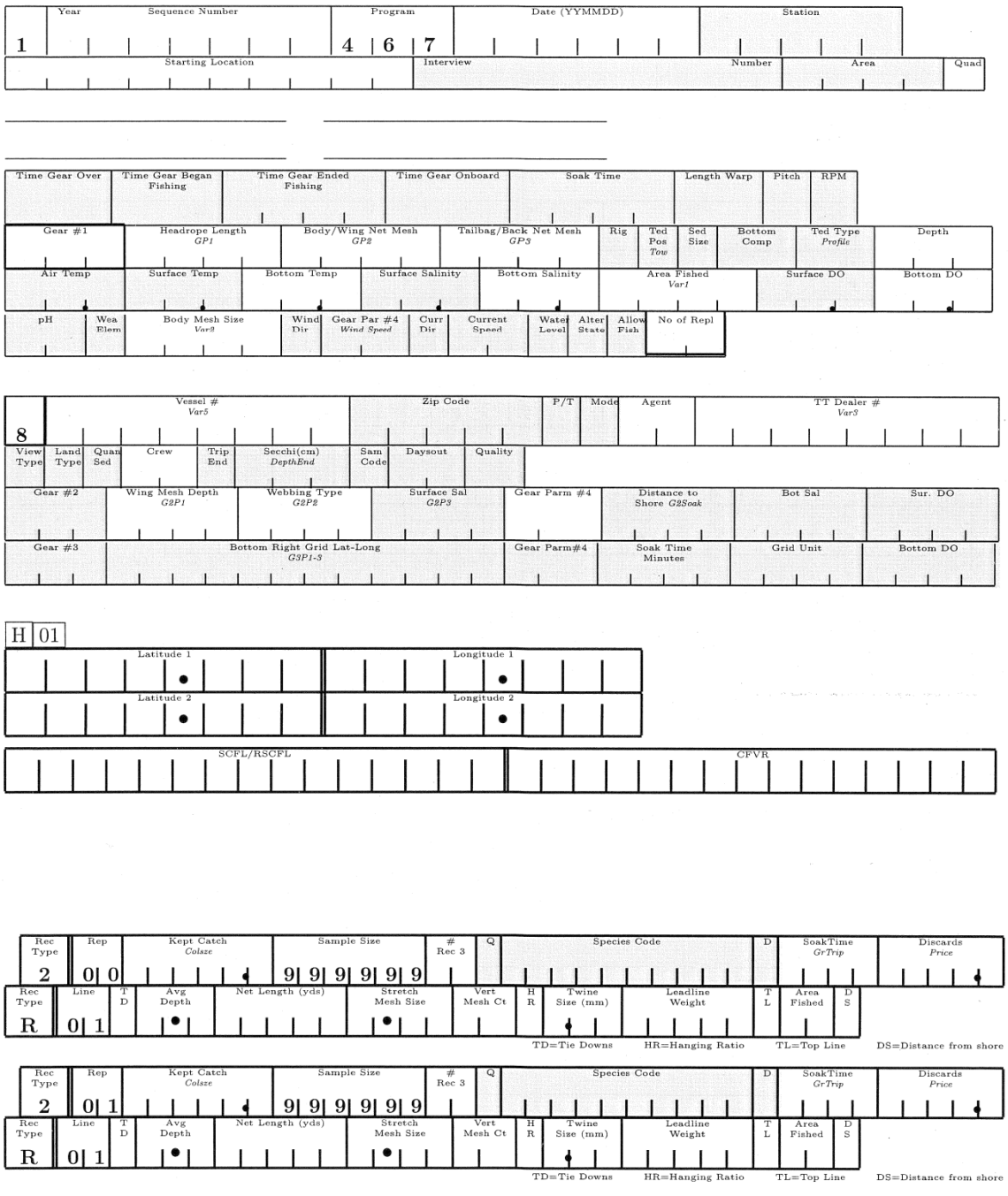


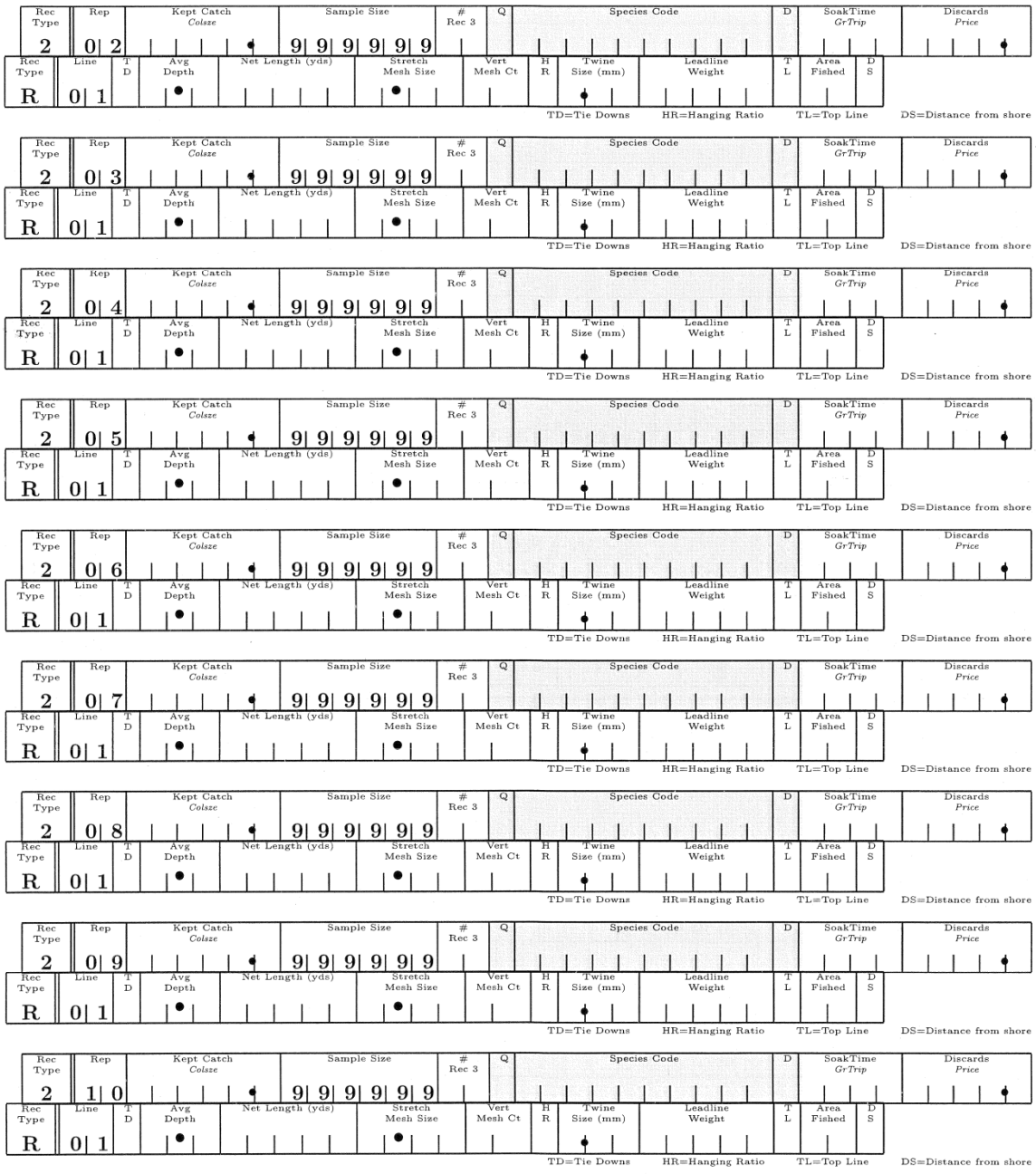
Program 467 Data Logs: Alternative Platform - Observer

Form SS160 Rev. September 7, 2010

ENVIRONMENTAL AND STATION DATA



ENVIRONMENTAL AND STATION DATA Continued



Form SS162

Rev. September 15, 2010

SPECIES BIOLOGICAL DATA

Program 467

Location

Date

Sequence No.

3	Repl No	Species	
Species Code			Status
Collection No		Collection Weight(kg)	
Sample No		Sample Weight(kg)	
Subsample No		Subsample Weight(kg)	
Form of Record	Tag Type	Number Tagged	
Quality	Tag Type	Number Tagged	

4	LineNum	Freq	Length	Weight	S	M	Bait/Hook Type *Pa*	Handling Time *Pb*	Cur Carapace Width *Pc*	Turtle Loc *Pd*	Hook Location *Pe*

Tag #2 *Pf*	A/D *EGG*	St	Tag #1	Etag Number

A/D=Alive or Dead St=Tag Status Etag= Pit Tag

H	H Id	Lattitude	Longitude

H Record ID numbers are 1-up per collection NOT replicate.

4	LineNum	Freq	Length	Weight	S	M	Bait/Hook Type *Pa*	Handling Time *Pb*	Cur Carapace Width *Pc*	Turtle Loc *Pd*	Hook Location *Pe*

Tag #2 *Pf*	A/D *EGG*	St	Tag #1	Etag Number

A/D=Alive or Dead St=Tag Status Etag= Pit Tag

H	H Id	Lattitude	Longitude

H Record ID numbers are 1-up per collection NOT replicate.

4	LineNum	Freq	Length	Weight	S	M	Bait/Hook Type *Pa*	Handling Time *Pb*	Cur Carapace Width *Pc*	Turtle Loc *Pd*	Hook Location *Pe*

Tag #2 *Pf*	A/D *EGG*	St	Tag #1	Etag Number

A/D=Alive or Dead St=Tag Status Etag= Pit Tag

H	H Id	Lattitude	Longitude

H Record ID numbers are 1-up per collection NOT replicate.

4	LineNum	Freq	Length	Weight	S	M	Bait/Hook Type *Pa*	Handling Time *Pb*	Cur Carapace Width *Pc*	Turtle Loc *Pd*	Hook Location *Pe*

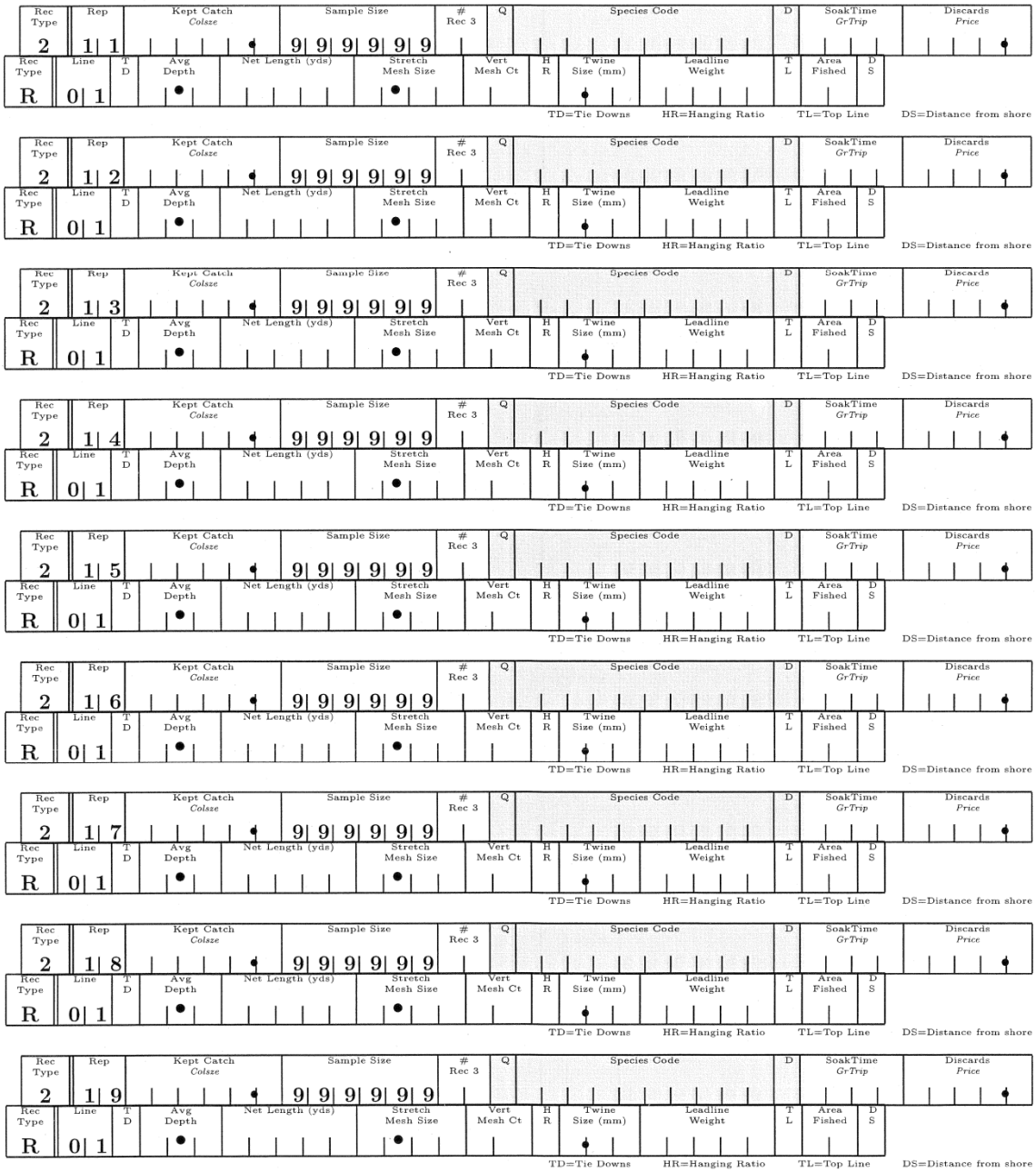
Tag #2 *Pf*	A/D *EGG*	St	Tag #1	Etag Number

A/D=Alive or Dead St=Tag Status Etag= Pit Tag

H	H Id	Lattitude	Longitude

H Record ID numbers are 1-up per collection NOT replicate.

ENVIRONMENTAL AND STATION DATA Continued



Form SS168 (Continuation of 162)

Rev. May 3, 2010

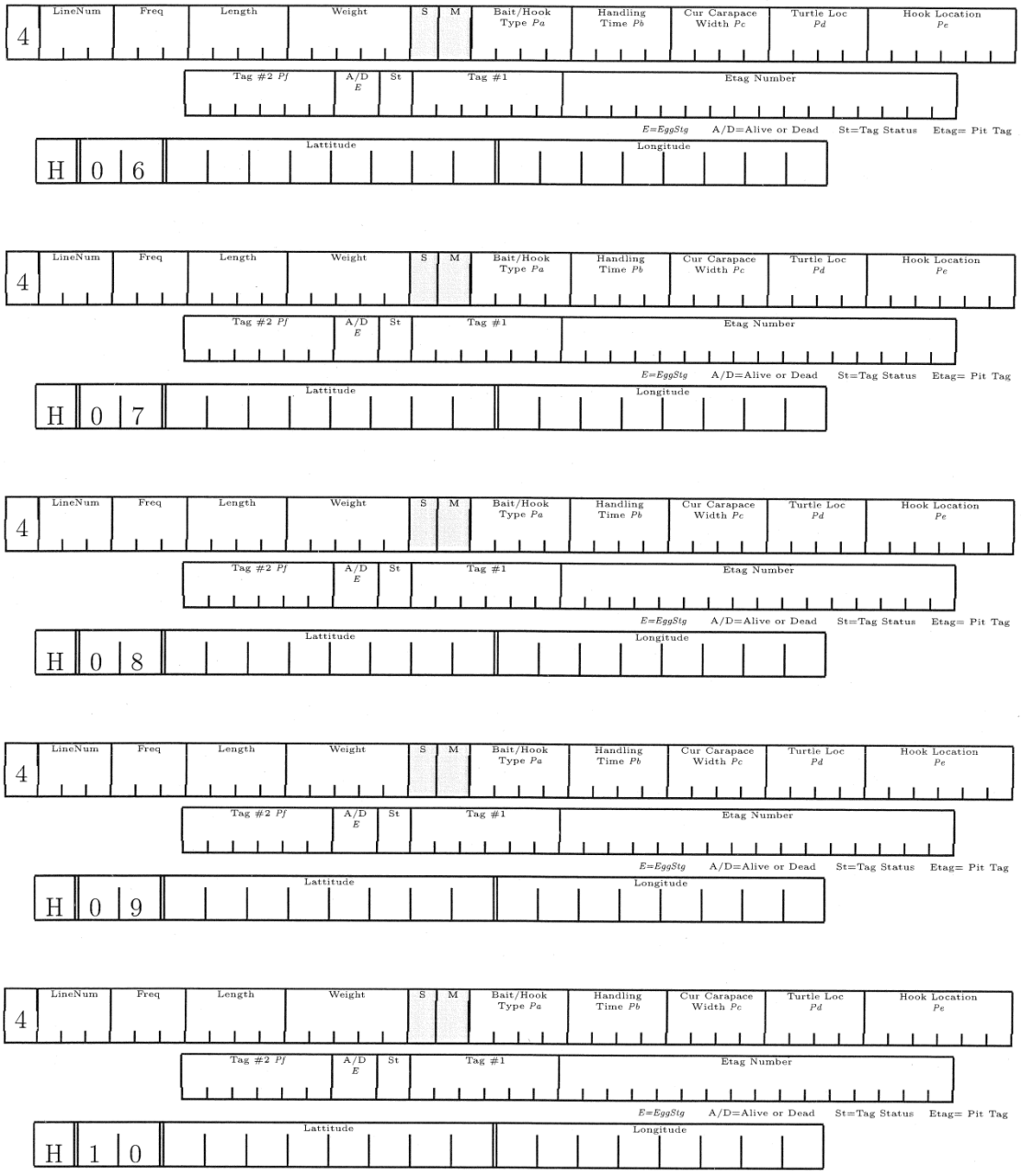
SPECIES BIOLOGICAL DATA

Program 467

Date

Location

Sequence No.



SEA TURTLE INCIDENTAL CAPTURE REPORT

OBSERVER'S NAME: _____ DATE _____ (year) - _____ (month) - _____ (day)

AFFILIATION/ADDRESS _____

_____ AREA CODE/PHONE NUMBER _____

GEAR _____ SOAK/TOW TIME _____

GEAR PARAMETERS INCLUDING MESH SIZE _____

LOCATION (include county, body of water; any nearby nautical landmarks such as channel markers, inlets, etc.) _____

_____

LATITUDE _____ LONGITUDE _____

REMARKS _____

_____

_____

TURTLE NO	SPECIES (use code)		COND (use code)	FLIPPER TAG #s (only for turtles found with tags)*	DISP (use codes)			CURVED LNGTH (mm)	CURVED WIDTH (mm)
1									

TABLE DEFINITIONS AND CODES

TURTLE No. = number assigned to each turtle captured at this intersection location in the order it was encountered by the observer (1, 2, 3...).

SPECIES:
CC = Loggerhead
CM = Green
DC = Leatherback
EL = Hawksbill
LK = Kemp's ridley
UN = Unidentified

COND (condition of turtle):
0 = Alive
1 = Fresh Dead
2 = Moderately decomposed
3 = Severely decomposed
4 = Dried carcass
5 = Skeleton, bones only

DISP (final disposition of turtle):
1 = Painted and left on a beach or dune
2 = Buried
3 = Salvaged carcass all or part
5 = Unpainted, left on a beach or dune
6 = Alive, released
7 = Alive, taken to a holding facility

Carapace measurements:

CURVED LNGTH – curved carapace length taken with metric tape measure only.
CURVED WIDTH – curved carapace width taken with metric tape measure only.

Observer Trip Information

Date______________ Port______________

Fishermens Name ______________________

Vessel # NC - ______________________

Observer Name____________________

Permit #________________________

Haul # ______

Net # ______

Soak Time *(hrs)* ____ ____ . _____

Haul (S*tart/End) -* Lat. _________________________

Long _________________________

Area *(circle)* Mainland S1 S2 S3 S4 OI HC OC CS, etc

Turtles Caught(#) ______ Kept Discard Reg. Discard

Comments:

Stretched Mesh Sizes ________

Meshes Deep ________

Twine Size ________

Total Yards ________

Tie-Downs ________

Water Depth ________

Distance from shore: ________

Haul # ______

Net # ______

Soak Time *(hrs)* ____ ____ . _____

Haul (S*tart/End) -* Lat. _________________________

Long _________________________

Area *(circle)* Mainland S1 S2 S3 S4 OI HC OC CS, etc

Turtles Caught(#) ______ Kept Discard Reg. Discard

Comments:

Stretched Mesh Sizes ________

Meshes Deep ________

Twine Size ________

Total Yards ________

Tie-Downs ________

Water Depth ________

Distance from shore: ________

Haul # ______

Net # ______

Soak Time *(hrs)* ____ ____ . _____

Haul (S*tart/End) -* Lat. _________________________

Long _________________________

Area *(circle)* Mainland S1 S2 S3 S4 OI HC OC CS, etc

Turtles Caught(#) ______ Kept Discard Reg. Discard

Comments:

Stretched Mesh Sizes ________

Meshes Deep ________

Twine Size ________

Total Yards ________

Tie-Downs ________

Water Depth ________

Distance from shore: ________

APPENDIX 2. SETTLEMENT AGREEMENT

SETTLEMENT AGREEMENT

THIS SETTLEMENT AGREEMENT (hereinafter, "Agreement") is made and entered into on the last day executed below, among the Karen Beasley Sea Turtle Rescue and Rehabilitation Center ("Plaintiff") and the North Carolina Division of Marine Fisheries; Dr. Louis Daniel III, in his official capacity as Director of the North Carolina Division of Marine Fisheries; and the North Carolina Marine Fisheries Commission ("hereinafter, collectively, "Defendants").

WITNESSETH

WHEREAS, on February 23, 2010, Plaintiff filed a complaint against the Defendants in the United States District Court for the Eastern District of North Carolina, Southern Division, file no. 7:10-CV-32-BO ("Complaint").

WHEREAS, in the Complaint, Plaintiff contends that Defendants are in violation of the Endangered Species Act ("ESA"), 16 U.S.C. §§ 1531 *et seq.* by authorizing gill nets to operate and to "take" protected sea turtles in state waters not covered by Incidental Take Permit ("ITP") No. 1528 issued to the North Carolina Division of Marine Fisheries ("DMF") by the National Marine Fisheries Service ("NMFS"), and not complying with the ITP requirements for observer coverage and enforcement.

WHEREAS, Defendants contend that the Court lacks jurisdiction over them on various grounds including sovereign immunity, lack of subject matter jurisdiction and personal jurisdiction, and further contend that they are not in violation of the ESA.

WHEREAS, the DMF is in the process of preparing an application for a statewide ITP from NMFS under Section 10 of the ESA to cover incidental takes of protected sea turtles by gill nets within the internal coastal waters of North Carolina.

WHEREAS, the Plaintiff and Defendants each acknowledge the efforts of the other to amicably resolve the controversy over the protection of sea turtles listed under the ESA while also maintaining a viable commercial gill net fishery.

NOW THEREFORE, in order to avoid further controversy and expense, without in any way waiving the Defendants' claims regarding sovereign immunity, the parties to this Agreement have agreed upon the following terms and conditions:

1. Restrictions on Large Mesh Gill Nets.

(a) For the purpose of this Agreement, large mesh gill nets are defined as 4-inch stretched mesh to 6 ½- inch stretched mesh, inclusive.

(b) Until such time that a statewide ITP is issued to DMF by NMFS, the following interim restrictions on large mesh gill nets apply within the internal coastal waters of North Carolina, as defined in 15A N.C.A.C. 3I.0101(1)(c):

> (i) Soak times shall be limited to approximately 12 hours, from sunset to sunrise, Monday through Friday. More specifically, the start and end times

for each soak period is as follows: sunset on Monday to sunrise on Tuesday; sunset on Tuesday to sunrise on Wednesday; sunset on Wednesday to sunrise on Thursday; sunset on Thursday to sunrise on Friday. Large mesh gill nets may be set no sooner than 1 hour before sunset and must be retrieved no later than 1 hour after sunrise. Any nets deployed earlier than this specified time or nets that remain deployed after the specified time will be subject to enforcement action by the N.C. Marine Patrol in accordance with state law and marine fisheries rules and regulations.

(ii) Large mesh gill nets shall be low-profile configured as follows:

(1) a net height of no more than 15 meshes.
(2) a lead core or leaded bottom line.
(3) no corks, floats or other buoys unless needed for identification requirements, except as provided in Paragraph 2(e) of this Agreement.

(iii) A maximum of 2,000 yards of large mesh gill net may be used per vessel, except as provided in Paragraph 2(e) of this Agreement.

(iv) Large mesh gill nets must be set in individual 100-yard shots with at least a 25 yard break between individual shots.

(v) Gill nets shall not choke coastal creeks in violation of 15A N.C.A.C. 3J .0101. There must be passage for sea turtles and other non-targeted species.

(vi) No gill nets over 6 1/2- inch stretched mesh will be allowed in internal coastal waters.

2. Applicability of Restrictions.

(a) Upon execution of this Agreement, the Restrictions as listed in the above Paragraph 1 and below Paragraphs 2(e) and 2(i) ("restrictions") will be implemented by proclamation to go into effect beginning May 15, 2010, effective year-round as interim measures until the DMF is issued a statewide ITP from NMFS pursuant to section 10 of the ESA, except that DMF may implement more restrictive measures if required by NMFS.

(b) The Pamlico Sound Gillnet Restricted Area (PSGNRA) covered by ITP No. 1528 is not subject to this Agreement, while the permit is in effect. ITP No. 1528 will remain in effect from September 1, 2010 to December 31, 2010, after which time the PSGNRA will be subject to this Agreement.

(c) The Currituck Sound, for the purpose of this Agreement, is defined as the area north of the Currituck Sound Bridge, which is located between the following coordinates: 36° 04.828'N, 75° 47.405'W (western end) and 36° 05.577'N, 75° 44.585'W (eastern end). The Currituck Sound is not subject to the provisions of this Agreement.

(d) The Albemarle Sound, for the purpose of this Agreement, is defined as the area west of a line running from coordinates 36° 09.928' N, 75° 54.695' W (northern end) and 35° 57.559' N, 75° 56.820' W (southern end). The Albemarle Sound is not subject to the provisions in this Agreement except for the observer coverage provisions as specified in Paragraph 3(d) of this Agreement.

(e) For the area south of the NC Highway 58 bridge, which is located between coordinates 77° 4.02738 W, 34° 40.78489 N (northern end) and 77° 3.7438 W, 34° 39.86202 N (southern end), floats are allowed to be used on nets and a maximum of 1000 yards of gill net may be used per vessel. All other restrictions specified in this Agreement shall apply to this area.

(f) The restrictions set forth in this Agreement shall apply only to set large mesh gill nets. They shall not apply to strike nets, runaround nets, drop nets or any other gear that is immediately retrieved.

(g) In recognition that low profile nets have not been tested at scale, adaptive management and monitoring measures will need to be implemented to assess their feasibility. Therefore, the restrictions in this Agreement shall not apply to scientific research or collection pursuant to N.C. Gen. Stat. § 113-200 (Fisheries Resource Grants), 15A N.C.A.C. 3O.0503(g) (Scientific or Educational Collection Permits), or conducted by the DMF or its employees or agents in efforts to assess, manage and monitor the large mesh gill net fishery in North Carolina, including but not limited to testing of low profile nets and alternative harvest methods.

(h) No provision of this Agreement shall be interpreted to supersede any existing DMF proclamation that is more restrictive.

(i) The restrictions shall apply to standard commercial fishing license ("SCFL") holders and recreational commercial gear license ("RCGL") holders.

3. Observer Program.

(a) The DMF shall provide observer coverage of large mesh gill net fishing beginning on May 15, 2010 on various platforms. Observers will consist of DMF staff, the N.C. Marine Patrol, and volunteer observers certified by DMF's observer training program. The observer coverage will not be static and may adapt according to season, sea turtle behavior and location, and other environmental and biological conditions.

(b) The DMF shall deploy resources sufficient to provide observer coverage with a target of 10% coverage and a minimum of 7% coverage per week of the total large mesh gill net fishing effort within internal coastal waters, except for areas exempted pursuant to this Agreement. For each fishing year, DMF will calculate observer coverage by using the previous year's effort data from the North Carolina trip ticket program.

(c) If the DMF is unable to provide minimum coverage due to financial, budget or staffing constraints, then the large mesh gill net fishery will be closed by proclamation until such time that the minimum coverage can be resumed.

(d) This subsection (d) applies only to Albemarle Sound as an interim measure until the DMF obtains a statewide ITP from NMFS. In the Albemarle Sound, as defined above in Paragraph 2(d), each N.C. Marine Patrol officer assigned to that area within the Northern District will be responsible for conducting one observed trip per week. Should reliable reports of sea turtle presence be submitted, additional observer coverage in such area will be required.

4. The Sea Turtle Advisory Committee (STAC).

(a) The Sea Turtle Advisory Committee shall be established as an advisory committee of the MFC.

(b) The STAC will consist of 12 members appointed by the MFC Chairman and the Karen Beasley Sea Turtle Rescue and Rehabilitation Center. The Karen Beasley Sea Turtle Rescue and Rehabilitation Center may appoint six of the twelve members of the STAC. The STAC may be dissolved by mutual agreement of the parties at any time.

(c) The duties of the STAC include but are not limited to the following: reviewing observer reports, devising means for fishermen to report turtle interactions, assisting with fishermen education, determining measures to reduce the incidental take of sea turtles, monitoring observer program issues, and reviewing all future ITP provisions and take calculations prior to formal application to NMFS.

5. ITP Development.

(a) The restrictions as listed in Paragraphs 1, 2(e) and 2(i) are minimum requirements for the 2010 statewide ITP application.

(b) The STAC will advise in the development of the new ITP applications and the overall take calculations.

(c) Effective for the 2012 license year (May 15, 2011), the dealer report required by the DMF will be expanded to include effort data recorded in terms of the number of 100-yard shots set by fishermen.

(d) The restrictions as listed in Paragraphs 1, 2(e) and 2(i) are deemed solely interim measures and will be in effect within internal coastal waters, not otherwise exempt, until NMFS issues the DMF an ITP for the affected areas. Furthermore, this Agreement shall not foreclose more lenient or more restrictive provisions in future ITP applications if warranted by biological data collected through reliable sources including but not limited to NMFS and the DMF.

6. Dismissal with Prejudice. Plaintiff shall dismiss its Complaint against Defendants with Prejudice within 10 calendar days of the execution of this Agreement by all the parties.

7. **Release of Claims.** The Plaintiff hereby releases and waives all claims and causes of action that it has against the Defendants, the State of North Carolina, and all other departments, agencies, divisions, and other components of the State of North Carolina and all past and present agents, employees, officials, and representatives of the State of North

Carolina on account of and/or in any way growing out of the actions or omissions arising from the use of gill nets in North Carolina's internal coastal waters alleged or which could have been alleged in Plaintiff's Complaint. This release and waiver of claims and causes of action continues in effect until a new Section 10 Permit under the ESA is issued by NMFS for North Carolina's internal coastal waters. Once the Section 10 Permit is issued, there will be no further need for the proclamation provided for in Paragraph 2(a) to remain in effect.

8. **Cost.** Each party shall bear its own costs, including attorney fees.

9. **No Admission of Liability.** The undersigned agree that this Agreement is a full and complete compromise settlement of disputed claims and causes of action set forth in Plaintiff's Complaint and is intended merely to terminate any and all claims or causes of action relating to the allegations therein. There is no admission of fault, wrongdoing, or liability by any party. Defendants do not waive their claim of sovereign immunity by entering into this Agreement.

10. **Full Cooperation.** The parties agree to cooperate fully, to execute any and all supplementary documents necessary to effectuate this Agreement, and to take all additional actions that may be necessary to give full force and effect to the terms of this Agreement.

11. **Enforceability.** In the event of breach of this Agreement, the parties have an action at law in any court having jurisdiction over the matter. The Agreement is not enforceable by third parties.

12. **Entire Agreement.** This Agreement contains the entire agreement between the parties and there are no understandings or agreements, verbal or otherwise, regarding this settlement except as expressly set forth herein.

13. **Reading of Agreement.** The parties hereby acknowledge that the individual executing the Agreement on his/her behalf is authorized to execute this Agreement on his/her behalf and to bind the respective entities to the terms contained herein and that he or she has read this Agreement, conferred with his or her attorney, fully understands its contents, consents to the settlement of the claims on the terms set forth herein, and does so in reliance upon his or her own judgment and advice of his or her attorney and not in reliance on any other representations or promises of Defendants or their representatives or attorneys.

IN WITNESS WHEREOF, this Agreement is executed in counterparts effective on the last date of execution indicated on the subsequent signature pages. This Agreement shall become effective upon the execution by all named parties.
[SIGNATURES APPEAR ON THE FOLLOWING PAGE]

PLAINTIFF:
BY: _____ dated 13 May, 2010
Jean Beasley, Director
Karen Beasley Sea Turtle Rescue and
Rehabilitation Center

DEFENDANTS:
BY: _____ dated 5/13/, 2010
Dr. Louis Daniel III, Director
For: North Carolina Division of Marine Fisheries

BY: _____ dated 5/13/, 2010
Dr. Louis Daniel III, Director
In his official capacity as Director of the
North Carolina Division of Marine Fisheries

BY: _____ dated May 13, 2010
W. Robert Bizzell, Chairman
For: North Carolina Marine Fisheries Commission

APPENDIX 3. LARGE MESH GILLNET PROCLAMATION, M-8-2010

M-8-2010(REVISED)

North Carolina Department of Environment and Natural Resources
Division of Marine Fisheries

Beverly Eaves Perdue
Governor

Dr. Louis B. Daniel III
Director

Dee Freema
Secretar

PROCLAMATION

RE: LARGE MESH GILL NETS: INTERNAL COASTAL WATERS

Dr. Louis B. Daniel III, Director, Division of Marine Fisheries, hereby announces that effective at **5:00 P.M., Sunday, June 13, 2010,** the following provisions shall apply to the use of large mesh gill nets:

I. SUSPENSION OF PORTION OF MARINE FISHERIES RULE 15A NCAC 03J .0103

The following portion of Marine Fisheries Rules for Coastal Waters 15A NCAC 03J .0103 **is suspended:**

Section (i) (1), which reads:

(i) For gill nets with a mesh length five inches or greater, it is unlawful:

(1) To use more than 3,000 yards of gill net per vessel in internal waters regardless of the number of individuals involved.

II. AREAS AND EXEMPTIONS

A. This proclamation applies to all internal coastal waters **except for Albemarle and Currituck sounds and their tributaries described as follows:**

1. In **Albemarle Sound**, the restrictions **do not apply** west of a line beginning at a point 35° 57.5590'N - 75° 56.8200' W; running northerly to a point 36° 09.9280'N - 75° 54.6950'W.

2. In **Currituck Sound**, the restrictions **do not apply** north of the Highway 158 Wright Memorial Bridge beginning at a point on the western shore at 36° 04.8280'N - 75° 47.4050'W; running easterly along the south side of the bridge to a point on the east shore at 36° 05.5770'N - 75° 44.5850'W.

B. Run-around or strike nets and drop nets that are used to surround a school of fish and then are immediately retrieved are exempted from the restrictions in this proclamation.

C. The Pamlico Sound Gill Net Restricted Area (PSGNRA) will operate under Incidental Take Permit (ITP) No. 1528 and is exempt from the restrictions in this proclamation during the September through December 2010 period. **Restrictions in this proclamation apply to the PSGNRA outside of that time period.**

III. GILL NET RESTRICTIONS

It is unlawful to use large mesh gill nets (defined as 4 inches to 6½ inches stretched mesh, inclusive) unless they comply with the following provisions:

A. It is unlawful to set and retrieve large mesh gill nets except during the following times:

1. No sooner than one hour before sunset on Monday and no later than one hour after sunrise on Tuesday.
2. No sooner than one hour before sunset on Tuesday and no later than one hour after sunrise on Wednesday.
3. No sooner than one hour before sunset on Wednesday and no later than one hour after sunrise on Thursday.
4. No sooner than one hour before sunset on Thursday and no later than one hour after sunrise on Friday.

3441 Arendell Street, P.O. Box 769, Morehead City, North Carolina 28557
Phone: 252-726-7021 \ FAX: 252-726-0254 \ Internet: www.ncdmf.net

B. It is unlawful to use large mesh gill nets of more than 15 meshes in height and without a lead core or leaded bottomline. It is unlawful to use cork, floats, or other buoys except those required for identification **except that south of the Highway 58 bridge**, beginning at a point on the north shore at 34° 40.7848'N - 77° 04.0273'W; running southerly to a point on the south shore at 34° 39.8620'N – 77° 03.7438'W, **floats are allowed.**

C. It is unlawful to use more than 2,000 yards of large mesh gill net per vessel north of the Highway 58 bridge (coordinates above) and it is unlawful to use more than 1,000 yards of large mesh gill net per vessel south of the Highway 58 bridge.

D. It is unlawful to set more than 100 yards of large mesh gill net without leaving a space of at least 25 yards between separate lengths of net.

IV. GENERAL INFORMATION

A. This proclamation is issued under the authority of N.C.G. S. 113-134; 113-170.4; 113-170.5; 113-182; 113-221.1; 143B-289.52 and N.C. Fisheries Rules 15A NCAC 03H .0103 and 03J .0101 and .0103.

B. It is unlawful to violate the provisions of any proclamation issued by the Fisheries Director under his delegated authority pursuant to N.C. Fisheries Rule 15A NCAC 03H .0103.

C. The intent of this proclamation is to implement gill net restrictions while the Division applies for a statewide incidental take permit from NMFS under Section 10 of the Endangered Species Act.

D. The restrictions in this proclamation apply to gill nets used by Recreational Commercial Gear License holders as well as Standard and Retired Commercial Fishing Licenses holders.

E. **The small mesh gill net attendance requirements in N.C. Marine Fisheries Rule 15A NCAC 03J .0103 (h), size restrictions in 03J .0103(a)(2), the navigational passage requirements in 03J .0101, as well as all other existing gill net rules and proclamations remain in effect.**

F. This proclamation supersedes Proclamation M-8-2010, dated May 13, 2010. It alters the previous language to allow top lines to connect the 100 yard lengths of net in accordance with N.C. Marine Fisheries Rule 15A NCAC 03J .0103 (c).

BY: _____
Dr. Louis B. Daniel III, Director
DIVISION OF MARINE FISHERIES

June 11, 2010
1:00 P.M.
M-8-20109(REVISED)
/DLT/sab

420 copies of this public document were printed at a cost of 15 cents per copy

Estimation of Turtle Interaction Counts for the North Carolina Commercial Fishing Fleet

Prepared by Don Holbert, Ph.D., Professor of Biostatistics (retired), East Carolina University, Greenville, NC

hobertd@ecu.edu

This work was conducted in Spring, 2011, under the guidance of N.C. Division of Marine Fisheries, 3441 Arendell Street, Morehead City, NC 28557

Notes on Update of Turtle Estimation Project with 2010 data (Prepared by Don HOLBERT, last update 15JUN2011)

General Goal is to estimate interactions by Year-MgmtUnit – Season – Method-Mesh.

Season: 1:months 12-2=winter, 2:3-5=spring, 3:6-8=summer,4: 9-11=fall.

Original mesh: ≤ 3 ¾ = small, >3 ¾ to <5=med, ≥ 5=large, but changed to newmesh2010:

Turtle CPUE data set (<4=small, ≥4=large), Fleet Effort data set (<4=small, ≥4 mesh ≤6.5=large).

Death (Eggstg) is coded 1=alive, 2=dead.

Turtles: Green, Kemps Ridley, Loggerhead, Leatherback (rare in NC), Hawksbill (rare in NC).

Strategy is to conduct analysis in 3 stages:

Stage 1: First calculate turtle CPUE, by year-unit-season-method-mesh, from datasets in which this can be calculated (such as P466, P467, NMFS, etc).

Stage 2: Fleet effort data is then obtained from a merge of P461, P466, and the trip ticket dataset. This becomes the primary analysis database to which the CPUE estimates from stage 1 will be applied.

Stage 3: Apply turtle CPUE estimates to the fleet data, and smooth with model fit (Poisson Regression).

Stage 1 Analyses: Calculating Turtle CPUE from various datasets.

First, here is a brief summary of the nature of these files. Descriptive tables will follow after this summary.

1.1 Program P466 (Observers)

The excel file contains 28,306 records over years 2001-2010. This file was processed using the code shown in appendix 1.

1.2 Program P467 (Alternative Platform)

The excel file contains 2,305 records, all year 2010. This file was processed using the code similar to that shown in appendix 1.

1.3 PamSdRivSth_IGNS-Indep Gillnet Survey

The original file contains effort and catch for turtles, all from management units B, C, and E. From this a summary sheet was created showing for each UNIT*YEAR*SEASON*METHOD*MESH the TOTEFFORT, turtle counts (dead and alive), and cpue for turtles, with one unit of effort defined as 1000yds for 1 soakday.

1.4 Section10 Data Program135

Independent experimental gillnets set perpendicular to shoreline. Has effort and turtle data, all from management unit A. I noticed that the new file supplied by Trish had some 2009 data that I did not have for analysis done last year, as well as the 2010 data. So the summary file from which CPUE data will be computed was updated to include this.

There were no turtle interactions recorded at all in the PRG135 data, but of course it will contribute to total effort. The following table shows contribution to effort, by year.

	toteffort
year	
0	171880
1	166040
2	167040
3	178560
4	166880
5	163760
6	163240
7	165720
8	163520
9	168560
10	162280
Totals	1837480

1.5 Independent_127

The original datafile has turtle count and effort data, all Cape Fear area stuff, management unit "E", years 2002-2007. I have created a summary file showing for each YEAR*SEASON*METHOD*MESH the TOTEFFORT, counts of turtles (dead and alive), and cpue for turtles with one unit of effort defined as 1000yds for 1 soakday. NOTE: Again there were no turtle interactions, but of course there is contribution to effort. A table showing contribution to effort is shown.

	toteffort
YEAR	
2	900
3	3600
4	5400
5	5400
6	5150
7	2050
Totals	22500

1.6 NMFS Core Sound Data

Datafile contains 37 records from NMFS observers in Core Sound in 2009.

1.7 FRG Dataset

The FRG datafile has 1336 records with data from the years 2000, 2001, 2004, 2007 and 2008, all from management unit E.

1.8 Summaries when all CPUE data sources are pooled

Next follows tables summarizing turtle counts from all data available for turtle CPUE calculation (i.e. the 7 files just described). Active gear has been excluded, as has Ocean data.

Note: There were 21 turtle interactions for which species was not recorded. These are included in total turtle count.

	totgreen	tothawks	totkemps	totlogg	totturts
program					
915igns	12	0	15	2	29
frg	36	0	4	3	64
nmfs	12	0	5	5	22
prg127	0	0	0	0	0
prg135	0	0	0	0	0
prog466	130	2	13	13	158
prog467	25	0	20	2	47
Totals	215	2	57	25	320

	totgreen	tothawks	totkemps	totlogg	totturts
year					
1	9	1	1	0	11
2	9	0	3	6	18
3	5	0	0	0	5
4	35	0	6	3	65
5	5	0	2	2	9
6	6	0	3	1	10
7	42	0	0	2	44
8	17	0	5	1	23
9	51	1	12	7	71
10	36	0	25	3	64
Totals	215	2	57	25	320

	totgreen	tothawks	totkemps	totlogg	totturts
unit					
A	0	0	0	0	0
B	144	2	28	13	187
C	0	0	0	2	2
D1	25	0	18	6	49
D2	1	0	0	1	2
E	45	0	11	3	80
Totals	215	2	57	25	320

	totgreen	tothawks	totkemps	totlogg	totturts
season					
fall	147	2	14	13	181
spring	3	0	4	1	8
summer	65	0	38	11	130
winter	0	0	1	0	1
Totals	215	2	57	25	320

	totgreen	tothawks	totkemps	totlogg	totturts
method					
passive	215	2	57	25	320
Totals	215	2	57	25	320

	totgreen	tothawks	totkemps	totlogg	totturts
mesh					
large	214	2	57	25	319
small	1	0	0	0	1
Totals	215	2	57	25	320

1.9 CPUE Summary Turtle CPUE statistics were computed for each UNIT*YEAR*SEASON*MESH (where available) by pooling catch and effort data over all sources. Note that a "unit of effort" is 1000yds for one day. The pooled CPUE database has 306 observations. The dataset is listed in appendix 3.

Here are a few summary statistics from this database:

First, by unit. Note that in principle a given unit could have 10(years)*4(seasons)*1(method)*2(meshes)=80 different CPUE values, corresponding to the various combinations of year*season*method*mesh, but this will occur only if, in the given unit, some data is available for every combination of year*season*method*mesh.

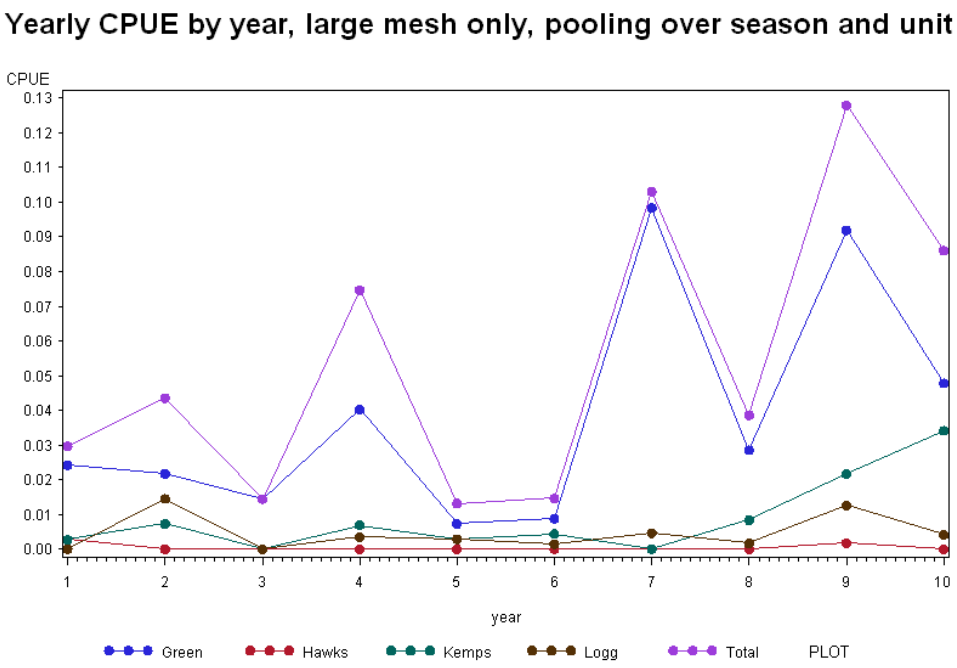
unit	N Obs	Variable	Minimum	25th Pctl	50th Pctl	Mean	75th Pctl	Maximum
A	79	greencpue	0.000	0.000	0.000	0.000	0.000	0.000
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.000	0.000	0.000
		loggcpue	0.000	0.000	0.000	0.000	0.000	0.000
		turtscpue	0.000	0.000	0.000	0.000	0.000	0.000
B	80	greencpue	0.000	0.000	0.000	0.018	0.006	0.174
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.006
		kempscpue	0.000	0.000	0.000	0.008	0.000	0.139
		loggcpue	0.000	0.000	0.000	0.001	0.000	0.023
		turtscpue	0.000	0.000	0.000	0.026	0.022	0.220
C	68	greencpue	0.000	0.000	0.000	0.000	0.000	0.000
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.000	0.000	0.000
		loggcpue	0.000	0.000	0.000	0.002	0.000	0.058
		turtscpue	0.000	0.000	0.000	0.002	0.000	0.058
D1	15	greencpue	0.000	0.000	0.000	0.142	0.342	0.642
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.040	0.000	0.418
		loggcpue	0.000	0.000	0.000	0.023	0.000	0.246
		turtscpue	0.000	0.000	0.000	0.205	0.377	1.045
D2	10	greencpue	0.000	0.000	0.000	0.011	0.000	0.108
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.000	0.000	0.000
		loggcpue	0.000	0.000	0.000	0.019	0.000	0.194
		turtscpue	0.000	0.000	0.000	0.030	0.000	0.194
E	54	greencpue	0.000	0.000	0.000	0.056	0.000	0.694
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.015	0.000	0.300
		loggcpue	0.000	0.000	0.000	0.003	0.000	0.073
		turtscpue	0.000	0.000	0.000	0.088	0.000	1.222

Next, by year . Note that in principle a given year could have 6(units)*4(seasons)*1(method)*2(meshes)=48 different CPUE values, corresponding to the various combinations of unit*season*method*mesh, but this will occur only if, in the given year, some data is available for every combination of unit*season*method*mesh.

year	N Obs	Variable	Minimum	25th Pctl	50th Pctl	Mean	75th Pctl	Maximum
1	27	greencpue	0.000	0.000	0.000	0.023	0.000	0.532
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.006
		kempscpue	0.000	0.000	0.000	0.005	0.000	0.133
		loggcpue	0.000	0.000	0.000	0.000	0.000	0.000
		turtscpue	0.000	0.000	0.000	0.028	0.000	0.665
2	22	greencpue	0.000	0.000	0.000	0.009	0.000	0.165
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.003	0.000	0.055
		loggcpue	0.000	0.000	0.000	0.004	0.000	0.075
		turtscpue	0.000	0.000	0.000	0.016	0.000	0.220
3	25	greencpue	0.000	0.000	0.000	0.015	0.000	0.342
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.000	0.000	0.000
		loggcpue	0.000	0.000	0.000	0.000	0.000	0.000
		turtscpue	0.000	0.000	0.000	0.015	0.000	0.342
4	30	greencpue	0.000	0.000	0.000	0.033	0.000	0.524
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.006	0.000	0.073
		loggcpue	0.000	0.000	0.000	0.005	0.000	0.073
		turtscpue	0.000	0.000	0.000	0.069	0.000	1.222
5	32	greencpue	0.000	0.000	0.000	0.012	0.000	0.377
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.001	0.000	0.022
		loggcpue	0.000	0.000	0.000	0.006	0.000	0.194
		turtscpue	0.000	0.000	0.000	0.019	0.000	0.377
6	30	greencpue	0.000	0.000	0.000	0.002	0.000	0.036
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.004	0.000	0.108
		loggcpue	0.000	0.000	0.000	0.000	0.000	0.004
		turtscpue	0.000	0.000	0.000	0.006	0.000	0.145
7	30	greencpue	0.000	0.000	0.000	0.051	0.000	0.694
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.000	0.000	0.000
		loggcpue	0.000	0.000	0.000	0.002	0.000	0.058
		turtscpue	0.000	0.000	0.000	0.053	0.000	0.694
8	31	greencpue	0.000	0.000	0.000	0.004	0.000	0.063
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.015	0.000	0.300
		loggcpue	0.000	0.000	0.000	0.000	0.000	0.004
		turtscpue	0.000	0.000	0.000	0.019	0.000	0.300

year	N Obs	Variable	Minimum	25th Pctl	50th Pctl	Mean	75th Pctl	Maximum
9	38	greencpue	0.000	0.000	0.000	0.023	0.000	0.615
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.004
		kempscpue	0.000	0.000	0.000	0.008	0.000	0.184
		loggcpue	0.000	0.000	0.000	0.008	0.000	0.246
		turtscpue	0.000	0.000	0.000	0.039	0.000	1.045
10	41	greencpue	0.000	0.000	0.000	0.038	0.000	0.642
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.019	0.000	0.418
		loggcpue	0.000	0.000	0.000	0.001	0.000	0.028
		turtscpue	0.000	0.000	0.000	0.058	0.000	0.642

Has turtle CPUE increased over this 10 year span? I computed a pooled CPUE for each year for the large mesh, pooling catch and effort data over seasons and units. Here is a plot of the yearly pooled CPUE values over the period:



Next, by season . Note that in principle a given season could have 6(units)*10(years)*1(method)*2(meshes)=120 different CPUE values, corresponding to the various combinations of unit*year*method*mesh, but this will occur only if, in the given season, some data is available for every combination of unit*year*method*mesh.

season	N Obs	Variable	Minimum	25th Pctl	50th Pctl	Mean	75th Pctl	Maximum
fall	82	greencpue	0.000	0.000	0.000	0.036	0.000	0.642
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.006
		kempscpue	0.000	0.000	0.000	0.002	0.000	0.097
		loggcpue	0.000	0.000	0.000	0.002	0.000	0.075
		turtscpue	0.000	0.000	0.000	0.042	0.000	0.642
spring	74	greencpue	0.000	0.000	0.000	0.002	0.000	0.084
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.003	0.000	0.099
		loggcpue	0.000	0.000	0.000	0.001	0.000	0.073
		turtscpue	0.000	0.000	0.000	0.006	0.000	0.220
summer	76	greencpue	0.000	0.000	0.000	0.047	0.000	0.694
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.020	0.000	0.418
		loggcpue	0.000	0.000	0.000	0.009	0.000	0.246
		turtscpue	0.000	0.000	0.000	0.083	0.053	1.222
winter	74	greencpue	0.000	0.000	0.000	0.000	0.000	0.000
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.002	0.000	0.139
		loggcpue	0.000	0.000	0.000	0.000	0.000	0.000
		turtscpue	0.000	0.000	0.000	0.002	0.000	0.139

Finally by mesh. Note that in principle a given mesh could have 6(units)*10(years)*4(seasons)*1(method)=240 different CPUE values, corresponding to the various combinations of unit*year*season*method, but this will occur only if, in the given mesh, some data is available for every combination of unit*year*season*method.

mesh	N Obs	Variable	Minimum	25th Pctl	50th Pctl	Mean	75th Pctl	Maximum
large	170	greencpue	0.000	0.000	0.000	0.038	0.000	0.694
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.006
		kempscpue	0.000	0.000	0.000	0.012	0.000	0.418
		loggcpue	0.000	0.000	0.000	0.005	0.000	0.246
		turtscpue	0.000	0.000	0.000	0.060	0.020	1.222
small	136	greencpue	0.000	0.000	0.000	0.001	0.000	0.174
		hawkscpue	0.000	0.000	0.000	0.000	0.000	0.000
		kempscpue	0.000	0.000	0.000	0.000	0.000	0.000
		loggcpue	0.000	0.000	0.000	0.000	0.000	0.000
		turtscpue	0.000	0.000	0.000	0.001	0.000	0.174

Stage 2 Analysis

The TTEffort file The original file had 17,545 cases. The variables were region, mesh, year, topspecies, TTname, nodc, group, trips, effstnd, ppcount, Poolyd, ppoolyd, poolmesh, and ppoolmesh, and included many (31) different target species.

The "region" field was actually a concatenation of unit-season-method, and these were broken out appropriately. In this file there are multiple records for any given UNIT*YEAR*SEASON*METHOD*MESH *TTSPECIES.

After deletion of records corresponding to the "active" fishing method (we are analyzing only PASSIVE net deployments), and deleting records for years outside of the range 2001-2010 (agreed not to use earlier data), we are left with 6,659 records. Of these, 730 (about 11%) were missing effort data. For the most part, the cases for which effort was missing tended to be cases for which TTname was croaker, bluefish, mackerel, spot, trout, or mullets. Effort can be quite well predicted (R-square ~ 93.3%) using a linear model relating effort to UNIT, YEAR, SEASON, MESH, TTNAME, and TRIPS. This was done, and where effort data was missing it was imputed using the prediction equation from this fitted model (negative predicted values were adjusted to effort1000=0.5). On the next page are some summary tables from the resulting file:

	effort1000	trips
unit		
A	194350	148816
B	143531	98590
C	50989	51595
D1	11651	6335
D2	7580	8332
E	26242	30290
Totals	434344	343958

	effort1000	trips
year		
1	52784	42201
2	47561	38260
3	44656	37083
4	41977	33631
5	39507	32180
6	42351	33137
7	43199	33650
8	44798	33966
9	43679	33188
10	33831	26662
Totals	434344	343958

	effort1000	trips
season		
fall	139708	110639
spring	113073	98290
summer	127076	83520
winter	54487	51509
Totals	434344	343958

	effort1000	trips
mesh		
large	341391	241807
small	92953	102151
Totals	434344	343958

Stage 3 Analysis:

The next step in the analysis involved using the pooled CPUE data obtained earlier (from FRG, IND127, P466, P467, PSIGNS, NMFS, and PRG135) to merge into the Fleet Effort file in order to obtain point estimates of turtle takes for each record. Estimates of turtle takes for each record were then obtained by multiplying total effort by the turtle CPUE (estimated turtle take = effort1000*CPUE1000). When no turtle CPUE was available for a particular UNIT*YEAR*SEASON*MESH combination, a pooled CPUE, pooling across years for the given UNIT*SEASON*MESH, was used.

Note: The SAS code for merging CPUE estimates with the fleet data is given in appendix 4.

Appendix 5 provides a summary of the merged database, showing for each UNIT*YEAR*SEASON*MESH the total fleet effort and total estimated turtles (Columns 1-8)

On the next page are a few summary tables from this merged database. The variable “estturtsby cpue” is the variable obtained by multiplying total effort1000 by CPUE1000.

	estturtsbycpue	effort1000	trips
year			
1	1527	52784	42201
2	1475	47561	38260
3	581	44656	37083
4	2192	41977	33631
5	567	39507	32180
6	1040	42351	33137
7	1935	43199	33650
8	1540	44798	33966
9	2258	43679	33188
10	1827	33831	26662
Totals	14943	434344	343958

	estturtsbycpue	effort1000	trips
unit			
A	0	194350	148816
B	7439	143531	98590
C	142	50989	51595
D1	3448	11651	6335
D2	358	7580	8332
E	3556	26242	30290
Totals	14943	434344	343958

	estturtsbycpue	effort1000	trips
mesh			
large	14421	341391	241807
small	522	92953	102151
Totals	14943	434344	343958

	estturtsbycpue	effort1000	trips
season			
fall	3773	139708	110639
spring	462	113073	98290
summer	10672	127076	83520
winter	35	54487	51509
Totals	14943	434344	343958

As a broad summary from these tables, this technique estimates approximately 15,000 turtle interactions over this 10 year period 2001-2010. Interactions in large mesh outnumber those in small mesh approximately 28:1. Interactions in summer outnumber those in all other seasons combined approximately 2 ½ : 1. The predominant regions where interactions occur are B, D1, and E, representing 97% of all interactions; for these 3 regions the interaction ratio is approximately 2:1:1 (for B:D1:E). Interactions have been spread fairly uniformly through the years, with 2003 and 2005 being the 2 lightest years (about 500 interactions each), and 2004 and 2009 the 2 heaviest years (about 2200 interactions each).

Modeling Turtle Interactions as a function of unit, year, season, and mesh.

Poisson regression can be used to model turtle rate (count per unit of effort) as a function of management unit, year, season and mesh. This method is designed to handle situations in which the response variable represents a count of events corresponding to some specified level of exposure. In our setting, the "event" is a turtle interaction, and the "exposure" is the amount of fishing effort that produced this number of events (i.e. this number of turtle interactions). In this model, the response is the expected (natural) logged count. The exposure variable (often called the "offset") goes into the model as log(exposure).

The fitted equation will be log(count) = b0 + b1*UNIT +b2*YEAR +b3*SEASON +b4*MESH + log(effort1000)

So log(count) - log(effort1000)= b0 + b1*UNIT +b2*YEAR +b3*SEASON +b4*MESH

So log(count/effort1000)= b0 + b1*UNIT +b2*YEAR +b3*SEASON +b4*MESH

i.e. log(rate) = b0 + b1*UNIT +b2*YEAR +b3*SEASON +b4*MESH

So, with this model, the turtle interaction rate gets modeled as a linear function of the explanatory variables. The model statement above is not technically correct because each of UNIT, SEASON, YEAR, and MESH are categorical variables whose categories are modeled as indicator variables. So "b1" in the above equations is really a vector of 5 coefficients b1=(b11, b12, b13, b14, b15) corresponding to the 5 indicator variables necessary to model the 6 levels of the variable "UNIT" (whose levels are A, B, C, D1, D2, E). Also, in a similar fashion, b2 and b3 are vectors of coefficients (but not b4; since MESH has just 2 levels, only one indicator variable is required). For any given UNIT*YEAR*SEASON*MESH, once a fitted value is obtained for "log(rate)", the actual rate is then estimated by exponentiation.

i.e. estimated rate = exp{estimated log(rate)}

The effect of this fitting is to "smooth" the data, in the sense that the fitted (i.e. "smoothed") values for cases that had unusually high counts will be pulled downward, while fitted (i.e. "smoothed") values for cases that had unusually low counts will be pulled upwards [compare this to fitting a line to a point scatter, where fitted values for data points above (below) the line are lower (higher) than the original data]. Fitted (expected) values, along with lower and upper 90% confidence limits, are given in appendix 5 (Columns 9-11). In fitting the Poisson regression model, the deviance scale was used to allow for the possibility of overdispersion.

On the following page is a table showing, for the year 2010, the estimated totals (from CPUE plugin) and corresponding fitted expected totals, along with 90% confidence limits. Results are shown for large mesh only, since there were essentially no turtle interactions in small mesh nets. The smoothing effect of the model is evident from a careful study of the CPUE plugin values (tcount values) and the corresponding fits. For example, in row 2 of the table (fall, unit B) the fit is higher than than the tcount, wheras in row 4 (fall, unit D1) the fit is lower than tcount. There are many other such examples. One important consideration is that this is a very "sparse" dataset, in the sense that, among the 478 combinations of unit*year*season*mesh, 405 (85%) of them had no turtle interactions. A consequence of this is that little weight should be given to the confidence limits for those cases with 0 turtle interactions.

year	season	unit	mesh	tottrips	toteffort	tcount	lwrCL	fit	uprCL
10	fall	A	large	2932.00	4778.64	0.00	0.0	0.0	1560.3
10	fall	B	large	3074.40	4088.24	189.96	300.1	388.1	501.8
10	fall	C	large	577.00	658.48	0.00	1.8	4.2	9.5
10	fall	D1	large	105.60	167.75	107.63	57.8	77.5	104.1
10	fall	D2	large	212.00	219.24	0.00	10.3	17.9	31.0
10	fall	E	large	487.00	549.43	106.65	103.0	137.1	182.5
10	spring	A	large	3401.00	3758.18	0.00	0.0	0.0	216.3
10	spring	B	large	988.30	1774.79	223.90	18.1	29.4	47.9
10	spring	C	large	960.00	841.86	0.00	0.4	0.9	2.3
10	spring	D1	large	55.70	130.73	0.00	6.4	10.6	17.5
10	spring	D2	large	59.00	79.60	0.00	0.6	1.1	2.3
10	spring	E	large	273.00	255.87	25.36	6.7	11.2	18.5
10	summer	A	large	1015.00	1626.54	0.00	0.0	0.0	1138.8
10	summer	B	large	1547.35	2866.80	421.41	459.5	583.4	740.7
10	summer	C	large	392.00	428.64	0.00	2.6	5.8	13.2
10	summer	D1	large	122.65	237.50	132.39	179.3	235.4	309.0
10	summer	D2	large	74.00	81.97	8.89	8.3	14.4	24.8
10	summer	E	large	287.00	332.79	88.86	135.2	178.1	234.6
10	winter	A	large	1171.00	1359.25	0.00	0.0	0.0	58.2
10	winter	B	large	169.35	175.53	0.00	0.4	1.9	9.5
10	winter	C	large	83.00	76.50	0.00	0.0	0.0	0.3
10	winter	D1	large	7.65	4.91	0.00	0.0	0.3	1.3
10	winter	E	large	63.00	29.46	0.00	0.2	0.9	4.2

The next question is how to make reasonable projections of turtle interaction counts for the coming year. Due to restrictions imposed in mid 2010, fishing effort will be lower. First I will make projections assuming no change in fishing effort, then make compensation for the reduced effort. There is no uniquely best way to make projections. The graph on page 8 indicates that the last 4 years (2007-2010) have seen 2 relatively high years and 2 relatively low years, so it seems reasonable to average the model-fitted values from these years. Doing that provides the following estimates:

unit	season	mesh	lwrCL	fit	uprCL
A	fall	large	0.0	0.0	1549.4
A	fall	small	0.0	0.0	19.8
A	spring	large	0.0	0.0	141.7
A	spring	small	0.0	0.0	6.1
A	summer	large	0.0	0.0	1560.3
A	summer	small	0.0	0.0	14.3
A	winter	large	0.0	0.0	49.6
A	winter	small	0.0	0.0	3.0
B	fall	large	197.7	256.8	333.6
B	fall	small	4.9	7.9	12.7
B	spring	large	16.3	26.5	43.1
B	spring	small	1.4	2.6	4.8
B	summer	large	532.5	672.7	850.1
B	summer	small	23.1	36.5	57.8
B	winter	large	0.3	1.5	7.1
B	winter	small	0.1	0.6	2.9
C	fall	large	2.1	4.8	10.8
C	fall	small	0.0	0.1	0.3
C	spring	large	0.4	0.9	2.3
C	spring	small	0.0	0.0	0.1
C	summer	large	4.0	8.9	20.1
C	summer	small	0.1	0.2	0.4
C	winter	large	0.0	0.1	0.4
C	winter	small	0.0	0.0	0.1
D1	fall	large	58.4	78.4	105.1
D1	fall	small	3.0	5.0	8.1
D1	spring	large	8.0	13.1	21.7
D1	spring	small	0.1	0.2	0.3
D1	summer	large	242.0	314.5	408.7
D1	summer	small	6.2	10.0	16.3
D1	winter	large	0.0	0.1	0.4
D1	winter	small	0.0	0.1	0.7

unit	season	mesh	lwrCL	fit	uprCL
D2	fall	large	8.9	15.4	26.6
D2	fall	small	0.2	0.3	0.6
D2	spring	large	0.6	1.2	2.5
D2	spring	small	0.0	0.0	0.0
D2	summer	large	12.9	22.1	37.9
D2	summer	small	0.1	0.2	0.4
D2	winter	large	0.0	0.1	0.5
D2	winter	small	0.0	0.0	0.0
E	fall	large	102.7	136.4	181.0
E	fall	small	3.7	6.0	9.8
E	spring	large	7.2	11.9	19.6
E	spring	small	0.3	0.6	1.1
E	summer	large	192.3	249.8	324.6
E	summer	small	2.1	3.5	5.6
E	winter	large	0.2	0.8	3.9
E	winter	small	0.1	0.4	1.9

Summing over season and mesh gives the following projected totals for the year for each management unit (Cols 1,2 in following table):

Col1:unit	Col2:unittotal	Col3:30%Col 2	Col4:40%Col 2	Col5:50%Col 2	Col6:60%Col 2
A	0.1	0.0	0.0	0.1	0.1
B	1005.1	301.5	402.0	502.6	603.1
C	15.0	4.5	6.0	7.5	9.0
D1	421.4	126.4	168.6	210.7	252.8
D2	39.3	11.8	15.7	19.7	23.6
E	409.3	122.8	163.7	204.7	245.6
TOTAL	1890.2	567.1	756.1	945.1	1134.2

Compensation for reduced effort: The proclamation made in May 2010 restricts fishing (but not in all units) to 12 hours, 4 days per week. As a simple proportion of the total time in a week, this is (12*4)/(24*7) ~ 30%. The table above shows, in cols 3-6, projected totals based on 30%, 40%, 50%, and 60% of the projections based on no restriction.

Projection Breakout by Species and Status:

The summary on page 3 shows that the 299 turtle interactions (known species) recorded in the files available for the turtle CPUE estimation have species break down as follows: Green-215, Hawksbill-2, Kemps Ridley-57, Loggerhead-25, equivalent to Green-71.91%, Hawksbill-0.67%, Kemps Ridley-19.06%, Loggerhead-8.36%. Further, among all recorded interactions, the ratio of turtles alive to turtles dead was essentially 2:1. Applying these percentages to the totals in red above provides the following projected species/status breakdown:

Col1:Species	Col2:Est. total	Col3:30%Col2	Col4:40%Col2	Col5:50%Col2	Col6:60%Col2
	1890.2	567.1	756.1	945.1	1134.2
Green	1359 911 Alive,448 Dead	408 272 Alive,136 Dead	544 363 Alive,181 Dead	680 453 Alive,227 Dead	816 544 Alive,272 Dead
Hawksbill	13 10 Alive,3 Dead	4 3 Alive,1 Dead	5 3 Alive,2 Dead	6 4 Alive, 2 Dead	8 5 Alive, 3 Dead
Kemps R.	360 240 Alive,120 Dead	108 72 Alive,36 Dead	144 96 Alive,48 Dead	180 120 Alive, 60 Dead	216 144 Alive,72 Dead
Loggerhead	158 105 Alive,53 Dead	47 31 Alive,16 Dead	63 42 Alive,21 Dead	79 53 Alive,26 Dead	95 63 Alive,32 Dead

11JUL2011. Final Analyses Following Responses from Team From Trish Fri 08JUL2011: Hi Dr Holbert. Based on input from the group, please run the final estimates using 2007-2010 data at 90% confidence level, using the model fitted with four scenarios: 1) no reductions, 2) 20% reduction, 3) 30% reduction and 4) 50% reduction applied to the large mesh data. Provide these estimates using the proportions of percent species composition and status (dead/alive) for each area, and season. Do the same with the small mesh data but with no reductions to those estimates.

I. Expected Count Projections, with 90% confidence limits, each unit*season, with 0%, 20%, 30%, 50% effort reduction, LARGE mesh. The following table shows, for each season in each unit, the modeled values for expected counts (="fit") along with 90% confidence limits (="lwrCL" and "uprCL"), with 0%, 20%, 30%, and 50% effort reduction, for LARGE mesh:

		No effort reduction			20% effort reduction			30% effort reduction			50% effort reduction		
un	season	lwrC	fit	uprC	lwrCL	fit	uprC	lwrC	fit	uprC	lwrC	fit	uprC
A	fall	0.0	0.0	1549.	0.0	0.0	1549.4	0.0	0.0	1549.	0.0	0.0	1549.
A	spring	0.0	0.0	141.7	0.0	0.0	141.7	0.0	0.0	141.7	0.0	0.0	141.7
A	summe	0.0	0.0	1560.	0.0	0.0	1560.3	0.0	0.0	1560.	0.0	0.0	1560.
A	winter	0.0	0.0	49.6	0.0	0.0	49.6	0.0	0.0	49.6	0.0	0.0	49.6
B	fall	197.7	256.8	333.6	146.4	205.5	292.5	120.7	179.8	279.7	69.3	128.4	269.4
B	spring	16.3	26.5	43.1	11.0	21.2	38.9	8.3	18.5	37.6	3.0	13.2	36.5
B	summe	532.5	672.7	850.1	397.9	538.2	742.5	330.6	470.9	708.8	196.1	336.4	681.9
B	winter	0.3	1.5	7.1	0.0	1.2	6.9	0.0	1.0	6.8	0.0	0.7	6.7
C	fall	2.1	4.8	10.8	1.1	3.8	10.1	0.7	3.3	9.8	0.0	2.4	9.6
C	spring	0.4	0.9	2.3	0.2	0.7	2.1	0.1	0.6	2.1	0.0	0.5	2.0
C	summe	4.0	8.9	20.1	2.2	7.1	18.6	1.3	6.2	18.2	0.0	4.5	17.8
C	winter	0.0	0.1	0.4	0.0	0.1	0.4	0.0	0.0	0.4	0.0	0.0	0.4
D1	fall	58.4	78.4	105.1	42.8	62.7	92.6	34.9	54.9	88.6	19.3	39.2	85.5
D1	spring	8.0	13.1	21.7	5.3	10.5	19.6	4.0	9.2	18.9	1.4	6.6	18.4
D1	summe	242.0	314.5	408.7	179.1	251.6	358.4	147.7	220.1	342.7	84.8	157.2	330.1
D1	winter	0.0	0.1	0.4	0.0	0.1	0.4	0.0	0.1	0.4	0.0	0.0	0.4
D2	fall	8.9	15.4	26.6	5.8	12.3	24.1	4.3	10.8	23.3	1.2	7.7	22.7
D2	spring	0.6	1.2	2.5	0.4	1.0	2.3	0.2	0.9	2.2	0.0	0.6	2.2
D2	summe	12.9	22.1	37.9	8.5	17.7	34.3	6.3	15.5	33.2	1.8	11.0	32.3
D2	winter	0.0	0.1	0.5	0.0	0.1	0.5	0.0	0.1	0.5	0.0	0.0	0.5
E	fall	102.7	136.4	181.0	75.5	109.1	159.2	61.8	95.5	152.4	34.6	68.2	146.9
E	spring	7.2	11.9	19.6	4.9	9.5	17.7	3.7	8.3	17.1	1.3	6.0	16.6
E	summe	192.3	249.8	324.6	142.3	199.8	284.7	117.3	174.9	272.2	67.4	124.9	262.2
E	winter	0.2	0.8	3.9	0.0	0.6	3.8	0.0	0.6	3.7	0.0	0.4	3.7

II. Expected Count Projections, with 90% confidence limits, each unit*season, with no effort reduction, SMALL mesh. The following table shows, for each season in each unit, the modeled values

for expected counts (="fit") along with 90% confidence limits (="lwrCL" and "uprCL"), with no effort reduction, for SMALL mesh:

unit	season	lwrCL	fit	uprCL
A	fall	0.0	0.0	19.8
A	spring	0.0	0.0	6.1
A	summer	0.0	0.0	14.3
A	winter	0.0	0.0	3.0
B	fall	4.9	7.9	12.7
B	spring	1.4	2.6	4.8
B	summer	23.1	36.5	57.8
B	winter	0.1	0.6	2.9
C	fall	0.0	0.1	0.3
C	spring	0.0	0.0	0.1
C	summer	0.1	0.2	0.4
C	winter	0.0	0.0	0.1
D1	fall	3.0	5.0	8.1
D1	spring	0.1	0.2	0.3
D1	summer	6.2	10.0	16.3
D1	winter	0.0	0.1	0.7
D2	fall	0.2	0.3	0.6
D2	spring	0.0	0.0	0.0
D2	summer	0.1	0.2	0.4
D2	winter	0.0	0.0	0.0
E	fall	3.7	6.0	9.8
E	spring	0.3	0.6	1.1
E	summer	2.1	3.5	5.6
E	winter	0.1	0.4	1.9

Comment: Given that, in all of the data that contributed to estimation of turtle CPUE, there was only 1 turtle recorded in small mesh net deployments, the estimates in 4 rows above seem inordinately high (specifically, the rows B-fall, B-summer, D1-summer, E-fall). I made some effort to tweak the model (like including certain interactions) but could not get anything more sensible. I think it's just the nature of the beast … the high turtle interaction rates in summer and in regions B, D1, and E have their impact on these estimates. So I don't think much faith should be placed in those estimates that seem out of kilter. As a matter of fact, that 1 green turtle recorded in small mesh was in a 5745 yard deployment in unit B in the summer, so the CPUE is (1/5745)*1000 = 0.1741 per 1000 yard-days. Since that happened in summer, and summer is a relatively heavily fished season, this contributes to kicking up that estimate.

Just for the sake of comparison, I fitted the model to small mesh only data, just to see what would happen. Here's how the fit comes out:

unit	season	lwrCL	fit	uprCL
A	fall	0.0	0.0	0.0
A	spring	0.0	0.0	0.0
A	summer	0.0	0.1	0.2
A	winter	0.0	0.0	0.0
B	fall	0.1	0.1	0.3
B	spring	0.1	0.1	0.3
B	summer	126.2	129.8	133.8
B	winter	0.1	0.1	0.3
C	fall	0.0	0.0	0.0
C	spring	0.0	0.0	0.0
C	summer	0.0	0.1	0.2
C	winter	0.0	0.0	0.0
D1	fall	0.0	0.0	0.0
D1	spring	0.0	0.0	0.0
D1	summer	0.0	0.1	0.3
D1	winter	0.0	0.0	0.0
D2	fall	0.0	0.0	0.0
D2	spring	0.0	0.0	0.0
D2	summer	0.0	0.1	0.2
D2	winter	0.0	0.0	0.0
E	fall	0.0	0.0	0.0
E	spring	0.0	0.0	0.0
E	summer	0.0	0.1	0.2
E	winter	0.0	0.0	0.0

So, everything seems more reasonable now except the unit/season where the 1 green turtle was caught. There's an old saying among data analysts that goes something like this: "When almost all data values are zero, anything that's not zero really stands out". This is a good illustration of that adage. I wish there was a simple answer to this problem, but I don't know one!

III. Breakdown of Expected Counts by species/status for the tables presented in I and II above.

In the data set on which CPUE calculations were based, the ratio of Alive to Dead animals was 2:1, and the proportion of Green, Hawksbill, Kemps, Loggerhead was 72%, 0.67%, 19%, 8.33% respectively. The table below shows the breakdown of expected counts into the 8 cells corresponding to species*status for the LARGE mesh expected counts with 0% EFFORT REDUCTION:

unit	season	fit	green_alive	green_dead	hawks_alive	hawks_dead	kemps_alive	kemps_dead	logg_alive	logg_dead
A	fall	0.0	0	0	0	0	0	0	0	0
A	spring	0.0	0	0	0	0	0	0	0	0
A	summer	0.0	0	0	0	0	0	0	0	0
A	winter	0.0	0	0	0	0	0	0	0	0
B	fall	256.8	124	61	1	1	33	16	14	7
B	spring	26.5	13	6	0	0	3	2	1	1
B	summer	672.7	325	160	3	1	86	42	38	18
B	winter	1.5	1	0	0	0	0	0	0	0
C	fall	4.8	2	1	0	0	1	0	0	0
C	spring	0.9	0	0	0	0	0	0	0	0
C	summer	8.9	4	2	0	0	1	1	0	0
C	winter	0.1	0	0	0	0	0	0	0	0
D1	fall	78.4	38	19	0	0	10	5	4	2
D1	spring	13.1	6	3	0	0	2	1	1	0
D1	summer	314.5	152	75	1	1	40	20	18	9
D1	winter	0.1	0	0	0	0	0	0	0	0
D2	fall	15.4	7	4	0	0	2	1	1	0
D2	spring	1.2	1	0	0	0	0	0	0	0
D2	summer	22.1	11	5	0	0	3	1	1	1
D2	winter	0.1	0	0	0	0	0	0	0	0
E	fall	136.4	66	32	1	0	17	9	8	4
E	spring	11.9	6	3	0	0	2	1	1	0
E	summer	249.8	121	59	1	1	32	16	14	7
E	winter	0.8	0	0	0	0	0	0	0	0
TOTALS		1,816	876	431	8	4	231	114	101	50

The corresponding tables for 20%, 30%, 50% effort reduction in LARGE mesh, and the SMALL mesh with no effort reduction, are on pages 22-25.

The table below shows the breakdown of expected counts into the 8 cells corresponding to species*status for the LARGE mesh expected counts with 20% EFFORT REDUCTION:

unit	season	fit	green_alive	green_dead	hawks_alive	hawks_dead	kemps_alive	kemps_dead	logg_alive	logg_dead
A	fall	0.0	0	0	0	0	0	0	0	0
A	spring	0.0	0	0	0	0	0	0	0	0
A	summer	0.0	0	0	0	0	0	0	0	0
A	winter	0.0	0	0	0	0	0	0	0	0
B	fall	205.5	99	49	1	0	26	13	11	6
B	spring	21.2	10	5	0	0	3	1	1	1
B	summer	538.2	260	128	2	1	69	34	30	15
B	winter	1.2	1	0	0	0	0	0	0	0
C	fall	3.8	2	1	0	0	0	0	0	0
C	spring	0.7	0	0	0	0	0	0	0	0
C	summer	7.1	3	2	0	0	1	0	0	0
C	winter	0.1	0	0	0	0	0	0	0	0
D1	fall	62.7	30	15	0	0	8	4	3	2
D1	spring	10.5	5	2	0	0	1	1	1	0
D1	summer	251.6	121	60	1	1	32	16	14	7
D1	winter	0.1	0	0	0	0	0	0	0	0
D2	fall	12.3	6	3	0	0	2	1	1	0
D2	spring	1.0	0	0	0	0	0	0	0	0
D2	summer	17.7	9	4	0	0	2	1	1	0
D2	winter	0.1	0	0	0	0	0	0	0	0
E	fall	109.1	53	26	0	0	14	7	6	3
E	spring	9.5	5	2	0	0	1	1	1	0
E	summer	199.8	96	47	1	0	25	13	11	5
E	winter	0.6	0	0	0	0	0	0	0	0
TOTALS		1,452.8	701	345	7	3	185	91	81	40

The table below shows the breakdown of expected counts into the 8 cells corresponding to species*status for the LARGE mesh expected counts with 30% EFFORT REDUCTION:

unit	season	fit	green_alive	green_dead	hawks_alive	hawks_dead	kemps_alive	kemps_dead	logg_alive	logg_dead
A	fall	0.0	0	0	0	0	0	0	0	0
A	spring	0.0	0	0	0	0	0	0	0	0
A	summer	0.0	0	0	0	0	0	0	0	0
A	winter	0.0	0	0	0	0	0	0	0	0
B	fall	179.8	87	43	1	0	23	11	10	5
B	spring	18.5	9	4	0	0	2	1	1	1
B	summer	470.9	227	112	2	1	60	30	26	13
B	winter	1.0	0	0	0	0	0	0	0	0
C	fall	3.3	2	1	0	0	0	0	0	0
C	spring	0.6	0	0	0	0	0	0	0	0
C	summer	6.2	3	1	0	0	1	0	0	0
C	winter	0.0	0	0	0	0	0	0	0	0
D1	fall	54.9	26	13	0	0	7	3	3	2
D1	spring	9.2	4	2	0	0	1	1	1	0
D1	summer	220.1	106	52	1	0	28	14	12	6
D1	winter	0.1	0	0	0	0	0	0	0	0
D2	fall	10.8	5	3	0	0	1	1	1	0
D2	spring	0.9	0	0	0	0	0	0	0	0
D2	summer	15.5	7	4	0	0	2	1	1	0
D2	winter	0.1	0	0	0	0	0	0	0	0
E	fall	95.5	46	23	0	0	12	6	5	3
E	spring	8.3	4	2	0	0	1	1	0	0
E	summer	174.9	84	42	1	0	22	11	10	5
E	winter	0.6	0	0	0	0	0	0	0	0
TOTALS		1,271.2	613	302	6	3	162	80	71	35

The table below shows the breakdown of expected counts into the 8 cells corresponding to species*status for the LARGE mesh expected counts with 50% EFFORT REDUCTION:

unit	season	fit	green_alive	green_dead	hawks_alive	hawks_dead	kemps_alive	kemps_dead	logg_alive	logg_dead
A	fall	0.0	0	0	0	0	0	0	0	0
A	spring	0.0	0	0	0	0	0	0	0	0
A	summer	0.0	0	0	0	0	0	0	0	0
A	winter	0.0	0	0	0	0	0	0	0	0
B	fall	128.4	62	31	1	0	16	8	7	4
B	spring	13.2	6	3	0	0	2	1	1	0
B	summer	336.4	162	80	2	1	43	21	19	9
B	winter	0.7	0	0	0	0	0	0	0	0
C	fall	2.4	1	1	0	0	0	0	0	0
C	spring	0.5	0	0	0	0	0	0	0	0
C	summer	4.5	2	1	0	0	1	0	0	0
C	winter	0.0	0	0	0	0	0	0	0	0
D1	fall	39.2	19	9	0	0	5	2	2	1
D1	spring	6.6	3	2	0	0	1	0	0	0
D1	summer	157.2	76	37	1	0	20	10	9	4
D1	winter	0.0	0	0	0	0	0	0	0	0
D2	fall	7.7	4	2	0	0	1	0	0	0
D2	spring	0.6	0	0	0	0	0	0	0	0
D2	summer	11.0	5	3	0	0	1	1	1	0
D2	winter	0.0	0	0	0	0	0	0	0	0
E	fall	68.2	33	16	0	0	9	4	4	2
E	spring	6.0	3	1	0	0	1	0	0	0
E	summer	124.9	60	30	1	0	16	8	7	3
E	winter	0.4	0	0	0	0	0	0	0	0
TOTALS		907.9	438	216	4	2	116	57	51	25

The table below shows the breakdown of expected counts into the 8 cells corresponding to species*status for the SMALL mesh expected counts (no effort reduction):

unit	season	fit	green_alive	green_dead	hawks_alive	hawks_dead	kemps_alive	kemps_dead	logg_alive	logg_dead
A	fall	0.0	0	0	0	0	0	0	0	0
A	spring	0.0	0	0	0	0	0	0	0	0
A	summer	0.0	0	0	0	0	0	0	0	0
A	winter	0.0	0	0	0	0	0	0	0	0
B	fall	7.9	4	2	0	0	1	0	0	0
B	spring	2.6	1	1	0	0	0	0	0	0
B	summer	36.5	18	9	0	0	5	2	2	1
B	winter	0.6	0	0	0	0	0	0	0	0
C	fall	0.1	0	0	0	0	0	0	0	0
C	spring	0.0	0	0	0	0	0	0	0	0
C	summer	0.2	0	0	0	0	0	0	0	0
C	winter	0.0	0	0	0	0	0	0	0	0
D1	fall	5.0	2	1	0	0	1	0	0	0
D1	spring	0.2	0	0	0	0	0	0	0	0
D1	summer	10.0	5	2	0	0	1	1	1	0
D1	winter	0.1	0	0	0	0	0	0	0	0
D2	fall	0.3	0	0	0	0	0	0	0	0
D2	spring	0.0	0	0	0	0	0	0	0	0
D2	summer	0.2	0	0	0	0	0	0	0	0
D2	winter	0.0	0	0	0	0	0	0	0	0
E	fall	6.0	3	1	0	0	1	0	0	0
E	spring	0.6	0	0	0	0	0	0	0	0
E	summer	3.5	2	1	0	0	0	0	0	0
E	winter	0.4	0	0	0	0	0	0	0	0
TOTALS		74.2	36	17.6	0	0.2	9	4.7	4	2

APPENDIX 1 SAS Code for extracting turtle CPUE from the P4662010 excel file.

```
* this code processes the P4662010 dataset containing turtle catch info;
libname p466 'D:\From Office Workstation (JUN2008)\CONSULTS\CONSULTS-
Other\NCDivMarFish\NCDMF_TurtleInteractionsProjectJAN2010\TrishMurphey-
MAR2011\P4662010';
dm wmgm 'clear log' wpgm;
dm wpgm 'clear output' wpgm;
options ls=100 ps=60 pageno=1 label;

* the excel file was imported and saved as 'p466.p4662010';
/*
data test; set p4662010; if _N_<100; run;
data p466.p4662010; set p4662010; run;
proc contents; run;
*/

data p4662010; set p466.p4662010;
* assign new mesh category;
format newmesh2010 $5.;
newmesh='';
if stmesh<4 then newmesh2010='small';
if stmesh>=4 then newmesh2010='large';
* assign season codes if necessary;
/*
seas=.;
if season='winter' then seas=1;
if season='spring' then seas=2;
if season='summer' then seas=3;
if season='fall' then seas=4;   */
run;

* first, make sure each data record is an independent contribution to effort;
* i.e. each record is a distinct control*netn466*hauln466;
```

```
* multiple records with same control1*netn466*hauln466 represent the same
effort - don't doublecount;
* if necessary use proc means to eliminate the duplication;
proc means noprint mean data=p4662010; class year unit season method
newmesh2010 control1 netn466 hauln466;
var effort;
types year*unit*season*method*newmesh2010*control1*netn466*hauln466;
output out=p466effort mean=meffort;
* this output data set has one record for each independent unit of effort;
run;
data p466effort; set p466effort;
effort=meffort;
keep effort year unit season method newmesh2010 control1 netn466 hauln466;
run;
* now get the corresponding dataset with total turtle counts;
data p4662010; set p4662010;
* assign species counts;
sturgalive=0; if species='A. oxyrinchus' and egg_stg=1 then
sturgalive=colnum;
sturgdead=0; if species='A. oxyrinchus' and egg_stg=2 then sturgdead=colnum;
sturgunk=0; if species='A. oxyrinchus' and egg_stg=. then sturgunk=colnum;
loggalive=0; if species='C. caretta' and egg_stg=1 then loggalive=colnum;
loggdead=0; if species='C. caretta' and egg_stg=2 then loggdead=colnum;
loggunk=0; if species='C. caretta' and egg_stg=. then loggunk=colnum;
greenalive=0; if species='C. mydas' and egg_stg=1 then greenalive=colnum;
greendead=0; if species='C. mydas' and egg_stg=2 then greendead=colnum;
greenunk=0; if species='C. mydas' and egg_stg=. then greenunk=colnum;
hawksalive=0; if species='E. imbricata' and egg_stg=1 then hawksalive=colnum;
hawksdead=0; if species='E. imbricata' and egg_stg=2 then hawksdead=colnum;
hawksunk=0; if species='E. imbricata' and egg_stg=. then hawksunk=colnum;
kempsalive=0; if species='L. kempi' and egg_stg=1 then kempsalive=colnum;
kempsdead=0; if species='L. kempi' and egg_stg=2 then kempsdead=colnum;
kempsunk=0; if species='L. kempi' and egg_stg=. then kempsunk=colnum;
run;
proc means noprint sum data=p4662010;
class year unit season method newmesh2010 control1 netn466 hauln466;
var greenalive    greendead   greenunk
hawksalive  hawksdead   hawksunk
kempsalive  kempsdead   kempsunk
loggalive   loggdead    loggunk
/* unkalive unkdead     unkunk      */
sturgalive  sturgdead   sturgunk;
types year*unit*season*method*newmesh2010*control1*netn466*hauln466;
output out=p466turts sum=ga gd gu ha hd hu ka kd ku la ld lu sa sd su;
run;
data p466turts; set p466turts;
* compute turtle statistics;
greenalive=ga;    greendead=gd;     greenunk=gu;
hawksalive=ha;    hawksdead=hd;     hawksunk=hu;
kempsalive=ka;    kempsdead=kd;     kempsunk=ku;
loggalive=la;     loggdead=ld;      loggunk=lu;
/* unkalive unkdead     unkunk      */
sturgalive=sa;    sturgdead=sd;     sturgunk=su;
totgreen=sum(of greenalive,greendead,greenunk);
tothawks=sum(of hawksalive,hawksdead,hawksunk);
totkemps=sum(of kempsalive,kempsdead,kempsunk);
totlogg=sum(of loggalive,loggdead,loggunk);
totturts=sum(of totgreen, tothawks, totkemps, totlogg);
keep year unit season method newmesh2010 control1 netn466 hauln466
totgreen tothawks totkemps totlogg totturts
```

```
greenalive  greendead   greenunk
hawksalive  hawksdead   hawksunk
kempsalive  kempsdead   kempsunk
loggalive   loggdead    loggunk
/* unkalive unkdead     unkunk      */
sturgalive  sturgdead   sturgunk;
run;
* next, merge the effort and turtle count datasets;

proc sort data=p466effort; by year unit season method newmesh2010 control1
netn466 hauln466; run;
proc sort data=p466turts; by year unit season method newmesh2010 control1
netn466 hauln466; run;

data p4662010rc; merge p466effort p466turts;
by year unit season method newmesh2010 control1 netn466 hauln466;
run;
proc contents data=p4662010rc; run;
* the dataset p4662010rc (reconstructed) is now the dataset from which turtle
CPUE will be calculated;

* tabulate turtle counts by each year unit season method mesh;

/* ods rtf file='list1.rtf';
title ' ';
proc means sum maxdec=0 noobs data=p4662010rc; class year unit season method
newmesh2010;
var greenalive    greendead   greenunk
hawksalive  hawksdead   hawksunk
kempsalive  kempsdead   kempsunk
loggalive   loggdead    loggunk
unkalive    unkdead     unkunk
sturgalive  sturgdead   sturgunk
totturts effort;
types year unit season method newmesh2010;
run;
ods rtf close; */

* next is a better tabulation;

ods rtf file='list2.rtf';
proc tabulate data=p4662010rc format=F4.;
class year unit season method newmesh2010;
var totgreen tothawks totkemps totlogg totturts;
table year ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum=' '*totkemps
sum=' '*totlogg sum=' '*totturts;
table unit ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum=' '*totkemps
sum=' '*totlogg sum=' '*totturts;
table season ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum='
'*totkemps sum=' '*totlogg sum=' '*totturts;
table method ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum='
'*totkemps sum=' '*totlogg sum=' '*totturts;
table newmesh2010 ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum='
'*totkemps sum=' '*totlogg sum=' '*totturts;
run;
ods rtf close;

* finally, compute turtle CPUEs;
proc means noprint sum data=p4662010rc;
class year unit season method newmesh2010;
```

```
var  totturts totgreen tothawks totkemps totlogg effort;
types year*unit*season*method*newmesh2010;
output out=p466turtscpue sum=stotturts stotgreen stothawks stotkemps stotlogg
seffort;
run;
data p466turtscpue; set p466turtscpue;
program='prog466';
totturts=stotturts; totgreen=stotgreen; tothawks=stothawks;
totkemps=stotkemps;
   totlogg=stotlogg; toteffort=seffort;
turtscpue1000=1000*stotturts/seffort;
keep program unit year season method newmesh2010
totturts totgreen tothawks totkemps totlogg toteffort turtscpue1000;
run;

proc print data=p466turtscpue; run;
```

APPENDIX 2. SAS Code for obtaining the pooled CPUE values.

```
* this code processes the various CPUE summary files to obtain pooled CPUE by
year-unit-season-method-mesh;
libname poolcpue 'D:\From Office Workstation (JUN2008)\CONSULTS\CONSULTS-
Other\NCDivMarFish\NCDMF_TurtleInteractionsProjectJAN2010\TrishMurphey-
MAR2011\AllCPUESummaries';
dm wmgm 'clear log' wpgm;
dm wpgm 'clear output' wpgm;
options ls=100 ps=60 pageno=1 label;

/*
* following is code to create working dataset;
*  first, combine summary files into a single file;
data dummy; format program $7. unit $2.; program='ddddddd'; unit='uu';
output; run;
proc print; run;
data allcpue;
set dummy poolcpue.frgcpuesummary poolcpue.nmfscpuesummary
poolcpue.p127cpuesummary
poolcpue.p135cpuesummary poolcpue.p466cpuesummary poolcpue.p467cpuesummary
poolcpue.p915cpuesummary;
run;
proc contents data=allcpue; run;
proc print data=allcpue; run;
data allcpue; set allcpue;
* make a few fixes;
if unit='uu' then delete; if unit='Er' then unit='E ';
if method='passiv' then method='passive';
if unit='Oc' then delete;
mesh=newmesh2010; drop newmesh2010;
run;

* save as permanent;
data poolcpue.cpueworking; set allcpue; run;
*/

data allcpue; set poolcpue.cpueworking;
* define subset you want to analyze;
if year ge 1 and year le 10;
if method='passive';
run;
proc contents data=allcpue; run;
```

```
proc freq; tables program/list; run;

ods rtf file='list2.rtf' bodytitle;
title ' ';
proc tabulate data=allcpue format=F4.;
class program year unit season method mesh;
var totgreen tothawks totkemps totlogg totturts;
table program ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum='
'*totkemps sum=' '*totlogg sum=' '*totturts;
table year ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum=' '*totkemps
sum=' '*totlogg sum=' '*totturts;
table unit ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum=' '*totkemps
sum=' '*totlogg sum=' '*totturts;
table season ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum='
'*totkemps sum=' '*totlogg sum=' '*totturts;
table method ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum='
'*totkemps sum=' '*totlogg sum=' '*totturts;
table mesh ALL='Totals' , sum=' '*totgreen sum=' '*tothawks sum=' '*totkemps
sum=' '*totlogg sum=' '*totturts;
run;
ods rtf close;

proc means sum data=allcpue;
* get the summary dataset, pooling across programs;
class unit year season method mesh;
var totgreen tothawks totkemps totlogg totturts toteffort;
output out=mns sum=sg sh sk sl st se;
run;
data mns; set mns; if _type_=31;
greencpue=1000*sg/se;
hawkscpue=1000*sh/se;
kempscpue=1000*sk/se;
loggcpue=1000*sl/se;
turtscpue=1000*st/se;
drop _type_ _freq_ sg sh sk sl st se;
run;

* save as permanent sas dataset;
data poolcpue.allcpuesumm; set mns; run;

ods rtf;
proc print noobs data=mns;
var unit year season method mesh greencpue hawkscpue kempscpue loggcpue
turtscpue;
run;

proc means maxdec=3 min p25 p50 mean p75 max data=mns; class mesh;
var greencpue hawkscpue kempscpue loggcpue turtscpue;
run;
ods rtf close;

proc gplot data=byyr;
axis1 minor=none label=(justify=center 'CPUE');
symbol1 v=dot I=join;
legend1 label=(position=(bottom right)) value=('Green'
'Hawks' 'Kemps' 'Logg' 'Total');
plot (greencpue hawkscpue kempscpue loggcpue turtscpue)*year
/overlay legend=legend1 vaxis=axis1;
run;
ods rtf;
```

```
proc print noobs data=byyr;
var year greencpue hawkscpue kempscpue loggcpue turtscpue;
run;
ods rtf close;

* make listing of pooled CPUE dataset;
data temp; set poolcpue.allcpuesumm; run;
ods rtf file='list1.rtf';
proc print noobs data=temp;
format greencpue hawkscpue kempscpue loggcpue turtscpue f5.4;
run;
ods rtf close;
```

APPENDIX 3 Pooled CPUE values, pooling across all 7 sources (FRG, IND127, P466, P467, PSIGNS, NMFS, and PRG135)

unit	year	season	method	mesh	greencpue	hawkscpue	kempscpue	loggcpue	turtscpue
A	1	fall	passive	large	.0000	.0000	.0000	.0000	.0000
A	1	fall	passive	small	.0000	.0000	.0000	.0000	.0000
A	1	spring	passive	large	.0000	.0000	.0000	.0000	.0000
A	1	spring	passive	small	.0000	.0000	.0000	.0000	.0000
A	1	summer	passive	large	.0000	.0000	.0000	.0000	.0000
A	1	summer	passive	small	.0000	.0000	.0000	.0000	.0000
A	1	winter	passive	large	.0000	.0000	.0000	.0000	.0000
A	1	winter	passive	small	.0000	.0000	.0000	.0000	.0000
A	2	fall	passive	large	.0000	.0000	.0000	.0000	.0000
A	2	fall	passive	small	.0000	.0000	.0000	.0000	.0000
A	2	spring	passive	large	.0000	.0000	.0000	.0000	.0000
A	2	spring	passive	small	.0000	.0000	.0000	.0000	.0000
A	2	summer	passive	large	.0000	.0000	.0000	.0000	.0000
A	2	summer	passive	small	.0000	.0000	.0000	.0000	.0000
A	2	winter	passive	large	.0000	.0000	.0000	.0000	.0000
A	2	winter	passive	small	.0000	.0000	.0000	.0000	.0000
A	3	fall	passive	large	.0000	.0000	.0000	.0000	.0000
A	3	fall	passive	small	.0000	.0000	.0000	.0000	.0000
A	3	spring	passive	large	.0000	.0000	.0000	.0000	.0000
A	3	spring	passive	small	.0000	.0000	.0000	.0000	.0000
A	3	summer	passive	large	.0000	.0000	.0000	.0000	.0000
A	3	summer	passive	small	.0000	.0000	.0000	.0000	.0000
A	3	winter	passive	large	.0000	.0000	.0000	.0000	.0000
A	3	winter	passive	small	.0000	.0000	.0000	.0000	.0000
A	4	fall	passive	large	.0000	.0000	.0000	.0000	.0000
A	4	fall	passive	small	.0000	.0000	.0000	.0000	.0000
A	4	spring	passive	large	.0000	.0000	.0000	.0000	.0000
A	4	spring	passive	small	.0000	.0000	.0000	.0000	.0000
A	4	summer	passive	large	.0000	.0000	.0000	.0000	.0000
A	4	summer	passive	small	.0000	.0000	.0000	.0000	.0000

unit	year	season	method	mesh	greencpue	hawkscpue	kempscpue	loggcpue	turtscpue
A	4	winter	passive	large	.0000	.0000	.0000	.0000	.0000
A	4	winter	passive	small	.0000	.0000	.0000	.0000	.0000
A	5	fall	passive	large	.0000	.0000	.0000	.0000	.0000
A	5	fall	passive	small	.0000	.0000	.0000	.0000	.0000
A	5	spring	passive	large	.0000	.0000	.0000	.0000	.0000
A	5	spring	passive	small	.0000	.0000	.0000	.0000	.0000
A	5	summer	passive	large	.0000	.0000	.0000	.0000	.0000
A	5	summer	passive	small	.0000	.0000	.0000	.0000	.0000
A	5	winter	passive	large	.0000	.0000	.0000	.0000	.0000
A	5	winter	passive	small	.0000	.0000	.0000	.0000	.0000
A	6	fall	passive	large	.0000	.0000	.0000	.0000	.0000
A	6	fall	passive	small	.0000	.0000	.0000	.0000	.0000
A	6	spring	passive	large	.0000	.0000	.0000	.0000	.0000
A	6	spring	passive	small	.0000	.0000	.0000	.0000	.0000
A	6	summer	passive	large	.0000	.0000	.0000	.0000	.0000
A	6	summer	passive	small	.0000	.0000	.0000	.0000	.0000
A	6	winter	passive	large	.0000	.0000	.0000	.0000	.0000
A	6	winter	passive	small	.0000	.0000	.0000	.0000	.0000
A	7	fall	passive	large	.0000	.0000	.0000	.0000	.0000
A	7	fall	passive	small	.0000	.0000	.0000	.0000	.0000
A	7	spring	passive	large	.0000	.0000	.0000	.0000	.0000
A	7	spring	passive	small	.0000	.0000	.0000	.0000	.0000
A	7	summer	passive	large	.0000	.0000	.0000	.0000	.0000
A	7	summer	passive	small	.0000	.0000	.0000	.0000	.0000
A	7	winter	passive	large	.0000	.0000	.0000	.0000	.0000
A	7	winter	passive	small	.0000	.0000	.0000	.0000	.0000
A	8	fall	passive	large	.0000	.0000	.0000	.0000	.0000
A	8	fall	passive	small	.0000	.0000	.0000	.0000	.0000
A	8	spring	passive	large	.0000	.0000	.0000	.0000	.0000
A	8	spring	passive	small	.0000	.0000	.0000	.0000	.0000
A	8	summer	passive	large	.0000	.0000	.0000	.0000	.0000
A	8	summer	passive	small	.0000	.0000	.0000	.0000	.0000

unit	year	season	method	mesh	greencpue	hawkscpue	kempscpue	loggcpue	turtscpue
A	8	winter	passive	large	.0000	.0000	.0000	.0000	.0000
A	8	winter	passive	small	.0000	.0000	.0000	.0000	.0000
A	9	fall	passive	large	.0000	.0000	.0000	.0000	.0000
A	9	fall	passive	small	.0000	.0000	.0000	.0000	.0000
A	9	spring	passive	large	.0000	.0000	.0000	.0000	.0000
A	9	spring	passive	small	.0000	.0000	.0000	.0000	.0000
A	9	summer	passive	large	.0000	.0000	.0000	.0000	.0000
A	9	summer	passive	small	.0000	.0000	.0000	.0000	.0000
A	9	winter	passive	large	.0000	.0000	.0000	.0000	.0000
A	9	winter	passive	small	.0000	.0000	.0000	.0000	.0000
A	10	fall	passive	large	.0000	.0000	.0000	.0000	.0000
A	10	fall	passive	small	.0000	.0000	.0000	.0000	.0000
A	10	spring	passive	large	.0000	.0000	.0000	.0000	.0000
A	10	spring	passive	small	.0000	.0000	.0000	.0000	.0000
A	10	summer	passive	large	.0000	.0000	.0000	.0000	.0000
A	10	winter	passive	large	.0000	.0000	.0000	.0000	.0000
A	10	winter	passive	small	.0000	.0000	.0000	.0000	.0000
B	1	fall	passive	large	.0222	.0055	.0000	.0000	.0277
B	1	fall	passive	small	.0000	.0000	.0000	.0000	.0000
B	1	spring	passive	large	.0000	.0000	.0000	.0000	.0000
B	1	spring	passive	small	.0000	.0000	.0000	.0000	.0000
B	1	summer	passive	large	.0561	.0000	.0000	.0000	.0561
B	1	summer	passive	small	.0000	.0000	.0000	.0000	.0000
B	1	winter	passive	large	.0000	.0000	.0000	.0000	.0000
B	1	winter	passive	small	.0000	.0000	.0000	.0000	.0000
B	2	fall	passive	large	.0279	.0000	.0093	.0232	.0604
B	2	fall	passive	small	.0000	.0000	.0000	.0000	.0000
B	2	spring	passive	large	.0000	.0000	.0000	.0000	.0000
B	2	spring	passive	small	.0000	.0000	.0000	.0000	.0000
B	2	summer	passive	large	.1647	.0000	.0549	.0000	.2197
B	2	summer	passive	small	.0000	.0000	.0000	.0000	.0000
B	2	winter	passive	large	.0000	.0000	.0000	.0000	.0000

unit	year	season	method	mesh	greencpue	hawkscpue	kempscpue	loggcpue	turtscpue
B	2	winter	passive	small	.0000	.0000	.0000	.0000	.0000
B	3	fall	passive	large	.0302	.0000	.0000	.0000	.0302
B	3	fall	passive	small	.0000	.0000	.0000	.0000	.0000
B	3	spring	passive	large	.0000	.0000	.0000	.0000	.0000
B	3	spring	passive	small	.0000	.0000	.0000	.0000	.0000
B	3	summer	passive	large	.0000	.0000	.0000	.0000	.0000
B	3	summer	passive	small	.0000	.0000	.0000	.0000	.0000
B	3	winter	passive	large	.0000	.0000	.0000	.0000	.0000
B	3	winter	passive	small	.0000	.0000	.0000	.0000	.0000
B	4	fall	passive	large	.0383	.0000	.0085	.0000	.0468
B	4	fall	passive	small	.0000	.0000	.0000	.0000	.0000
B	4	spring	passive	large	.0000	.0000	.0000	.0000	.0000
B	4	spring	passive	small	.0000	.0000	.0000	.0000	.0000
B	4	summer	passive	large	.0398	.0000	.0199	.0000	.0596
B	4	summer	passive	small	.0000	.0000	.0000	.0000	.0000
B	4	winter	passive	large	.0000	.0000	.0000	.0000	.0000
B	4	winter	passive	small	.0000	.0000	.0000	.0000	.0000
B	5	fall	passive	large	.0120	.0000	.0040	.0040	.0201
B	5	fall	passive	small	.0000	.0000	.0000	.0000	.0000
B	5	spring	passive	large	.0000	.0000	.0000	.0000	.0000
B	5	spring	passive	small	.0000	.0000	.0000	.0000	.0000
B	5	summer	passive	large	.0000	.0000	.0220	.0000	.0220
B	5	summer	passive	small	.0000	.0000	.0000	.0000	.0000
B	5	winter	passive	large	.0000	.0000	.0000	.0000	.0000
B	5	winter	passive	small	.0000	.0000	.0000	.0000	.0000
B	6	fall	passive	large	.0178	.0000	.0000	.0036	.0214
B	6	fall	passive	small	.0000	.0000	.0000	.0000	.0000
B	6	spring	passive	large	.0000	.0000	.0000	.0000	.0000
B	6	spring	passive	small	.0000	.0000	.0000	.0000	.0000
B	6	summer	passive	large	.0362	.0000	.1085	.0000	.1446
B	6	summer	passive	small	.0000	.0000	.0000	.0000	.0000
B	6	winter	passive	large	.0000	.0000	.0000	.0000	.0000

unit	year	season	method	mesh	greencpue	hawkscpue	kempscpue	loggcpue	turtscpue
B	6	winter	passive	small	.0000	.0000	.0000	.0000	.0000
B	7	fall	passive	large	.1741	.0000	.0000	.0054	.1795
B	7	fall	passive	small	.0000	.0000	.0000	.0000	.0000
B	7	spring	passive	large	.0000	.0000	.0000	.0000	.0000
B	7	spring	passive	small	.0000	.0000	.0000	.0000	.0000
B	7	summer	passive	large	.0621	.0000	.0000	.0000	.0621
B	7	summer	passive	small	.0000	.0000	.0000	.0000	.0000
B	7	winter	passive	large	.0000	.0000	.0000	.0000	.0000
B	7	winter	passive	small	.0000	.0000	.0000	.0000	.0000
B	8	fall	passive	large	.0632	.0000	.0042	.0042	.0716
B	8	fall	passive	small	.0000	.0000	.0000	.0000	.0000
B	8	spring	passive	large	.0000	.0000	.0221	.0000	.0221
B	8	spring	passive	small	.0000	.0000	.0000	.0000	.0000
B	8	summer	passive	large	.0621	.0000	.0000	.0000	.0621
B	8	summer	passive	small	.0000	.0000	.0000	.0000	.0000
B	8	winter	passive	large	.0000	.0000	.1385	.0000	.1385
B	8	winter	passive	small	.0000	.0000	.0000	.0000	.0000
B	9	fall	passive	large	.1599	.0044	.0178	.0044	.1866
B	9	fall	passive	small	.0000	.0000	.0000	.0000	.0000
B	9	spring	passive	large	.0000	.0000	.0000	.0000	.0000
B	9	spring	passive	small	.0000	.0000	.0000	.0000	.0000
B	9	summer	passive	large	.0864	.0000	.0864	.0173	.1900
B	9	summer	passive	small	.0000	.0000	.0000	.0000	.0000
B	9	winter	passive	large	.0000	.0000	.0000	.0000	.0000
B	9	winter	passive	small	.0000	.0000	.0000	.0000	.0000
B	10	fall	passive	large	.0338	.0000	.0042	.0084	.0465
B	10	fall	passive	small	.0000	.0000	.0000	.0000	.0000
B	10	spring	passive	large	.0841	.0000	.0421	.0000	.1262
B	10	spring	passive	small	.0000	.0000	.0000	.0000	.0000
B	10	summer	passive	large	.0840	.0000	.0630	.0000	.1470
B	10	summer	passive	small	.1741	.0000	.0000	.0000	.1741
B	10	winter	passive	large	.0000	.0000	.0000	.0000	.0000

unit	year	season	method	mesh	greencpue	hawkscpue	kempscpue	loggcpue	turtscpue
B	10	winter	passive	small	.0000	.0000	.0000	.0000	.0000
C	1	spring	passive	large	.0000	.0000	.0000	.0000	.0000
C	1	spring	passive	small	.0000	.0000	.0000	.0000	.0000
C	1	summer	passive	large	.0000	.0000	.0000	.0000	.0000
C	1	summer	passive	small	.0000	.0000	.0000	.0000	.0000
C	1	winter	passive	large	.0000	.0000	.0000	.0000	.0000
C	1	winter	passive	small	.0000	.0000	.0000	.0000	.0000
C	2	fall	passive	large	.0000	.0000	.0000	.0000	.0000
C	2	fall	passive	small	.0000	.0000	.0000	.0000	.0000
C	3	fall	passive	large	.0000	.0000	.0000	.0000	.0000
C	3	fall	passive	small	.0000	.0000	.0000	.0000	.0000
C	3	summer	passive	large	.0000	.0000	.0000	.0000	.0000
C	3	summer	passive	small	.0000	.0000	.0000	.0000	.0000
C	4	fall	passive	large	.0000	.0000	.0000	.0000	.0000
C	4	fall	passive	small	.0000	.0000	.0000	.0000	.0000
C	4	spring	passive	large	.0000	.0000	.0000	.0000	.0000
C	4	spring	passive	small	.0000	.0000	.0000	.0000	.0000
C	4	summer	passive	large	.0000	.0000	.0000	.0000	.0000
C	4	summer	passive	small	.0000	.0000	.0000	.0000	.0000
C	4	winter	passive	large	.0000	.0000	.0000	.0000	.0000
C	4	winter	passive	small	.0000	.0000	.0000	.0000	.0000
C	5	fall	passive	large	.0000	.0000	.0000	.0000	.0000
C	5	fall	passive	small	.0000	.0000	.0000	.0000	.0000
C	5	spring	passive	large	.0000	.0000	.0000	.0000	.0000
C	5	spring	passive	small	.0000	.0000	.0000	.0000	.0000
C	5	summer	passive	large	.0000	.0000	.0000	.0000	.0000
C	5	summer	passive	small	.0000	.0000	.0000	.0000	.0000
C	5	winter	passive	large	.0000	.0000	.0000	.0000	.0000
C	5	winter	passive	small	.0000	.0000	.0000	.0000	.0000
C	6	fall	passive	large	.0000	.0000	.0000	.0000	.0000
C	6	fall	passive	small	.0000	.0000	.0000	.0000	.0000
C	6	spring	passive	large	.0000	.0000	.0000	.0000	.0000

unit	year	season	method	mesh	greencpue	hawkscpue	kempscpue	loggcpue	turtscpue
C	6	spring	passive	small	.0000	.0000	.0000	.0000	.0000
C	6	summer	passive	large	.0000	.0000	.0000	.0000	.0000
C	6	summer	passive	small	.0000	.0000	.0000	.0000	.0000
C	6	winter	passive	large	.0000	.0000	.0000	.0000	.0000
C	6	winter	passive	small	.0000	.0000	.0000	.0000	.0000
C	7	fall	passive	large	.0000	.0000	.0000	.0000	.0000
C	7	fall	passive	small	.0000	.0000	.0000	.0000	.0000
C	7	spring	passive	large	.0000	.0000	.0000	.0000	.0000
C	7	spring	passive	small	.0000	.0000	.0000	.0000	.0000
C	7	summer	passive	large	.0000	.0000	.0000	.0580	.0580
C	7	summer	passive	small	.0000	.0000	.0000	.0000	.0000
C	7	winter	passive	large	.0000	.0000	.0000	.0000	.0000
C	7	winter	passive	small	.0000	.0000	.0000	.0000	.0000
C	8	fall	passive	large	.0000	.0000	.0000	.0000	.0000
C	8	fall	passive	small	.0000	.0000	.0000	.0000	.0000
C	8	spring	passive	large	.0000	.0000	.0000	.0000	.0000
C	8	spring	passive	small	.0000	.0000	.0000	.0000	.0000
C	8	summer	passive	large	.0000	.0000	.0000	.0000	.0000
C	8	summer	passive	small	.0000	.0000	.0000	.0000	.0000
C	8	winter	passive	large	.0000	.0000	.0000	.0000	.0000
C	8	winter	passive	small	.0000	.0000	.0000	.0000	.0000
C	9	fall	passive	large	.0000	.0000	.0000	.0000	.0000
C	9	fall	passive	small	.0000	.0000	.0000	.0000	.0000
C	9	spring	passive	large	.0000	.0000	.0000	.0000	.0000
C	9	spring	passive	small	.0000	.0000	.0000	.0000	.0000
C	9	summer	passive	large	.0000	.0000	.0000	.0493	.0493
C	9	summer	passive	small	.0000	.0000	.0000	.0000	.0000
C	9	winter	passive	large	.0000	.0000	.0000	.0000	.0000
C	9	winter	passive	small	.0000	.0000	.0000	.0000	.0000
C	10	fall	passive	large	.0000	.0000	.0000	.0000	.0000
C	10	fall	passive	small	.0000	.0000	.0000	.0000	.0000
C	10	spring	passive	large	.0000	.0000	.0000	.0000	.0000

unit	year	season	method	mesh	greencpue	hawkscpue	kempscpue	loggcpue	turtscpue
C	10	spring	passive	small	.0000	.0000	.0000	.0000	.0000
C	10	summer	passive	large	.0000	.0000	.0000	.0000	.0000
C	10	summer	passive	small	.0000	.0000	.0000	.0000	.0000
C	10	winter	passive	large	.0000	.0000	.0000	.0000	.0000
C	10	winter	passive	small	.0000	.0000	.0000	.0000	.0000
D1	2	fall	passive	large	.0000	.0000	.0000	.0752	.0752
D1	3	fall	passive	large	.3419	.0000	.0000	.0000	.3419
D1	4	fall	passive	large	.0410	.0000	.0000	.0000	.0410
D1	4	winter	passive	large	.0000	.0000	.0000	.0000	.0000
D1	5	fall	passive	large	.3774	.0000	.0000	.0000	.3774
D1	7	fall	passive	large	.0000	.0000	.0000	.0000	.0000
D1	7	summer	passive	large	.0000	.0000	.0000	.0000	.0000
D1	9	fall	passive	large	.0000	.0000	.0000	.0000	.0000
D1	9	fall	passive	small	.0000	.0000	.0000	.0000	.0000
D1	9	summer	passive	large	.6146	.0000	.1844	.2459	1.045
D1	9	winter	passive	small	.0000	.0000	.0000	.0000	.0000
D1	10	fall	passive	large	.6416	.0000	.0000	.0000	.6416
D1	10	spring	passive	large	.0000	.0000	.0000	.0000	.0000
D1	10	summer	passive	large	.1115	.0000	.4181	.0279	.5574
D1	10	winter	passive	small	.0000	.0000	.0000	.0000	.0000
D2	5	spring	passive	large	.0000	.0000	.0000	.0000	.0000
D2	5	summer	passive	large	.0000	.0000	.0000	.1938	.1938
D2	9	fall	passive	large	.0000	.0000	.0000	.0000	.0000
D2	9	fall	passive	small	.0000	.0000	.0000	.0000	.0000
D2	10	fall	passive	large	.0000	.0000	.0000	.0000	.0000
D2	10	fall	passive	small	.0000	.0000	.0000	.0000	.0000
D2	10	spring	passive	large	.0000	.0000	.0000	.0000	.0000
D2	10	spring	passive	small	.0000	.0000	.0000	.0000	.0000
D2	10	summer	passive	large	.1084	.0000	.0000	.0000	.1084
D2	10	summer	passive	small	.0000	.0000	.0000	.0000	.0000
E	1	spring	passive	large	.0000	.0000	.0000	.0000	.0000
E	1	spring	passive	small	.0000	.0000	.0000	.0000	.0000

unit	year	season	method	mesh	greencpue	hawkscpue	kempscpue	loggcpue	turtscpue
E	1	summer	passive	large	.5319	.0000	.1330	.0000	.6649
E	1	winter	passive	large	.0000	.0000	.0000	.0000	.0000
E	1	winter	passive	small	.0000	.0000	.0000	.0000	.0000
E	2	fall	passive	large	.0000	.0000	.0000	.0000	.0000
E	2	summer	passive	large	.0000	.0000	.0000	.0000	.0000
E	2	winter	passive	large	.0000	.0000	.0000	.0000	.0000
E	3	fall	passive	large	.0000	.0000	.0000	.0000	.0000
E	3	spring	passive	large	.0000	.0000	.0000	.0000	.0000
E	3	summer	passive	large	.0000	.0000	.0000	.0000	.0000
E	3	winter	passive	large	.0000	.0000	.0000	.0000	.0000
E	4	fall	passive	large	.2887	.0000	.0000	.0000	.4948
E	4	spring	passive	large	.0733	.0000	.0733	.0733	.2198
E	4	summer	passive	large	.5236	.0000	.0698	.0698	1.222
E	4	winter	passive	large	.0000	.0000	.0000	.0000	.0000
E	5	fall	passive	large	.0000	.0000	.0000	.0000	.0000
E	5	spring	passive	large	.0000	.0000	.0000	.0000	.0000
E	5	summer	passive	large	.0000	.0000	.0000	.0000	.0000
E	5	winter	passive	large	.0000	.0000	.0000	.0000	.0000
E	5	winter	passive	small	.0000	.0000	.0000	.0000	.0000
E	6	fall	passive	large	.0000	.0000	.0000	.0000	.0000
E	6	spring	passive	large	.0000	.0000	.0000	.0000	.0000
E	6	spring	passive	small	.0000	.0000	.0000	.0000	.0000
E	6	summer	passive	large	.0000	.0000	.0000	.0000	.0000
E	6	winter	passive	large	.0000	.0000	.0000	.0000	.0000
E	6	winter	passive	small	.0000	.0000	.0000	.0000	.0000
E	7	fall	passive	large	.6061	.0000	.0000	.0000	.6061
E	7	spring	passive	large	.0000	.0000	.0000	.0000	.0000
E	7	summer	passive	large	.6944	.0000	.0000	.0000	.6944
E	7	winter	passive	large	.0000	.0000	.0000	.0000	.0000
E	8	fall	passive	large	.0000	.0000	.0000	.0000	.0000
E	8	fall	passive	small	.0000	.0000	.0000	.0000	.0000
E	8	spring	passive	large	.0000	.0000	.0000	.0000	.0000

unit	year	season	method	mesh	greencpue	hawkscpue	kempscpue	loggcpue	turtscpue
E	8	spring	passive	small	.0000	.0000	.0000	.0000	.0000
E	8	summer	passive	large	.0000	.0000	.2999	.0000	.2999
E	8	summer	passive	small	.0000	.0000	.0000	.0000	.0000
E	8	winter	passive	large	.0000	.0000	.0000	.0000	.0000
E	9	fall	passive	large	.0000	.0000	.0000	.0000	.0000
E	9	fall	passive	small	.0000	.0000	.0000	.0000	.0000
E	9	spring	passive	large	.0000	.0000	.0000	.0000	.0000
E	9	spring	passive	small	.0000	.0000	.0000	.0000	.0000
E	9	summer	passive	large	.0000	.0000	.0000	.0000	.0000
E	9	summer	passive	small	.0000	.0000	.0000	.0000	.0000
E	9	winter	passive	large	.0000	.0000	.0000	.0000	.0000
E	9	winter	passive	small	.0000	.0000	.0000	.0000	.0000
E	10	fall	passive	large	.0971	.0000	.0971	.0000	.1941
E	10	fall	passive	small	.0000	.0000	.0000	.0000	.0000
E	10	spring	passive	large	.0000	.0000	.0991	.0000	.0991
E	10	spring	passive	small	.0000	.0000	.0000	.0000	.0000
E	10	summer	passive	large	.2289	.0000	.0381	.0000	.2670
E	10	summer	passive	small	.0000	.0000	.0000	.0000	.0000
E	10	winter	passive	large	.0000	.0000	.0000	.0000	.0000
E	10	winter	passive	small	.0000	.0000	.0000	.0000	.0000

Appendix 4: SAS Code used to merge turtle CPUE data with fleet effort data, and conduct various analyses

```
* this code processes the TripTicket/FleetEffort file to get year-unit-
season-method-mesh effort data;
libname flteff 'D:\From Office Workstation (JUN2008)\CONSULTS\CONSULTS-
Other\NCDivMarFish\NCDMF_TurtleInteractionsProjectJAN2010\TrishMurphey-
MAR2011\FleetEffort';
libname poolcpue 'D:\From Office Workstation (JUN2008)\CONSULTS\CONSULTS-
Other\NCDivMarFish\NCDMF_TurtleInteractionsProjectJAN2010\TrishMurphey-
MAR2011\AllCPUESummaries';
dm wmgm 'clear log' wpgm;
dm wpgm 'clear output' wpgm;
options ls=100 ps=60 pageno=1 label;

/*
* code to set up permanent SAS dataset;
*  first, import excel file;
PROC IMPORT
     DATAFILE= "D:\From Office Workstation (JUN2008)\CONSULTS\CONSULTS-
Other\NCDivMarFish\NCDMF_TurtleInteractionsProjectJAN2010\TrishMurphey-
MAR2011\FleetEffort\TTEffort_6-9-2011.xlsx"
       OUT= WORK.fleeteff
     DBMS=EXCEL REPLACE;
     SHEET="TTMergeAll";
     GETNAMES=YES;
     MIXED=YES;
     USEDATE=YES;
     SCANTIME=YES;
RUN; QUIT;

data fleeteff; set fleeteff;
* keep relevant variables;
keep region mesh year topspecies TTname   nodc group trips effstnd
ppcount Poolyd    ppoolyd     poolmesh ppoolmesh;
run;

data fleetefft; set fleeteff;
* make a few fixes;
format effort1000 10.2 unit $2. year 8. season $6. method $7. ;
effort1000=effstnd;
year=mod(year, 100);
unit=substrn(region, 1, 2);
if unit='A0' then do; unit='A '; end;
if unit='B0' then do; unit='B '; end;
if unit='C0' then do; unit='C '; end;
if unit='E0' then do; unit='E '; end;
seasont=substrn(region, 3, 1);
if seasont='1' then do; season='winter';end;
if seasont='2' then do; season='spring';end;
if seasont='3' then do; season='summer';end;
if seasont='4' then do; season='fall  ';end;
methodt=substrn(region, 4, 6);
if methodt='ACTIVE' then method='active';
if methodt='PASSIV' then method='passive';
mesh=lowcase(mesh);
* if effort1000=. then delete;
if region= '1PASSIV' or region='2PASSIV' or region='4PASSIV' then delete;
drop seasont methodt effstnd;
run;
```

```
*save as permanent SAS  dataset;
data flteff.fleetall; set fleetefft; run;
*/

* the working fleet effort file is flteff.fleetall;
* NOTE the 2 cases with missing values for mesh are in the late '90s ;

/*
data fleetall; set flteff.fleetall;
* select subset of interest;
if method='passive';
if year le 10 and year ne 0;;
run;
proc contents data=fleetall; run;
proc means data=fleetall n nmiss mean min max; var effort1000; run;
proc glm data=fleetall; class unit year season mesh TTname;
model effort1000=unit year season mesh TTname trips;
output out=peff p=predeff1000;
run; quit;

data peff; set peff;
if predeff1000<0 then predeff1000=0.5;
keep unit year season mesh TTname trips predeff1000;
run;

proc sort data=fleetall; by unit year season mesh TTname trips; run;
proc sort data=peff; by unit year season mesh TTname trips; run;

data fleetall; merge fleetall peff; by unit year season mesh TTname trips;
run;
data fleetall; set fleetall; if effort1000=. then effort1000=predeff1000;
run;

proc freq data=fleetall; tables year/list; run;

/*
* make a few summary tables;
ods rtf file='list1.rtf';
proc tabulate data=fleetall format=F10.0;
class year unit season mesh;
var effort1000 trips;
table unit ALL='Totals' , sum=' '*effort1000 sum=' '*trips;
table year ALL='Totals' , sum=' '*effort1000 sum=' '*trips;
table season ALL='Totals' , sum=' '*effort1000 sum=' '*trips;
table mesh ALL='Totals' , sum=' '*effort1000 sum=' '*trips;
run;
ods rtf close;
*/
/*
* now merge the turtle CPUE values into the effort summary file;
data cpuesumm; set poolcpue.allcpuesumm;
* define subset you want to analyze;
if year ge 1 and year le 10;
if method='passive';
run;

data cpuesumm; set cpuesumm; keep unit year season mesh turtscpue; run;
proc sort data=cpuesumm; by unit year season mesh; run;
proc sort data=fleetall; by unit year season mesh; run;
```

```
data effort_cpue; merge fleetall cpuesumm; by unit year season mesh; run;
data effort_cpue; set effort_cpue;
if mesh='small' and turtscpue=. then do;
turtscpue=0; end;
run;
proc print data=effort_cpue; var unit year season mesh effort1000 trips
turtscpue; run;

* need to plug in turtle CPUE estimates for cases where they are missing;
* this occurs mostly in the D management units and earlier years;
* will compute pooled CPUE values by UNIT-SEASON-MESH to use in such cases;

* ----------------- this block imputes the few missing turtle CPUE values ---
-----------;
* computing a 'reduced' cpue file;
proc means sum data=poolcpue.cpueworking;
* get the summary dataset, for unit*season*mesh, pooling across programs
years;
class unit season method mesh;
var totgreen tothawks totkemps totlogg totturts toteffort;
output out=mns sum=sg sh sk sl st se;
run;
proc contents; run;
data poolcpuer; set mns; if _type_=15; if method='passive';
greencpuer=1000*sg/se;
hawkscpuer=1000*sh/se;
kempscpuer=1000*sk/se;
loggcpuer=1000*sl/se;
turtscpuer=1000*st/se;
drop _type_ _freq_ sg sh sk sl st se;
run;
proc print; run;

proc sort data=effort_cpue; by unit season mesh year; run;
proc sort data=poolcpuer; by unit season mesh; run;
data effort_cpue; merge effort_cpue poolcpuer; by unit season mesh; run;
data effort_cpue; set effort_cpue;
if turtscpue=. and mesh='small' then do; turtscpue=0; end;
if turtscpue=. and mesh='large' then do; turtscpue=turtscpuer; end;
run;

* computing a 'further reduced' cpue file to impute the remaining 18 turtle
CPUE values;
* will compute pooled CPUE by UNIT-MESH for these few cases;

proc means sum data=poolcpue.cpueworking;
* get the summary dataset, for unit*mesh, pooling across programs years
seasons;
class unit mesh method;
var totgreen tothawks totkemps totlogg totturts toteffort;
output out=mns sum=sg sh sk sl st se;
run;
proc contents; run;
data poolcpuer2; set mns; if _type_=7; if method='passive';
greencpuer2=1000*sg/se;
hawkscpuer2=1000*sh/se;
kempscpuer2=1000*sk/se;
loggcpuer2=1000*sl/se;
turtscpuer2=1000*st/se;
```

```
drop _type_ _freq_ sg sh sk sl st se;
run;

proc sort data=poolcpuer2; by unit mesh; run;
proc sort data=effort_cpue; by unit mesh; run;

data effort_cpue; merge effort_cpue poolcpuer2; by unit mesh; run;
data effort_cpue; set effort_cpue;
if turtscpue=. then do; turtscpue=turtscpuer2; end;
drop greencpuer hawkscpuer kempscpuer loggcpuer turtscpuer
     greencpuer2 hawkscpuer2 kempscpuer2 loggcpuer2 turtscpuer2;
run;

* save as final effort-cpue working file;
data flteff.effort_cpue_fin; set effort_cpue; run;

proc means n nmiss min max mean data=effort_cpue;
var turtscpue effort1000;
run;

* ---------------------------------- END OF BLOCK ----------------------------
-------;
*/
data effcpuefin; set flteff.effort_cpue_fin; run;
data effcpuefin; set effcpuefin;
* plug in turtle count estimates;
estturtsbycpue=effort1000*turtscpue;
run;

* make a summary of effort and turtle count totals;
proc means sum maxdec=1 data=effcpuefin;
class unit year season mesh;
var effort1000 trips estturtsbycpue;
output out=sums sum=sumeff sumtrips sumestturts;
run;
data sums; set sums; if _type_=15;
ncases=_freq_;
toteffort=sumeff; tottrips=sumtrips; totturts=sumestturts;
drop _type_ _freq_ sumeff sumtrips sumestturts;;
proc print noobs data=sums;
format toteffort tottrips totturts F10.0;
run;
* make a few summary tables;
ods rtf file='list1.rtf';
proc tabulate data=effcpuefin format=F10.0;
class year unit season mesh;
var estturtsbycpue effort1000 trips;
table unit ALL='Totals' ,sum=' '*estturtsbycpue sum=' '*effort1000 sum='
'*trips;
table year ALL='Totals' ,sum=' '*estturtsbycpue sum=' '*effort1000 sum='
'*trips;
table season ALL='Totals' ,sum=' '*estturtsbycpue sum=' '*effort1000 sum='
'*trips;
table mesh ALL='Totals' ,sum=' '*estturtsbycpue sum=' '*effort1000 sum='
'*trips;
run;
ods rtf close;

* Now for some model fitting;
* in this block, we fit to the entire fleet effort file;
```

```
data effcpuefin; set flteff.effort_cpue_fin; run;
data effcpuefin; set effcpuefin;
* eps (epsilon) is the additive fuzz to improve fitting algoritm;
eps=.01;
* plug in turtle count estimates;
estturtsbycpue=effort1000*turtscpue;
lneffort1000=log(effort1000);
tcount=estturtsbycpue+eps;
run;

proc genmod data=effcpuefin;
      class unit year season mesh;
      model tcount = unit year season mesh
                     /* unit*year unit*season unit*mesh year*season
year*mesh season*mesh  */

                                  /dist   = poisson
                        link   = log dscale
                        offset = lneffort1000;
output out=fits l=l95 p=fit u=u95;
run;
data fits; set fits;
tcount=tcount-eps; l95=l95-eps; fit=fit-eps; u95=u95-eps;
if l95<0 then l95=0;
if fit<0 then fit=0;
if u95<0 then u95=0;
diff=abs(tcount-fit); run;
proc means data=fits; var diff tcount fit; run;
ods rtf file='newlist.rtf';
proc print noobs data=fits;
format l95 fit u95 f6.1;
var unit year season mesh tcount l95 fit u95;
* var estturtsbycpue l95 fit u95;
run;
ods rtf close;

* ----------------------------------------------------------------;

* in this block, we fit to the fleet effort file summarized to totals for
unit*year*season*mesh;

data effcpuefin; set flteff.effort_cpue_fin; run;
data effcpuefin; set effcpuefin;
* plug in turtle count estimates;
estturtsbycpue=effort1000*turtscpue;
run;

proc means sum data=effcpuefin;
class unit year season mesh;
var effort1000 trips estturtsbycpue;
output out=flttot sum=sumeff sumtrips sumestturts;
run;
data flttot; set flttot; if _type_=15;
ncases=_freq_;
toteffort=sumeff; tottrips=sumtrips; totturts=sumestturts;
drop _type_ _freq_ sumeff sumtrips sumestturts;
run;
proc print data=flttot; run;
```

```
data flttot; set flttot;
* eps (epsilon) is the additive fuzz to improve fitting algorithm given many
zero counts;
eps=.01;
* plug in turtle count estimates;
lneffort1000=log(toteffort);
tcount=totturts+eps;
* delete cases that are not to be included in the model fit;
* if unit='A' or unit='C' or unit='D2' then delete;
* if mesh='small' then delete;
* if season='winter' then delete;
run;


proc genmod data=flttot;
      class unit year season mesh;
      model tcount = unit year season mesh
                    /* unit*year unit*season unit*mesh year*season
year*mesh season*mesh  */

                                 /p cl alpha=0.1
                       dist   = poisson
                       link   = log dscale
                       offset = lneffort1000;
output out=fits l=lwrCL p=fit u=uprCL;
run;
data fits; set fits;
tcount=tcount-eps; lwrCL=lwrCL-eps; fit=fit-eps; uprCL=uprCL-eps;
if lwrCL<0 then lwrCL=0;
if fit<0 then fit=0;
if uprCL<0 then uprCL=0;
diff=tcount-fit;
absdiff=abs(tcount-fit); run;
proc means data=fits; var diff absdiff tcount fit; run;
proc freq data=fits; tables tcount/list; run;
ods rtf file='newlist.rtf';
/* data fits; set fits; if mesh='large'; run;
   proc sort data=fits; by year season unit mesh; run;  */
proc print noobs data=fits;
format lwrCL fit uprCL f6.1;
var year season unit mesh tottrips toteffort tcount lwrCL fit uprCL;
* var estturtsbycpue lwrCL fit uprCL;
run;
ods rtf close;

* average last 4 years values;
data fits7_10; set fits; if year ge 7; run;
proc means mean data=fits7_10; class unit season mesh;
var lwrCL fit uprCL;
output out=fitsmns mean= lwrCLmn fitmn uprCLmn;
run;
data fitsmns; set fitsmns;
lwrCL=lwrCLmn; fit=fitmn; uprCL=uprCLmn;
if _type_=7;
drop _freq_ lwrCLmn fitmn uprCLmn; run;

ods rtf file='list1.rtf';
proc print noobs data=fitsmns;
format lwrCL fit uprCL f6.1;
var unit season mesh lwrCL fit uprCL;
```

```
run;
ods rtf close;

* get unit totals;
proc means sum data=fitsmns; class unit;
var fit;
output out=unittotals sum=sfit;
run;
data unittotals; set unittotals; if _type_=1;
unittotal=sfit;
run;

ods rtf file='list1.rtf';
proc print noobs data=unittotals;
format unittotal f6.1;
var unit unittotal;
run;
ods rtf close;

* summarize CPUE totals and FITTED totals;
ods rtf file='list1.rtf';
proc tabulate data=fits format=F10.0;
class year unit season mesh;
var tcount fit;
table unit ALL='Totals' ,sum=' '*tcount sum=' '*fit;
table year ALL='Totals' ,sum=' '*tcount sum=' '*fit;
table season ALL='Totals' ,sum=' '*tcount sum=' '*fit;
table mesh ALL='Totals' ,sum=' '*tcount sum=' '*fit;
run;
ods rtf close;
```

APPENDIX 5.

Columns 1-8: Fleet effort totals by unit-year-season-mesh, with turtle estimates filled in based on pooled CPUEs.

Columns 9-11: Fitted expected values from Poisson Regression model, with 90% confidence limits.

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SE P	Col9 LWRCL	Col10 FIT	Col11 UPRCL
A	1	fall	large	14	8342	5079	0		0.0	0.0	1569.1
A	1	fall	small	22	592	513	0		0.0	0.0	15.5
A	1	spring	large	19	4349	4048	0		0.0	0.0	144.1
A	1	spring	small	29	1232	1371	0		0.0	0.0	5.7
A	1	summer	large	17	5504	3138	0		0.0	0.1	2218.8
A	1	summer	small	27	264	446	0		0.0	0.0	14.9
A	1	winter	large	17	5701	4365	0		0.0	0.0	140.4
A	1	winter	small	23	1323	1718	0		0.0	0.0	4.5
A	2	fall	large	16	6185	3872	0		0.0	0.0	1155.6
A	2	fall	small	19	1103	873	0		0.0	0.0	28.8
A	2	spring	large	19	3688	3097	0		0.0	0.0	121.4
A	2	spring	small	29	1317	1553	0		0.0	0.0	6.0
A	2	summer	large	13	4321	2467	0		0.0	0.0	1730.7
A	2	summer	small	23	579	867	0		0.0	0.0	32.3
A	2	winter	large	17	5219	3738	0		0.0	0.0	127.8
A	2	winter	small	21	1248	1690	0		0.0	0.0	4.2
A	3	fall	large	14	5075	3295	0		0.0	0.0	355.2
A	3	fall	small	26	442	376	0		0.0	0.0	4.3
A	3	spring	large	21	3417	3098	0		0.0	0.0	42.1
A	3	spring	small	25	1956	2320	0		0.0	0.0	3.4
A	3	summer	large	17	3541	2022	0		0.0	0.0	531.1
A	3	summer	small	20	320	490	0		0.0	0.0	6.7
A	3	winter	large	16	4452	3081	0		0.0	0.0	40.8
A	3	winter	small	23	1518	2020	0		0.0	0.0	1.9
A	4	fall	large	15	4633	2764	0		0.0	0.0	1211.5
A	4	fall	small	24	422	366	0		0.0	0.0	15.4

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SE P	Col9 LWRC L	Col10 FIT	Col11 UPRC L
A	4	spring	large	21	4178	3994	0		0.0	0.0	192.6
A	4	spring	small	22	1063	1234	0		0.0	0.0	6.8
A	4	summer	large	14	3609	2025	0		0.0	0.0	2022.9
A	4	summer	small	18	260	424	0		0.0	0.0	20.4
A	4	winter	large	15	3291	2217	0		0.0	0.0	112.8
A	4	winter	small	23	948	1259	0		0.0	0.0	4.5
A	5	fall	large	13	5676	3649	0		0.0	0.0	445.1
A	5	fall	small	24	373	356	0		0.0	0.0	4.1
A	5	spring	large	16	2732	2772	0		0.0	0.0	37.8
A	5	spring	small	24	1275	1569	0		0.0	0.0	2.4
A	5	summer	large	15	2799	1582	0		0.0	0.0	470.6
A	5	summer	small	21	294	443	0		0.0	0.0	6.9
A	5	winter	large	14	2780	1965	0		0.0	0.0	28.6
A	5	winter	small	20	862	1146	0		0.0	0.0	1.2
A	6	fall	large	15	5903	3660	0		0.0	0.0	766.3
A	6	fall	small	23	488	440	0		0.0	0.0	8.8
A	6	spring	large	20	3562	3033	0		0.0	0.0	81.5
A	6	spring	small	23	833	934	0		0.0	0.0	2.6
A	6	summer	large	11	3741	2136	0		0.0	0.0	1041.1
A	6	summer	small	25	215	363	0		0.0	0.0	8.3
A	6	winter	large	16	2707	2071	0		0.0	0.0	46.1
A	6	winter	small	26	547	768	0		0.0	0.0	1.3
A	7	fall	large	16	7298	4490	0		0.0	0.0	1755.7
A	7	fall	small	26	782	601	0		0.0	0.0	26.3
A	7	spring	large	17	3341	2778	0		0.0	0.0	141.7
A	7	spring	small	28	866	913	0		0.0	0.0	5.1
A	7	summer	large	14	2789	1608	0		0.0	0.0	1438.3
A	7	summer	small	21	126	229	0		0.0	0.0	9.1
A	7	winter	large	17	3241	2300	0		0.0	0.0	102.2
A	7	winter	small	20	444	640	0		0.0	0.0	1.9

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
A	8	fall	large	17	6704	4052	0		0.0	0.0	1003.6
A	8	fall	small	27	485	366	0		0.0	0.0	10.1
A	8	spring	large	24	3078	2463	0		0.0	0.0	81.2
A	8	spring	small	27	1223	1303	0		0.0	0.0	4.5
A	8	summer	large	18	4547	2569	0		0.0	0.0	1458.9
A	8	summer	small	25	160	306	0		0.0	0.0	7.2
A	8	winter	large	17	1196	1386	0		0.0	0.0	23.4
A	8	winter	small	24	920	1438	0		0.0	0.0	2.5
A	9	fall	large	19	7759	4756	0		0.0	0.0	1878.0
A	9	fall	small	22	671	556	0		0.0	0.0	22.7
A	9	spring	large	18	2993	2182	0		0.0	0.0	127.7
A	9	spring	small	24	1199	1258	0		0.0	0.0	7.1
A	9	summer	large	17	4250	2448	0		0.0	0.1	2204.9
A	9	summer	small	27	261	480	0		0.0	0.0	18.9
A	9	winter	large	15	461	505	0		0.0	0.0	14.6
A	9	winter	small	17	815	1174	0		0.0	0.0	3.6
A	10	fall	large	13	4779	2932	0		0.0	0.0	1560.3
A	10	fall	small	21	445	346	0		0.0	0.0	20.2
A	10	spring	large	19	3758	3401	0		0.0	0.0	216.3
A	10	spring	small	28	974	1074	0		0.0	0.0	7.8
A	10	summer	large	11	1627	1015	0		0.0	0.0	1138.8
A	10	summer	small	24	227	427	0		0.0	0.0	22.1
A	10	winter	large	17	1359	1171	0		0.0	0.0	58.2
A	10	winter	small	16	690	942	0		0.0	0.0	4.1
B	1	fall	large	17	3065	2294	85		125.2	167.5	224.2
B	1	fall	small	39	940	1091	0		4.3	7.1	11.6
B	1	spring	large	28	2058	1214	0		11.9	19.7	32.4
B	1	spring	small	46	2122	1951	0		1.5	2.8	5.3
B	1	summer	large	18	3986	2126	224		361.0	467.2	604.6
B	1	summer	small	38	1375	746	0		13.8	22.3	35.9

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SE P	Col9 LWRC L	Col10 FIT	Col11 UPRC L
B	1	winter	large	14	827	937	0		1.1	5.3	25.6
B	1	winter	small	28	590	567	0		0.1	0.5	2.6
B	2	fall	large	21	2788	2087	169		112.9	151.4	203.0
B	2	fall	small	42	1061	1131	0		4.8	8.0	13.1
B	2	spring	large	29	1568	809	0		9.0	14.9	24.5
B	2	spring	small	38	1696	1556	0		1.2	2.2	4.2
B	2	summer	large	17	3874	2054	851		346.6	450.9	586.6
B	2	summer	small	29	787	510	0		7.8	12.7	20.5
B	2	winter	large	14	175	175	0		0.2	1.1	5.4
B	2	winter	small	21	473	412	0		0.1	0.4	2.1
B	3	fall	large	16	2365	1771	71		31.3	47.9	73.2
B	3	fall	small	40	657	764	0		1.0	1.8	3.3
B	3	spring	large	27	1199	650	0		2.4	4.2	7.6
B	3	spring	small	41	2288	2109	0		0.5	1.1	2.3
B	3	summer	large	20	3778	2027	0		109.7	163.9	244.9
B	3	summer	small	29	880	626	0		3.0	5.3	9.3
B	3	winter	large	15	165	175	0		0.1	0.4	1.9
B	3	winter	small	28	419	382	0		0.0	0.1	0.7
B	4	fall	large	26	3002	2244	140		176.7	228.2	294.8
B	4	fall	small	52	1115	1239	0		7.3	11.7	18.9
B	4	spring	large	28	1923	984	0		15.8	25.5	41.3
B	4	spring	small	42	1705	1539	0		1.7	3.1	5.8
B	4	summer	large	22	4479	2380	267		585.0	730.1	911.3
B	4	summer	small	31	831	483	0		11.8	18.7	29.7
B	4	winter	large	10	155	134	0		0.3	1.4	6.7
B	4	winter	small	27	347	282	0		0.1	0.4	2.1
B	5	fall	large	19	3362	2540	67		50.0	76.2	116.1
B	5	fall	small	38	768	870	0		1.3	2.4	4.3
B	5	spring	large	19	1382	790	0		3.0	5.5	9.9
B	5	spring	small	39	2278	2047	0		0.6	1.2	2.5

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
B	5	summer	large	22	3921	2124	86		127.3	190.6	285.5
B	5	summer	small	32	1618	788	0		6.1	10.9	19.2
B	5	winter	large	13	122	110	0		0.1	0.3	1.6
B	5	winter	small	18	397	332	0		0.0	0.1	0.7
B	6	fall	large	20	3415	2583	73		92.7	128.6	178.5
B	6	fall	small	42	1005	1159	0		3.1	5.2	8.8
B	6	spring	large	32	2361	1169	0		9.2	15.5	26.2
B	6	spring	small	40	1627	1466	0		0.8	1.5	2.8
B	6	summer	large	25	4814	2609	696		287.0	388.8	526.7
B	6	summer	small	35	1089	633	0		7.3	12.2	20.2
B	6	winter	large	15	158	144	0		0.1	0.7	3.4
B	6	winter	small	23	575	508	0		0.1	0.3	1.8
B	7	fall	large	24	3660	2800	657		197.2	256.0	332.2
B	7	fall	small	46	870	970	0		5.2	8.4	13.6
B	7	spring	large	28	2172	1098	0		16.3	26.5	43.2
B	7	spring	small	42	1858	1736	0		1.7	3.1	5.8
B	7	summer	large	25	4257	2335	264		505.4	638.4	806.3
B	7	summer	small	39	923	681	0		12.0	19.1	30.5
B	7	winter	large	21	149	158	0		0.2	1.2	5.9
B	7	winter	small	29	623	493	0		0.1	0.7	3.5
B	8	fall	large	22	3601	2708	258		117.6	156.6	208.5
B	8	fall	small	48	889	947	0		3.3	5.3	8.8
B	8	spring	large	31	3154	1590	70		14.6	24.0	39.4
B	8	spring	small	40	1475	1384	0		0.8	1.5	2.9
B	8	summer	large	25	6845	3621	425		495.9	638.3	821.5
B	8	summer	small	36	732	479	0		5.8	9.4	15.2
B	8	winter	large	14	219	266	30		0.2	1.1	5.4
B	8	winter	small	28	686	462	0		0.1	0.5	2.4
B	9	fall	large	18	3221	2423	601		176.1	226.7	291.9
B	9	fall	small	44	738	813	0		4.5	7.2	11.5

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
B	9	spring	large	30	2111	981	0		16.1	26.0	42.0
B	9	spring	small	39	1312	1237	0		1.2	2.2	4.1
B	9	summer	large	24	5506	2926	1046		669.1	830.9	1031.9
B	9	summer	small	31	1582	920	0		20.9	33.0	52.2
B	9	winter	large	17	192	173	0		0.3	1.6	7.6
B	9	winter	small	27	632	459	0		0.1	0.7	3.6
B	10	fall	large	18	4088	3074	190		300.1	388.1	501.8
B	10	fall	small	43	819	834	0		6.8	10.7	17.0
B	10	spring	large	27	1775	988	224		18.1	29.4	47.9
B	10	spring	small	44	1527	1468	0		1.9	3.5	6.5
B	10	summer	large	19	2867	1547	421		459.5	583.4	740.7
B	10	summer	small	25	2998	1323	522		53.6	84.4	133.1
B	10	winter	large	12	176	169	0		0.4	1.9	9.5
B	10	winter	small	24	291	205	0		0.1	0.4	2.2
C	1	fall	large	9	1215	1025	0		1.9	4.4	10.1
C	1	fall	small	19	377	516	0		0.1	0.2	0.5
C	1	spring	large	13	1037	960	0		0.3	0.7	1.6
C	1	spring	small	19	293	371	0		0.0	0.0	0.1
C	1	summer	large	9	1764	1560	0		6.1	13.9	31.3
C	1	summer	small	17	110	240	0		0.0	0.1	0.3
C	1	winter	large	14	651	838	0		0.0	0.3	1.6
C	1	winter	small	13	273	299	0		0.0	0.0	0.1
C	2	fall	large	13	1521	1277	0		2.4	5.5	12.6
C	2	fall	small	21	494	608	0		0.1	0.2	0.6
C	2	spring	large	14	1609	1494	0		0.4	1.0	2.5
C	2	spring	small	23	448	561	0		0.0	0.0	0.1
C	2	summer	large	10	1395	1234	21		4.8	10.9	24.6
C	2	summer	small	15	127	285	0		0.0	0.1	0.3
C	2	winter	large	15	484	620	0		0.0	0.2	1.2
C	2	winter	small	15	344	393	0		0.0	0.0	0.1

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
C	3	fall	large	10	861	718	0		0.5	1.2	2.8
C	3	fall	small	14	207	303	0		0.0	0.0	0.1
C	3	spring	large	16	2107	1931	0		0.2	0.5	1.3
C	3	spring	small	20	373	509	0		0.0	0.0	0.0
C	3	summer	large	9	2121	1875	0		2.6	6.2	14.7
C	3	summer	small	13	54	126	0		0.0	0.0	0.0
C	3	winter	large	13	323	418	0		0.0	0.0	0.3
C	3	winter	small	14	455	526	0		0.0	0.0	0.1
C	4	fall	large	8	1420	1185	0		3.2	7.2	16.3
C	4	fall	small	18	106	169	0		0.0	0.1	0.2
C	4	spring	large	13	1787	1784	0		0.6	1.6	3.9
C	4	spring	small	17	289	414	0		0.0	0.0	0.1
C	4	summer	large	6	983	869	0		4.8	10.7	24.1
C	4	summer	small	12	48	99	0		0.0	0.1	0.2
C	4	winter	large	13	289	321	0		0.0	0.2	1.0
C	4	winter	small	10	185	214	0		0.0	0.0	0.1
C	5	fall	large	10	1139	978	0		0.7	1.7	4.2
C	5	fall	small	21	124	198	0		0.0	0.0	0.1
C	5	spring	large	12	1392	1473	0		0.1	0.4	1.0
C	5	spring	small	18	366	493	0		0.0	0.0	0.0
C	5	summer	large	10	1406	1253	0		1.9	4.6	11.0
C	5	summer	small	13	38	87	0		0.0	0.0	0.0
C	5	winter	large	13	335	359	0		0.0	0.0	0.3
C	5	winter	small	16	237	282	0		0.0	0.0	0.0
C	6	fall	large	9	1211	1051	0		1.3	3.1	7.1
C	6	fall	small	22	226	373	0		0.0	0.1	0.2
C	6	spring	large	14	1582	1526	0		0.3	0.7	1.8
C	6	spring	small	18	281	418	0		0.0	0.0	0.0
C	6	summer	large	11	1222	1088	0		2.9	6.6	15.2
C	6	summer	small	17	85	161	0		0.0	0.1	0.2

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
C	6	winter	large	12	163	187	0		0.0	0.0	0.3
C	6	winter	small	12	381	465	0		0.0	0.0	0.1
C	7	fall	large	8	1375	1210	0		2.8	6.4	14.6
C	7	fall	small	19	306	463	0		0.1	0.2	0.5
C	7	spring	large	16	1560	1557	0		0.5	1.3	3.2
C	7	spring	small	18	577	645	0		0.0	0.1	0.2
C	7	summer	large	10	936	837	54		4.2	9.4	21.2
C	7	summer	small	17	121	230	0		0.1	0.2	0.4
C	7	winter	large	12	163	186	0		0.0	0.1	0.5
C	7	winter	small	15	267	312	0		0.0	0.0	0.1
C	8	fall	large	10	931	791	0		1.2	2.7	6.2
C	8	fall	small	22	236	326	0		0.0	0.1	0.2
C	8	spring	large	16	941	882	0		0.2	0.5	1.2
C	8	spring	small	17	514	571	0		0.0	0.0	0.1
C	8	summer	large	9	1053	931	0		2.9	6.6	14.9
C	8	summer	small	17	160	285	0		0.0	0.1	0.3
C	8	winter	large	12	191	198	0		0.0	0.1	0.4
C	8	winter	small	13	232	278	0		0.0	0.0	0.1
C	9	fall	large	9	1224	1048	0		2.6	5.8	13.0
C	9	fall	small	17	176	282	0		0.0	0.1	0.3
C	9	spring	large	13	1183	1300	0		0.4	1.0	2.4
C	9	spring	small	16	484	526	0		0.0	0.0	0.1
C	9	summer	large	9	1365	1214	67		6.2	13.8	30.9
C	9	summer	small	16	177	323	0		0.1	0.2	0.6
C	9	winter	large	9	145	146	0		0.0	0.1	0.5
C	9	winter	small	12	160	196	0		0.0	0.0	0.1
C	10	fall	large	9	658	577	0		1.8	4.2	9.5
C	10	fall	small	15	130	155	0		0.0	0.1	0.3
C	10	spring	large	14	842	960	0		0.4	0.9	2.3
C	10	spring	small	14	223	241	0		0.0	0.0	0.1

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
C	10	summer	large	10	429	392	0		2.6	5.8	13.2
C	10	summer	small	12	74	155	0		0.0	0.1	0.3
C	10	winter	large	10	77	83	0		0.0	0.0	0.3
C	10	winter	small	11	140	161	0		0.0	0.0	0.1
D1	1	fall	large	7	170	108	28		33.0	45.3	62.2
D1	1	fall	small	17	128	152	0		2.8	4.7	7.8
D1	1	spring	large	11	209	92	0		5.8	9.7	16.2
D1	1	spring	small	18	40	50	0		0.1	0.2	0.5
D1	1	summer	large	10	516	264	349		222.6	294.3	389.0
D1	1	summer	small	14	125	27	0		6.0	9.9	16.1
D1	1	winter	large	2	3	4	0		0.0	0.1	0.4
D1	1	winter	small	8	7	9	0		0.0	0.0	0.1
D1	2	fall	large	9	185	116	14		35.6	49.0	67.3
D1	2	fall	small	24	91	64	0		2.0	3.3	5.6
D1	2	spring	large	11	272	112	0		7.5	12.5	20.9
D1	2	spring	small	12	12	12	0		0.0	0.1	0.1
D1	2	summer	large	9	487	252	330		207.9	276.1	366.6
D1	2	summer	small	9	49	14	0		2.3	3.9	6.4
D1	2	winter	large	2	7	14	0		0.0	0.2	1.1
D1	2	winter	small	3	3	3	0		0.0	0.0	0.1
D1	3	fall	large	8	196	124	67		12.5	19.3	30.0
D1	3	fall	small	20	67	80	0		0.5	0.9	1.7
D1	3	spring	large	12	241	100	0		2.3	4.1	7.5
D1	3	spring	small	19	47	59	0		0.0	0.1	0.2
D1	3	summer	large	11	584	303	395		81.7	123.5	186.5
D1	3	summer	small	15	75	21	0		1.2	2.2	3.9
D1	3	winter	large	4	21	41	0		0.0	0.2	1.2
D1	3	winter	small	9	6	6	0		0.0	0.0	0.0
D1	4	fall	large	11	299	188	12		83.5	110.6	146.4
D1	4	fall	small	27	103	117	0		3.2	5.2	8.6

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
D1	4	spring	large	8	285	122	0		11.3	18.5	30.2
D1	4	spring	small	20	58	73	0		0.3	0.5	1.0
D1	4	summer	large	8	589	305	399		366.9	467.4	595.6
D1	4	summer	small	11	73	8	0		5.0	8.0	12.9
D1	4	winter	large	2	0	1	0		0.0	0.0	0.1
D1	4	winter	small	5	8	3	0		0.0	0.0	0.2
D1	5	fall	large	12	363	241	137		25.8	40.1	62.4
D1	5	fall	small	22	41	56	0		0.3	0.6	1.1
D1	5	spring	large	9	105	44	0		1.1	2.0	3.7
D1	5	spring	small	17	31	40	0		0.0	0.1	0.2
D1	5	summer	large	9	314	161	213		48.8	74.3	113.2
D1	5	summer	small	10	56	3	0		1.0	1.8	3.3
D1	5	winter	large	2	3	5	0		0.0	0.0	0.2
D1	5	winter	small	1	4	1	0		0.0	0.0	0.0
D1	6	fall	large	9	226	143	38		29.0	41.5	59.3
D1	6	fall	small	28	116	116	0		1.7	2.9	5.0
D1	6	spring	large	14	180	75	0		3.4	5.8	9.9
D1	6	spring	small	18	16	19	0		0.0	0.1	0.1
D1	6	summer	large	10	307	158	208		86.7	120.7	167.9
D1	6	summer	small	13	54	5	0		1.7	2.9	5.0
D1	6	winter	large	1	0	0	0		0.0	0.0	0.0
D1	6	winter	small	5	16	4	0		0.0	0.0	0.2
D1	7	fall	large	12	319	205	0		81.5	108.8	145.1
D1	7	fall	small	29	98	95	0		2.8	4.6	7.6
D1	7	spring	large	14	211	90	0		7.6	12.5	20.6
D1	7	spring	small	19	29	31	0		0.1	0.2	0.4
D1	7	summer	large	10	480	247	0		271.1	350.4	452.9
D1	7	summer	small	20	145	22	0		9.0	14.6	23.6
D1	7	winter	large	4	2	4	0		0.0	0.1	0.4
D1	7	winter	small	11	33	10	0		0.0	0.2	0.9

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
D1	8	fall	large	10	248	157	41		38.4	52.6	72.0
D1	8	fall	small	23	146	63	0		2.6	4.3	7.1
D1	8	spring	large	11	334	137	0		7.4	12.4	20.6
D1	8	spring	small	17	16	20	0		0.0	0.1	0.1
D1	8	summer	large	11	698	362	473		240.6	317.2	418.2
D1	8	summer	small	14	112	10	0		4.3	7.0	11.6
D1	8	winter	large	1	1	1	0		0.0	0.0	0.1
D1	8	winter	small	9	43	9	0		0.0	0.1	0.7
D1	9	fall	large	9	217	138	0		56.0	74.5	99.2
D1	9	fall	small	24	97	56	0		2.8	4.6	7.5
D1	9	spring	large	12	286	118	0		10.4	17.1	28.1
D1	9	spring	small	16	15	17	0		0.1	0.1	0.2
D1	9	summer	large	8	483	250	505		277.2	355.0	454.7
D1	9	summer	small	10	82	4	0		5.1	8.3	13.4
D1	9	winter	large	2	0	1	0		0.0	0.0	0.1
D1	9	winter	small	6	20	4	0		0.0	0.1	0.5
D1	10	fall	large	9	168	106	108		57.8	77.5	104.1
D1	10	fall	small	25	99	52	0		3.9	6.3	10.3
D1	10	spring	large	8	131	56	0		6.4	10.6	17.5
D1	10	spring	small	17	21	25	0		0.1	0.2	0.4
D1	10	summer	large	9	238	123	132		179.3	235.4	309.0
D1	10	summer	small	7	75	2	0		6.4	10.2	16.5
D1	10	winter	large	4	5	8	0		0.0	0.3	1.3
D1	10	winter	small	4	12	2	0		0.0	0.1	0.4
D2	1	fall	large	4	181	173	0		4.9	8.5	14.8
D2	1	fall	small	13	152	320	0		0.5	1.0	2.0
D2	1	spring	large	6	148	108	0		0.6	1.2	2.4
D2	1	spring	small	10	5	30	0		0.0	0.0	0.0
D2	1	summer	large	4	277	249	38		16.2	27.9	48.2
D2	1	summer	small	8	16	27	0		0.1	0.2	0.4

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SE P	Col9 LWRC L	Col10 FIT	Col11 UPRC L
D2	1	winter	large	1	12	1	0		0.0	0.1	0.3
D2	1	winter	small	7	4	15	0		0.0	0.0	0.0
D2	2	fall	large	7	215	208	0		5.7	10.0	17.5
D2	2	fall	small	16	119	252	0		0.4	0.8	1.5
D2	2	spring	large	3	218	156	0		0.9	1.8	3.5
D2	2	spring	small	5	3	11	0		0.0	0.0	0.0
D2	2	summer	large	5	314	282	44		18.2	31.4	54.3
D2	2	summer	small	7	8	29	0		0.0	0.1	0.2
D2	2	winter	large	1	1	1	0		0.0	0.0	0.0
D2	2	winter	small	6	3	29	0		0.0	0.0	0.0
D2	3	fall	large	6	231	221	0		2.1	4.0	7.6
D2	3	fall	small	12	142	289	0		0.2	0.3	0.7
D2	3	spring	large	4	265	190	0		0.4	0.8	1.7
D2	3	spring	small	8	4	44	0		0.0	0.0	0.0
D2	3	summer	large	3	336	302	47		6.7	12.5	23.4
D2	3	summer	small	7	13	20	0		0.0	0.1	0.1
D2	3	winter	large	2	12	2	0		0.0	0.0	0.1
D2	3	winter	small	4	19	47	0		0.0	0.0	0.0
D2	4	fall	large	7	289	277	0		11.0	18.9	32.4
D2	4	fall	small	9	102	207	0		0.5	0.9	1.8
D2	4	spring	large	7	175	126	0		1.0	2.0	3.9
D2	4	spring	small	9	21	97	0		0.0	0.0	0.1
D2	4	summer	large	6	266	239	37		21.9	37.3	63.3
D2	4	summer	small	8	8	43	0		0.1	0.1	0.3
D2	4	winter	large	4	34	7	1		0.0	0.3	1.3
D2	4	winter	small	4	2	15	0		0.0	0.0	0.0
D2	5	fall	large	7	243	237	0		2.5	4.7	8.9
D2	5	fall	small	14	87	174	0		0.1	0.2	0.5
D2	5	spring	large	5	124	89	0		0.2	0.4	0.9
D2	5	spring	small	6	3	49	0		0.0	0.0	0.0

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
D2	5	summer	large	5	328	295	64		7.3	13.7	25.7
D2	5	summer	small	7	3	14	0		0.0	0.0	0.0
D2	5	winter	small	6	3	24	0		0.0	0.0	0.0
D2	6	fall	large	6	242	233	0		4.4	7.8	14.0
D2	6	fall	small	13	73	161	0		0.2	0.3	0.7
D2	6	spring	large	8	145	107	0		0.4	0.8	1.7
D2	6	spring	small	9	4	23	0		0.0	0.0	0.0
D2	6	summer	large	5	176	158	24		6.9	12.2	21.7
D2	6	summer	small	3	2	6	0		0.0	0.0	0.0
D2	6	winter	large	4	20	13	1		0.0	0.1	0.4
D2	6	winter	small	6	3	31	0		0.0	0.0	0.0
D2	7	fall	large	6	258	252	0		9.0	15.5	26.8
D2	7	fall	small	13	54	117	0		0.2	0.4	0.9
D2	7	spring	large	5	133	99	0		0.7	1.4	2.8
D2	7	spring	small	5	3	9	0		0.0	0.0	0.0
D2	7	summer	large	5	165	148	23		12.4	21.2	36.4
D2	7	summer	small	8	18	12	0		0.2	0.3	0.6
D2	7	winter	large	3	41	8	2		0.0	0.3	1.5
D2	7	winter	small	6	7	62	0		0.0	0.0	0.0
D2	8	fall	large	7	224	216	0		4.8	8.4	14.7
D2	8	fall	small	16	38	82	0		0.1	0.2	0.4
D2	8	spring	large	4	121	87	0		0.4	0.8	1.6
D2	8	spring	small	10	5	22	0		0.0	0.0	0.0
D2	8	summer	large	4	205	184	28		9.5	16.4	28.5
D2	8	summer	small	10	22	24	0		0.1	0.2	0.5
D2	8	winter	large	2	1	2	0		0.0	0.0	0.0
D2	8	winter	small	5	4	50	0		0.0	0.0	0.0
D2	9	fall	large	6	326	312	0		11.5	19.7	33.9
D2	9	fall	small	9	32	67	0		0.1	0.3	0.5
D2	9	spring	large	3	156	112	0		0.8	1.6	3.3

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SE P	Col9 LWRC L	Col10 FIT	Col11 UPRC L
D2	9	spring	small	9	5	23	0		0.0	0.0	0.0
D2	9	summer	large	4	280	252	39		21.4	36.4	61.8
D2	9	summer	small	7	5	16	0		0.0	0.1	0.2
D2	9	winter	large	1	1	1	0		0.0	0.0	0.0
D2	9	winter	small	5	6	38	0		0.0	0.0	0.0
D2	10	fall	large	5	219	212	0		10.3	17.9	31.0
D2	10	fall	small	10	34	90	0		0.2	0.4	0.8
D2	10	spring	large	7	80	59	0		0.6	1.1	2.3
D2	10	spring	small	5	3	10	0		0.0	0.0	0.0
D2	10	summer	large	5	82	74	9		8.3	14.4	24.8
D2	10	summer	small	7	6	24	0		0.1	0.1	0.3
D2	10	winter	small	6	3	37	0		0.0	0.0	0.0
E	1	fall	large	11	511	439	124		54.2	73.5	99.6
E	1	fall	small	19	285	814	0		3.4	5.7	9.4
E	1	spring	large	14	560	416	0		8.5	14.1	23.3
E	1	spring	small	14	242	196	0		0.4	0.8	1.6
E	1	summer	large	12	1020	877	678		238.0	314.4	415.3
E	1	summer	small	14	63	203	0		1.6	2.7	4.4
E	1	winter	large	12	75	120	0		0.2	1.2	6.1
E	1	winter	small	8	47	95	0		0.0	0.1	0.5
E	2	fall	large	12	775	678	0		81.6	110.7	150.0
E	2	fall	small	19	243	681	0		2.9	4.8	8.0
E	2	spring	large	12	848	658	47		12.7	21.1	35.1
E	2	spring	small	17	87	89	0		0.1	0.3	0.6
E	2	summer	large	10	931	799	0		215.1	284.9	377.3
E	2	summer	small	13	88	288	0		2.3	3.7	6.1
E	2	winter	large	10	62	93	0		0.2	1.0	5.0
E	2	winter	small	10	38	56	0		0.0	0.1	0.4
E	3	fall	large	10	695	612	0		24.1	37.0	56.8
E	3	fall	small	18	246	712	0		1.0	1.8	3.3

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
E	3	spring	large	12	926	741	0		4.8	8.6	15.5
E	3	spring	small	15	186	164	0		0.1	0.2	0.5
E	3	summer	large	11	1152	990	0		87.1	131.4	198.1
E	3	summer	small	14	44	137	0		0.4	0.7	1.2
E	3	winter	large	13	107	164	0		0.1	0.7	3.3
E	3	winter	small	10	66	102	0		0.0	0.0	0.3
E	4	fall	large	9	641	553	317		97.2	128.1	168.7
E	4	fall	small	17	280	826	0		4.7	7.7	12.7
E	4	spring	large	12	436	393	96		9.3	15.2	24.9
E	4	spring	small	11	203	195	0		0.5	1.0	1.8
E	4	summer	large	7	755	649	923		251.9	323.8	416.2
E	4	summer	small	14	66	215	0		2.4	3.9	6.3
E	4	winter	large	13	139	230	0		0.7	3.3	15.8
E	4	winter	small	11	78	119	0		0.0	0.2	1.3
E	5	fall	large	9	534	469	0		20.6	31.8	49.1
E	5	fall	small	18	223	632	0		1.0	1.8	3.3
E	5	spring	large	16	298	290	0		1.7	3.1	5.7
E	5	spring	small	16	108	113	0		0.1	0.1	0.3
E	5	summer	large	8	755	650	0		63.3	96.5	147.0
E	5	summer	small	12	42	134	0		0.4	0.7	1.3
E	5	winter	large	15	99	173	0		0.1	0.7	3.4
E	5	winter	small	8	62	81	0		0.0	0.1	0.3
E	6	fall	large	13	825	739	0		58.0	81.7	115.0
E	6	fall	small	20	262	760	0		2.1	3.6	6.1
E	6	spring	large	10	391	313	0		4.0	6.8	11.5
E	6	spring	small	12	50	69	0		0.1	0.1	0.2
E	6	summer	large	6	885	761	0		135.9	187.9	260.0
E	6	summer	small	11	21	70	0		0.4	0.6	1.0
E	6	winter	large	13	52	103	0		0.1	0.6	2.9
E	6	winter	small	9	91	126	0		0.0	0.1	0.7

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
E	7	fall	large	7	773	675	468		107.3	142.1	188.3
E	7	fall	small	20	236	624	0		3.6	6.0	9.8
E	7	spring	large	16	471	440	0		9.2	15.1	24.9
E	7	spring	small	16	119	195	0		0.3	0.5	1.0
E	7	summer	large	10	672	579	466		203.6	264.8	344.4
E	7	summer	small	15	52	158	0		1.7	2.8	4.6
E	7	winter	large	12	70	129	0		0.3	1.5	7.3
E	7	winter	small	11	109	169	0		0.1	0.3	1.6
E	8	fall	large	9	731	638	0		61.3	83.6	114.0
E	8	fall	small	23	292	765	0		2.8	4.6	7.7
E	8	spring	large	11	335	316	0		4.0	6.7	11.2
E	8	spring	small	14	147	166	0		0.2	0.4	0.8
E	8	summer	large	10	716	615	215		131.8	175.4	233.4
E	8	summer	small	13	83	266	0		1.7	2.8	4.7
E	8	winter	large	13	29	45	0		0.1	0.4	1.9
E	8	winter	small	10	74	127	0		0.0	0.1	0.7
E	9	fall	large	11	987	866	0		139.3	182.6	239.3
E	9	fall	small	20	282	780	0		4.4	7.2	11.8
E	9	spring	large	10	455	400	0		9.0	14.7	24.0
E	9	spring	small	15	184	196	0		0.4	0.8	1.5
E	9	summer	large	11	960	825	0		298.4	380.9	486.1
E	9	summer	small	15	68	214	0		2.3	3.7	6.1
E	9	winter	large	11	21	46	0		0.1	0.4	2.1
E	9	winter	small	10	97	127	0		0.0	0.3	1.5
E	10	fall	large	10	549	487	107		103.0	137.1	182.5
E	10	fall	small	17	179	477	0		3.8	6.2	10.0
E	10	spring	large	14	256	273	25		6.7	11.2	18.5
E	10	spring	small	17	100	148	0		0.3	0.6	1.1
E	10	summer	large	5	333	287	89		135.2	178.1	234.6
E	10	summer	small	14	60	198	0		2.7	4.4	7.2

Col 1 unit	Col 2 year	Col3 season	Col4 mesh	Col5 ncases	Col6 toteffort	Col7 tottrips	Col8 totturts	SEP	Col9 LWRCL	Col10 FIT	Col11 UPRCL
E	10	winter	large	10	29	63	0		0.2	0.9	4.2
E	10	winter	small	7	180	209	0		0.1	0.7	3.6