

South Carolina Saltwater Recreational License Fund Project Completion Report

Project Title: A Study of the Movements of the Dolphin, *Corypheana hippurus*, Off the Southeast Coast of the US.

Project Goals and Objectives: 1. Document the movement and dispersal patterns of the common dolphin off South Carolina and the Southeast Coast of the US to address defining the stock's geographic range. 2. Generate information on harvest rates among consumer groups, document reporting rate variations for recovered tags offering high reward verses standard reward and growth rates through reported recaptures. 3. Generate information on relative occurrence of species along the east coast based on mark-release data.

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Project Duration: 1 July 2001 through 31 March 2006.

Statement of Work:

Tag kits were provided to more than 900 private fishermen who volunteered to tag dolphin for this study. These anglers fished from Nantucket, Massachusetts to Key West, Florida over to Sugarland, Texas, in the Gulf of Mexico, the Bahamas Islands and in the Caribbean. More than 700 different anglers fishing aboard 293 privately owned offshore fishing vessels tagged dolphin for the study. In total, 4,922 dolphin were tagged along the entire US eastern seaboard south of Nantucket in the Bahamas and Gulf of Mexico. Fish were tagged along the entire US eastern seaboard south of Nantucket, in the Bahamas and Gulf of Mexico. Temporal and spatial data were collected on more than 4,600 of the fish tagged.

Hallprint model PDAT nylon dart tag with a 15.2-cm external yellow polyethylene streamer was utilized to mark the fish. A similar PDAT, tag except orange in color, was used in conjunction with a cash reward tag (\$20 cash printed on the tag) to compare reporting rates with non cash reward tags. The cash tag was deployed in over 800 fish primarily in south Florida and the Florida Straits to compare with tag recovery reporting of the non-cash reward tag. Recovery reports were received on 115 tags. Recoveries came primarily from the east coast but others were reported from the eastern Atlantic south of the Azores Islands, eastern Caribbean Sea and western Caribbean Sea. An internet website was utilized to disseminate information to interested fishermen and the media. The website also served to register anglers to tag fish as well as receive reports on tagged fish recoveries. Only recreational fishermen participated in tagging fish for this study.

The project utilized its website and a newsletter to carry out its public educational outreach. The website has been visited an average of 9,000 times each year by internet users all over the world. This website became the first known fisheries research site to receive tagged fish recovery reports via the internet. This site is also regularly used by news media to prepare articles on the findings of this study. The project issued 31 electronic newsletters during its operation with a distributed to an average of 900 fishermen and outdoor reporters who had asked to receive it. Many fishing clubs along the east coast extended the newsletter readership by forwarding the newsletter to their membership.

The study divided the east coast into nine zones based on geomorphic similarities of continental shelf and primary ocean current (Table 1). Two additional zones were included, one for Bahamian territorial waters and one for the Gulf of Mexico. These zones were created to facilitate the comparison of tagging and movement data among the major fishing areas. Distance traveled by recaptured fish was based on most direct route likely taken by the fish.

Table 1. Geographic Zones for Dolphin Movement Study.

Zone	Area	Southern Limit	Northern Limit
1	Bahamas	22°N	28°N
2	FL Straits	23°N	25°N
3	South Florida	25°N	27°N
4	Central Florida	27°N	30°N
5	North FL & GA	30°N	32°N
6	Central SC	32°N	33°N
7	N. SC - S. NC	33°N	35°N
8	Northern NC	35°N	36.5°N
9	Virginia	36.5°N	38°N
10	N. Mid-Atlantic	38°N	
11	Gulf of Mexico	24°N	30 °N

Results:

TAGGING

While over 700 anglers and 290 vessels tagged one or more dolphin for the study, it was the effort by a core group of vessels that made the project a success. A group of 51 boats, 17% of the participating vessels, tagged 76%, (3,724), of the dolphin tagged. Two vessels tagged more than 500 dolphin each during the four-year study. This core group of 51 vessels averaged tagging 73 fish per boat during the study. Based on number of fish tagged, the largest recreational fishery for dolphin occurs in the South Atlantic Bight (SAB), North Carolina to Key West, Florida where 95% of the fish were tagged.

Tagging activity was concentrated in two primary areas along the east coast, south Florida and the Florida Straits (23° N to 27° N latitude) and the Carolinas (32 N° to 35° N latitude). While the number of fish tagged increased each year, the number of fish tagged in a zone was highly variable among the years (Table 2). The Mid-Atlantic Bight, Zones 8 -10, exhibited the lowest tagging activity of the eastern seaboard, providing less than 2% of the fish tagged. This is likely the result of the reduced abundance of species in this region coupled with the high esteem anglers have for the species as a food fish. The low tagging activity in the Gulf of Mexico was the result of the project not seeking to have fish tagged there until late summer of 2004. While the high level of tagging occurring in Zones 2, 3 and 6 was the result of the large recreational fishery for dolphin in these areas, the presence of a large dolphin fishery did not necessarily result in high levels of tagging activity. Such was the case in North Carolina which has the second highest level of recreational dolphin harvest on the east coast according to the Marine Recreational Fishing Statistical Survey (MRFSS) conducted by NOAA Fisheries but contributed less than 3% of the fish tagged. In some areas such as Zones 1 and 7 the majority of tagging was the results of only one or two vessels.

Table 2. Number of Fish Tagged Annually by Zone.

Zone	2002	2003	2004	2005	Total	Percent
1	0	13	58	64	135	2.74
2	114	527	509	796	1946	39.53
3	34	176	171	429	810	16.45
4	83	49	58	44	234	4.73
5	15	78	65	36	194	3.94
6	224	366	541	262	1393	28.3
7	1	77	21	19	118	2.4
8	2	3	12	4	21	0.43
9	0	2	3	9	14	0.28
10	0	22	4	10	36	0.73
11	0	0	11	10	21	0.47
Total	473	1313	1453	1683	4922	

Fishermen as well as researchers report that dolphin have been caught every month of the year in the Gulf Stream/Florida Current between Cape Hatteras, NC and Key West, FL. While dolphin were tagged in every calendar-month for this study, over 84 % of the fish were marked during the period of May through August (Table 3). Only in zone 3 were fish tagged every month of the year. Zones 2 and 4 had fish tagged in 11 of the months. In South Carolina and the Bahamas, zone 6 and 1, dolphin were tagged during 8 months of the year.

Table 3. Monthly Tagging Activity by Zone, 2002 through 2005.

Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	9	12	41	25	23	19	4	2	0	0	0	0	135
2	0	3	62	30	317	630	581	256	46	15	1	5	1946
3	2	14	14	45	83	235	225	128	14	30	18	2	810
4	12	0	1	22	44	55	20	10	3	28	21	18	234
5	0	0	0	21	86	31	46	6	0	4	0	0	194
6	0	0	0	182	568	304	156	155	22	1	5	0	1393
7	0	0	0	4	18	19	37	30	5	3	2	0	118
8	0	0	0	0	0	2	14	5	0	0	0	0	21
9	0	0	0	0	0	0	4	3	7	0	0	0	14
10	0	0	0	0	0	0	3	18	13	2	0	0	36
11	0	0	0	0	0	0	16	2	3	0	0	0	21
Total	23	29	118	329	1139	1295	1106	615	113	83	47	25	4922
Percent	0.47	0.59	2.4	6.69	23.1	26.33	22.52	12.5	2.3	1.69	0.96	0.51	

Observed tagging activity did provide an obtuse index to the temporal abundance of dolphin in an area simply because they had to be present to be caught for tagging. However, according to reports by fishermen, most tagging activity occurred on trips after fishermen had caught the dolphin they wanted to eat during earlier trips. Thus most of the tagging occurred after the first 2 to 4 weeks of the area's main dolphin season. Peak abundance, as indicated by the number of fish tagged each month, varied among the years in most areas, however, a general south to north seasonal progression was exhibited (Table 3). Bahamas exhibited the earliest season beginning as early as February and continuing as late as July. Florida Straits and south Florida had the earliest season on the east coast beginning as early as March and lasting as late as August. Off South Carolina the dolphin-run begins in April and can last as late as August. In waters off North Carolina dolphin begin their run in late April or early May and will remain in the area as late as September/October. The latest seasonal occurrence was in the Mid-Atlantic

Bight where the fish first show up in June and may remain as late as October. Insufficient tagging occurred in the Gulf of Mexico to provide seasonal information.

Spatial analysis of catch locations for fish tagged in zone 5 and 6 showed the majority of dolphin were caught inshore of the 200m isobath. Using Arcview 6.0 to analyze the spatial distribution of the release sites indicated that from 62 to 82% of the fish tagged annually were captured inshore. The highest incident of dolphin tagging beyond the 200m isobath occurred in 2005 when 38.6% of the fish tagged were in the deeper waters. Recognizing that fishermen will only catch fish where they fish, and that anglers do not like to travel any further than necessary, these data suggest that in 2005 dolphin were not as abundant inshore of the 200m isobath as in 2002 through 2004.

Standard reward tags were distributed to the general public and were placed in 83.2%, (4098 fish), of the dolphin tagged. Tags offering cash rewards were placed in 827 fish or 16.8% of the fish tagged (Table 4). Fishery biologists and volunteers who had demonstrated their abilities to properly apply tags to dolphin during the first two years of the study were utilized to apply cash reward tags. Over 75% of the cash reward tags were deployed in zones 2 and 3 during 2004 and 2005 to provide the highest recovery potential.

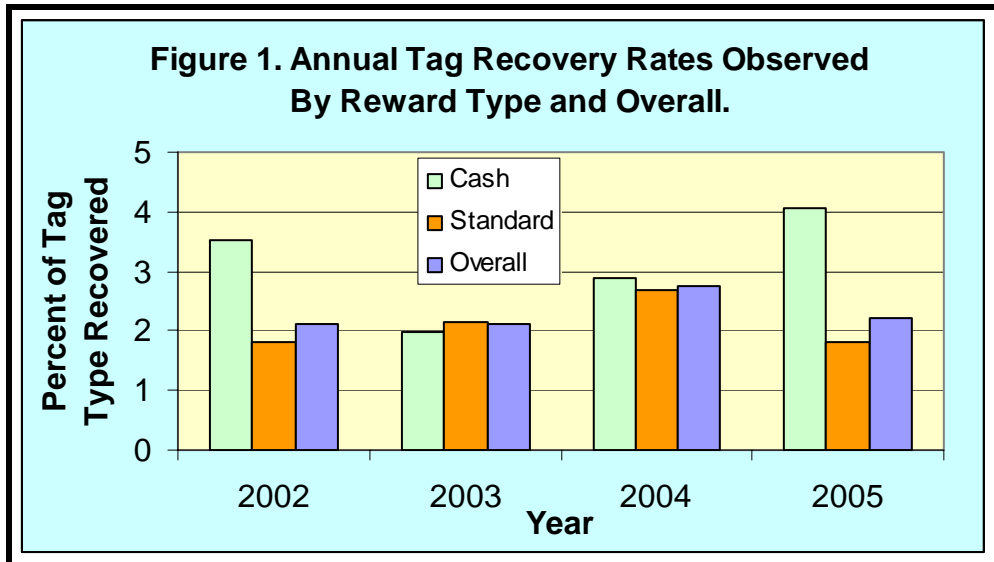
Table 4. Annual number of tags deployed by reward type.

Year	Cash	Standard	Total
2002	85	388	473
2003	101	1212	1313
2004	345	1111	1456
2005	296	1387	1683
Total	827	4098	4925

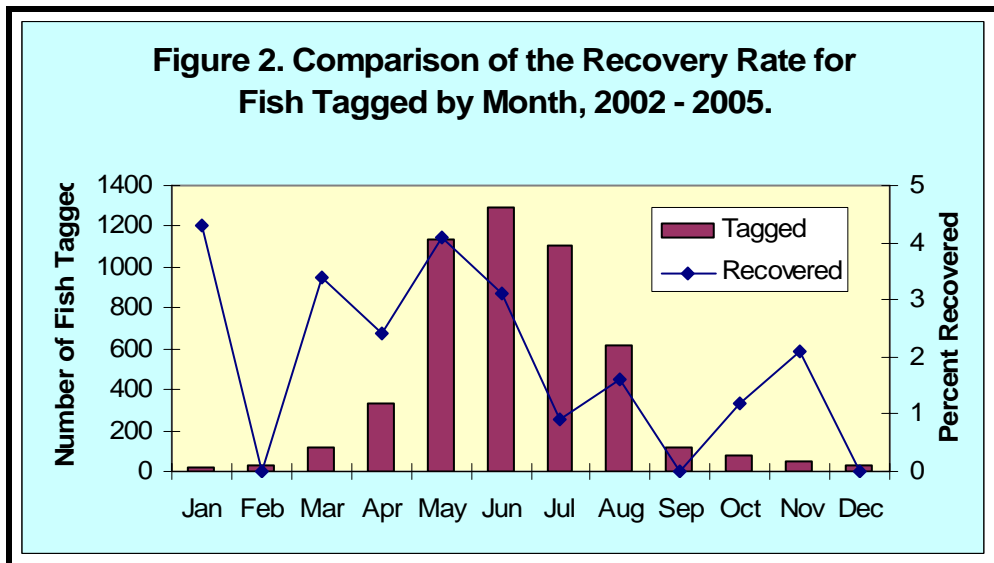
TAG RECOVERIES

Tag Recovery Rates

115 tags were reported recovered during the study for a reporting rate of 2.34%. Cash reward tags were involved in 27 of the reports while the standard reward tag comprised the remaining 88 reports. Overall tag reporting rates varied little among the years from 2.1 in 2002 to 2.8% in 2004 (Figure 1). Cash reward tags exhibited a higher overall rate of reporting, 3.26%, than the standard reward tags with 2.17%. However, the higher rate may have been a result of several factors. First the orange tag was more visible against the yellow body of the fish. Secondly, the tags were applied by people with more experienced which probably resulted in a higher survival rate and improved tag retention. The fact that the \$20 cash reward was not the motivating factor in reporting the tag recovery was made clear by the majority of the people reporting these tags choosing the tee shirt instead of the cash when given the option.

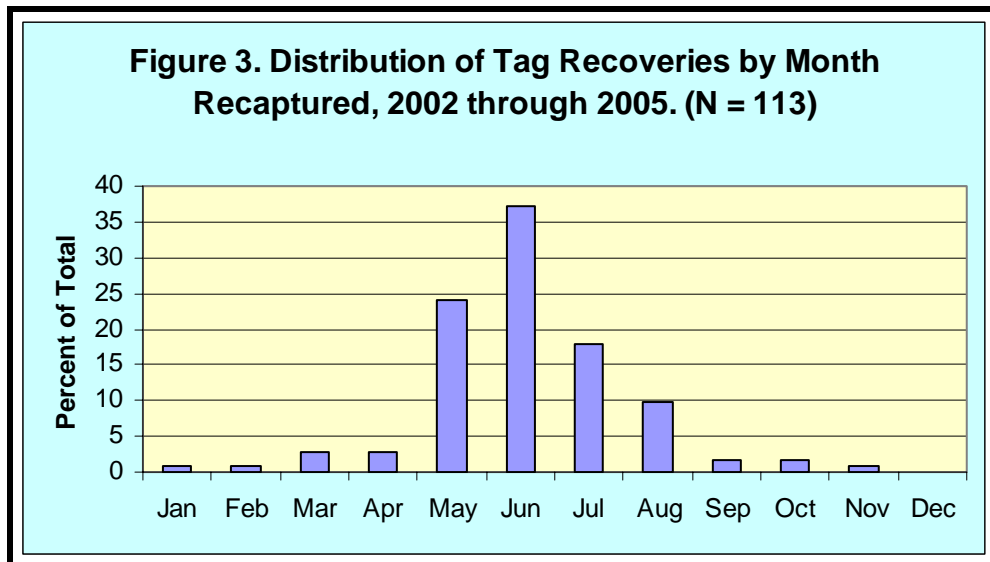


Recovery rates for fish tagged in each month were highly variable but did exhibit a definite trend. Fish tagged from January through June accounted for 59.5% of the fish tagged but these fish were involved in 90.3% of the recoveries. This translates into a 3.5% recovery rate for fish tagged during the first half of the calendar year. While 40.5% of the dolphin were marked during July through December, only 0.6% of these fish were reported recaptured. The higher winter/spring recovery rate could be the result of a higher level of survival for fish tagged in the cooler waters and because fish tagged earlier in the year are exposed to more fishing effort along the US coast than those tagged later in the year. Figure 2 clearly shows the sharp contrast in the recovery rates for fish tagged in each month between the first and second half of the year. Recovery rates for Florida Keys (zone 2) and South Carolina (zone 6) which had the highest levels of tagging showed very similar recovery rates, 2.8 and 2.4% respectively.



Temporal Distribution of Recoveries

More tag recoveries occurred from May through August, Figure 3, than the rest of the year. More than 88% of all recoveries occurred during this period. Over 92% of the recoveries of fish tagged off the Florida Keys, zone 2, occurred from May through July. Similarly in zone 6, 91% of the recoveries for fish marked in this area were recovered from April through June.



Recoveries of tagged dolphin in the SAB, zones 2 through 7, occurred primarily during May, June and July (Table 5). A few earlier recoveries during March and April in zones 2, 3 and 4 reflect the earlier arrival of fish in these southern areas. In keeping with the same south to north temporal progression, tag recoveries extended later into the summer in zone 7, the most northern area of the SAB, with 18% of that area's recoveries occurring in August. Tag recoveries in the Mid-Atlantic Bight (MAB), zones 8, 9 and 10 further supported the south to north movement hypothesis with the earliest recaptures occurring in zone 8 during June followed by recoveries as late as September and October in the more northern areas of the MAB. The clustering of recoveries along the south Florida and North Carolina coasts is due in part to the large offshore fishing effort that is directed at dolphin in these locations.

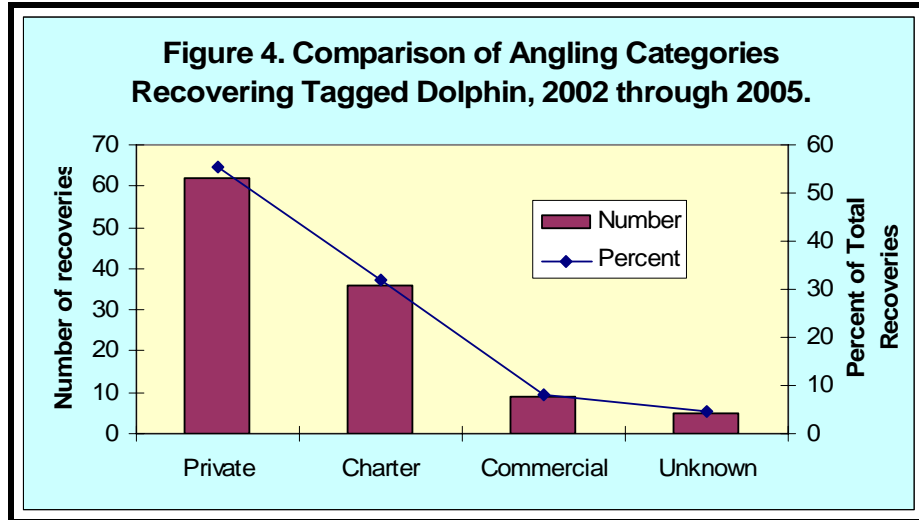
Table 5. Temporal distribution of tag recaptures by recovery zone, 2002 - 2005.

Recapture Zone	Recapture Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	1	0	0	1	0	1	0	0	0	0	0	0	3
2	0	0	1	0	6	10	1	0	0	0	0	0	18
3	0	0	1	0	8	14	2	1	0	0	0	0	26
4	0	0	1	1	2	2	2	0	0	1	0	0	9
5	0	0	0	0	3	1	0	0	0	0	0	0	4
6	0	0	0	0	4	3	2	0	0	0	0	0	9
7	0	0	0	0	4	7	7	4	0	0	0	0	22
8	0	0	0	0	0	4	5	2	0	0	0	0	11
9	0	0	0	0	0	0	0	1	0	0	0	0	1
10	0	0	0	0	0	0	1	3	2	1	0	0	7
11	0	0	0	0	0	0	0	0	0	0	0	0	0
International	0	2	0	1	0	0	0	0	0	0	0	0	3
Total	1	2	3	3	27	42	20	11	2	2	0	0	113

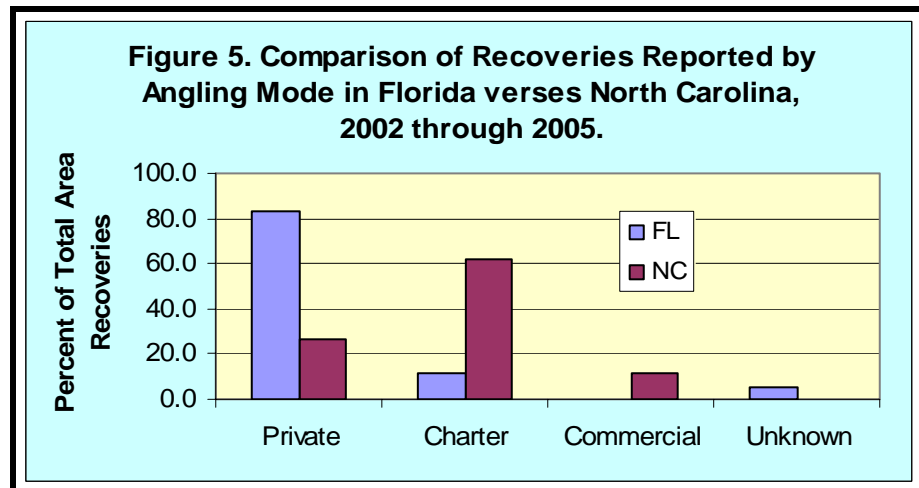
Tag Recoveries by Angling Mode

There are three primary components to the United States domestic dolphin fishery, private recreational, for-hire (charter/head) recreational, and commercial. The number of tag recovery reports varied among the segments (Figure 4). Commercially-harvested dolphin are largely harvested as a by-catch of fishing directed at other species, but are directly targeted on occasion. Commercial vessels reported catching

8% (9 fish) of the tagged dolphin recovered. These were captured off Georgia, South Carolina, North Carolina, New York and the Azores Islands. Charter boats recovered 32% of all reported tag recaptures (36 fish). It was anglers fishing aboard private recreational vessels who reported the largest number of the tagged fish recoveries, 55% (62 fish). The distribution of the tag recoveries between the commercial and recreational user groups conforms very closely with landings reported for these segments. Angling category was not available for 5 recaptures.



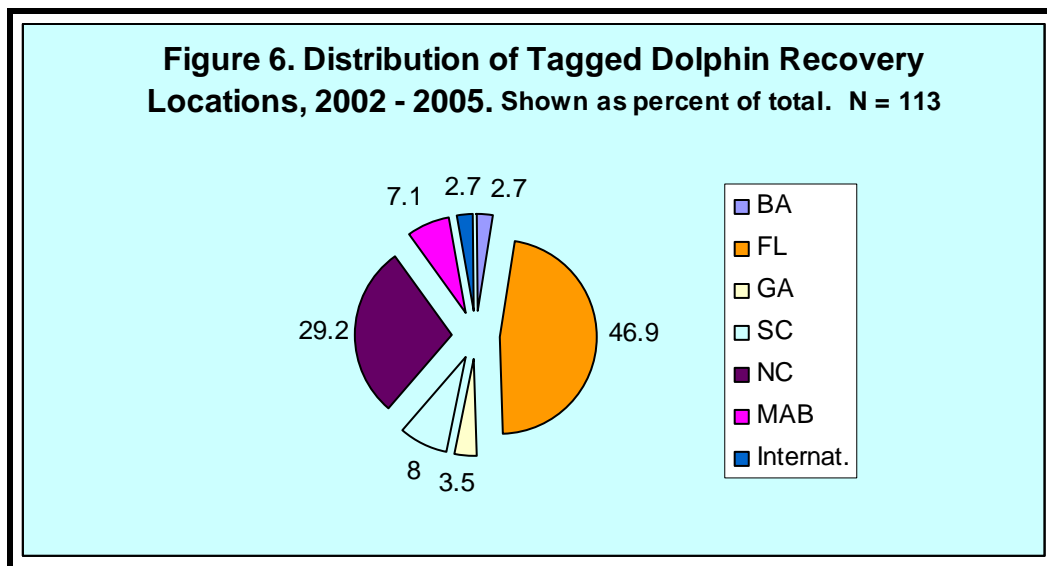
In comparing the role that the various angling modes play in the dolphin fishery of Florida and North Carolina, a very different harvest pattern emerges (Figure 5). Recreational anglers fishing from private boats were responsible for more than 80% of the tag recoveries reported from Florida while Florida’s for-hire fleet reported only 11% of the recoveries and commercial vessels reported no tag recoveries. In North Carolina the for-hire vessels, specifically charter boats, recovered over 60% of the tags reported from the Tar Heel state. Recreational anglers aboard private boats reported 26% of the North Carolina recoveries while commercial vessels were responsible for 12% of the tags reported.



Geographic Distribution of Tag Recoveries

Tagged dolphin were recovered in every zone along the East Coast, in the Bahamas, Caribbean Sea and eastern Atlantic. With it large fishery for dolphin, it is not surprising that more tags were recovered off Florida than any other state, 47% (Figure 6). Anglers fishing out of North Carolina had the second highest number of recovery reports, (29%) and South Carolina ranked a distant third with only 8% of the

recaptures taken off the Palmetto State. Only 7% of the tag recoveries came from the Mid-Atlantic Bight north of North Carolina. Vessels fishing off Georgia, zone 5, managed to recapture only 4 tagged fish. Anglers reported three tag recoveries in the Bahamas which accounted for 2.7% of the recaptures (3 fish). International recoveries (see Over-winter Dispersals) of fish tagged off the East Coast also accounted for 2.7% of all recaptures.



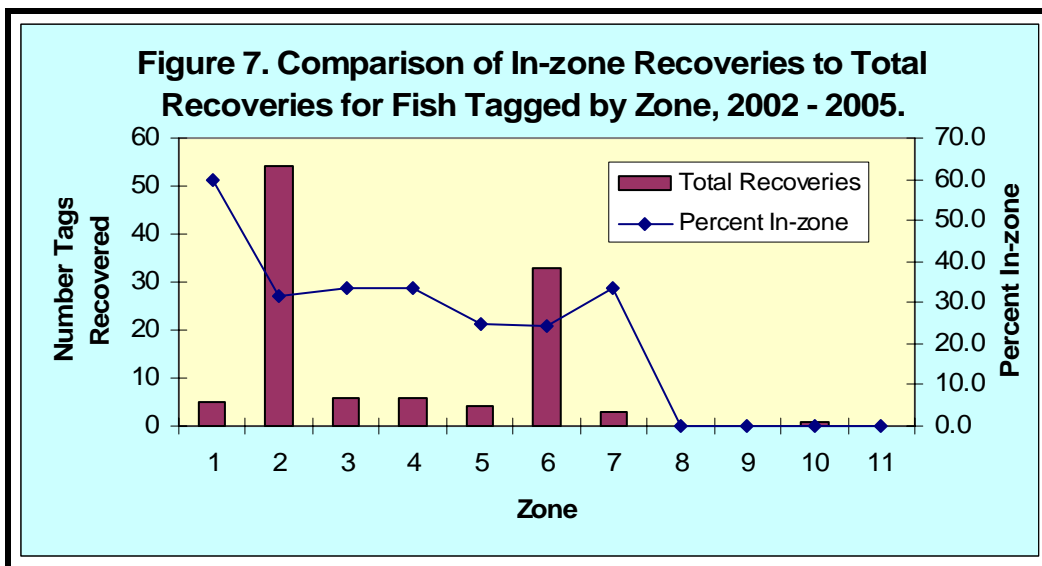
Tag recaptures show a very clear south to north dispersal pattern for fish tagged along the east coast in spring and summer (Table 6) and recovered the same year. However, seven recoveries from the East Coast indicated southerly movements. But four fish recovered south of their release site were still in the same zone having moved less than 25 miles. Only two fish recovered in the same calendar year as tagged exhibited movements to a zone south of their release site. Both fish were tagged during May in zone 4 and recovered in zone 3. Two other recoveries of East Coast fish that displayed southerly movements were recovered during spring following the year they were tagged. The remaining 103 tagged fish recoveries indicated a net northerly movement.

Table6. Spatial distribution of tagged fish recoveries by zone of release, 2002 - 2005.

Release Zone	Recapture Zone												Total	
	1	2	3	4	5	6	7	8	9	10	11	Intern.		
1	3	0	0	0	1	0	1	0	0	0	0	0	0	5
2	0	17	23	5	0	0	2	5	0	2	0	0	0	54
3	0	0	2	2	0	0	1	1	0	0	0	1	0	6
4	0	0	2	2	1	0	1	0	0	0	0	0	0	6
5	0	0	0	0	1	1	0	1	0	1	0	0	0	4
6	0	0	0	0	0	8	11	8	1	3	0	2	0	33
7	0	0	0	0	1	1	1	0	0	0	0	0	0	3
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	1	0	0	0	0	0	0	1
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3	17	27	9	4	10	18	15	1	6	0	3	0	113

It should be noted that 12 (18%) of the 66 recoveries of dolphin tagged in Florida were recaptured from North Carolina northward into the Mid-Atlantic Bight, zones 7 through 10. Recognizing the south-to-north movement pattern, it is puzzling why no fish tagged off Florida have been recovered off South Carolina. Over 80% of the recoveries of dolphin tagged off Florida were recaptured off Florida. This is appreciably higher than dolphin tagged and recovered off South Carolina which accounted for 24% of the Palmetto state's recaptures.

Recoveries of fish within the same zone as tagged comprised 30% of the overall recaptures. Annual level of in-zone recoveries ranged from 26% in 2005 to 37% in 2003. Recoveries in these years were shown to have the fastest average rate of travel and the slowest average travel rate respectively, which probably played a major role in such recaptures. In-zone recaptures occurred in zones 1 through 7 with the highest number reported in zone 2 with 17 such recoveries followed by zone 6 which had 8 (Figure 7). The highest rate for in-zone recaptures occurred in the Bahamas accounting for 60% (3 fish recovered) of area's tag recoveries. In-zone recoveries are likely a function of the combined factors of the number of fish being tagged, level of fishing effort applied and the hydrodynamics (speed and eddy formation) of the Gulf Stream that year.



Most in-zone recoveries occurred after relatively short liberty periods (less than one week). In zone 2 where the highest number of in-zone recaptures occurred, the average in-zone recovery was at liberty for 4.5 days and traveled 42.9 miles (Table 7). However, in-zone recoveries had a markedly different profile off South Carolina, zone 6, where the average liberty was 26.5 days and the distance traveled 22.3 miles. Four of the eight in-zone recoveries off South Carolina were at liberty from 22 to 76 days. One fish tagged and recovered in zone 6 was at liberty for 70 days and was recaptured only 19 miles from the original release site.

Table 7. Comparison overall averages for in-zone recoveries for zones 2 and 6, 2002 to 2005 combined.

Zone	Number	Liberty	Distance	Speed
2	17	4.5	42.9	9.5
6	8	26.5	22.3	0.8

Annual Movement Behavior

Recoveries exhibited considerable variations among the years in their movement profiles (Table 8). Average annual liberty periods range from a low of 24.5 days in 2005 to a high of 51 days in 2004. The average annual distance traveled varied from 236 miles (2003) to 304 miles (2004) with the overall average speed of travel ranging from 5 miles per day to 12 miles per day. Discounting a tag that washed ashore and one taken from the stomach of a large bull dolphin, the four-year average was 40.5 days at liberty, 281 miles traveled at a speed of 6.9 miles per day. The data clearly indicate that recoveries of fish tagged in 2005 showed a faster rate of travel than previous years even though they had the shortest average liberty period (Table 7).

Table 8. Annual averages for all recoveries. (Does not include tags recovered from a beach or taken from a fish's stomach.)

Year	Number Recoveries	Liberty Days	Distance Miles	Travel Rate Miles/Day
2002	10	38.1	271.8	7.1
2003	27	46.9	235.6	5
2004	40	51.1	304.3	6
2005	36	24.5	292	11.9
Wt. Ave.	113	40.5	281.1	6.9

Annual movement patterns can be viewed from many perspectives depending on what filters are applied to the data. If short-term recoveries having liberty periods of one day or less are omitted along with the wash-up and ingested tags, a slightly different profile is shown for the average annual tag recoveries. With all years combined, there is a 17% increase in the average liberty period to 47 days along with a 14% increase in distance traveled to 321 miles (Table 9). However, little change was noted in the average speed of travel each year.

Table 9. All recoveries except those tags recovered from a beach, taken from a fish's stomach or having liberties of one day or less.

Year	Number Recoveries	Liberty Days	Distance Miles	Travel Rate Miles/Day
2002	8	47.6	332.8	7.0
2003	25	50.6	252.5	5
2004	36	56.7	332.5	5.9
2005	28	32.3	365.5	11.3
Wt. Ave.	97	47.3	321.4	6.8

Finally, by removing the long distance and extended liberties represented by the international recoveries along with in-zone (short distance) recoveries and the previous eliminations, both the long and short term extremes are removed from the equation. This filtration should have drawn the annual averages closer together but it had the opposite effect. While the overall liberty period declined 3% from the previous analysis the distance traveled increased 8% combining to produce a 10% increase in the speed of travel (Table 10). However, even under this restricted analysis, 2005 recoveries continued to exhibit the fastest speed of travel while 2003 remained the slowest year for travel speed.

Table 10. All recoveries except those tags recovered from a beach or taken from a fish's stomach, recoveries with liberties of one day or less, international and in-zone recoveries.

Year	Number Recoveries	Liberty Days	Distance Miles	Travel Rate Miles/Day
2002	7	54.1	375.4	6.9
2003	17	70.6	350.9	5
2004	24	43.1	306	7.1
2005	20	28.4	398.3	14
Wt. Ave.	69	46.1	346.4	7.5

Differences were observed in the average speed of travel between recoveries of fish tagged in the Florida Straits, zone 2, versus those tagged off South Carolina, zone 6. Recoveries from zone 2 consistently traveled at a higher rate of speed and had shorter liberty periods than those originating from zone 6 (Table 11). Zone 2 fish traveled at speeds that were from 2.2 (out-of-zone recaptures) to 11.8 (in-zone recoveries) times faster on average than their South Carolina counter parts. Average liberty periods for fish from the Florida Straits were only 0.17 (in-zone recoveries) to 0.57 (MAB recoveries) the length of time for zone 6 recoveries.

Table 11. Comparison of time at liberty and travel speed for fish tagged in zone 2 and zone 6 and recaptured.

In-zone Recaptures

Release Zone	Number	Liberty	Distance	Speed
2	17	4.5	42.9	9.5
6	8	26.5	22.3	0.8

Out-of-zone Recaptures (less recoveries with 1 day or less liberty and international recoveries)

Release Zone	Number	Liberty	Distance	Speed
2	32	26.8	384.6	14.4
6	23	49.4	212	6.5

Recaptures in the Mid-Atlantic Bight (zones 8, 9 and 10)

Release Zone	Number	Liberty	Distance	Speed
2	7	36.7	912.3	24.9
6	12	64.1	425.5	6.6

Over-winter Dispersals

The absence or very low abundance of the species during winter months in all but the most southern tip of the US East Coast indicates a movement away from the US east coast. The spring influx of large schools of dolphin into the Florida Straits also implies movement from another area outside US territorial waters. Nine tag recoveries presented in Table 12 represent fish recaptured during or following the winter after their original release. Five of the tagged fish were recovered from US East Coast waters while the other four were found in the Caribbean Sea and eastern Atlantic. The over-winter recoveries off the US mainland could be fish that never left domestic waters but more likely indicate fish returning to US waters. Caribbean recoveries came from south of Puerto Rico, Antigua and the Belize/Mexico border. The eastern Atlantic recovery came from south-southwest of the Azores Islands. As a whole, Caribbean and eastern Atlantic recoveries occurred earlier in the calendar year

than the over-winter recoveries along the US coast. This indicates some level of interaction of fish in the two areas.

Table 12. Recaptures involving over-winter dispersals, 2002 - 2005.

Tag Number	Release Date	Release Zone	Days Liberty	Month Recovered	Distance Miles	Travel Rate miles/day	Recapture Area	Direction of Travel
K033036	06/27/03	7	313	May	291	0.9	5	SW
K035911	10/08/03	10	221	May	453	2.1	7	SW
K036046	11/28/03	4	161	May	65	0.4	4	N
K036485	07/08/04	2	324	May	298	0.9	4	NNE
K044728*	06/24/05	3	236	Feb	105	0.5	3	N
K032173	06/15/04	6	241	Feb	2,487	10.3	E Atlantic	E
K035498	05/15/04	6	330	April	1,221	3.7	W Caribbean	SSW
K044696*	06/19/05	3	230	Feb	1,494	6.5	E Caribbean	ESE
K045232*	07/23/05	2	246	Mar	1,036	4.2	NE Caribbean	ESE

* Denotes late report of recovery not included in other analysis.

Discussion

Participation by recreational anglers in tagging fish for research is based on many factors. The abundance of the species in an area, the popularity of that species as food or its fighting ability and the number of active anglers in the area that pursue the species. Angler involvement is also based on the level of conservation awareness and the “full freezer” factor. Education is a major factor in building conservation awareness among anglers. Sunshine State anglers have often been the first to experience declines in fish stocks. Subsequently, they are sensitive to fishery conservation issues and the desire to head-off fishery problems when possible. South Carolina’s marine anglers have been exposed to the concept of tagging fish for science since 1974 when the SC DNR first sought public assistance in tagging fish. Subsequently, many Palmetto State anglers have grown up with the concept of assisting science by tagging marine fish. The “full freezer” factor spans all species and regions. It is based on the premise that anglers become more willing to tag and release fish after they have caught all they want to eat. This hypothesis suggests that annual tagging activity would normally lag behind the initial occurrence or availability of the species.

The Marine Recreational Fisheries Statistical Survey conducted by NOAA Fisheries showed that of the Atlantic states harvesting dolphin recreationally, Florida (54.7%), North Carolina (39.2%) and South Carolina (1.5%) were the top three states during 2000 through 2004. The Mid-Atlantic Bight above North Carolina was responsible for less than 5% of the total east coast recreational harvest. Florida anglers accounted for the majority, 60.7% of the dolphin tagged during the four-year study. However, it was South Carolina fishermen that marked and released the second highest number providing 32.2% of the fish tagged. North Carolina anglers contributed only 2.8% of the total fish tagged. More fish were tagged off the Florida Keys, zone 2, than any other single zone, 1,946 fish with South Carolina fishermen tagging the second highest number in zone 6, 1,393 fish (28.3%).

During the four years of this study, dolphin were tagged in each month of the calendar year off the East Coast. This year-round presence is supported by anecdotal reports by fishermen in the SAB who have said they have caught dolphin in the Gulf Stream during the winter months, but always in small numbers. While a clear south-to-north spring/summer progression was noted in the occurrence of fish off the east coast, data did reveal a primary season for the SAB. The SAB dolphin fishing season

extends from April through August based on the fact that over 90% of the tagging activity and tag recaptures took place during that period. While existing data for the MAB would indicate a later season, June through September, there are insufficient data to assess dolphin occurrence in this region.

The number of dolphin tagged was not uniformly distributed among the zones along the US east coast nor did it correlate with a state's dolphin harvest as reported by MRFSS. But by having two areas of high tagging activity separated by 7° latitude along the migratory route, it was possible to compare movement patterns between different areas. Data showed a clear pattern of more rapid travel northward for fish recovered out of their tagging zone. Fish tagged off south Florida traveled at an average of 14.4 miles per day compared to those tagged off South Carolina which traveled at 6.5 miles per day. This is likely related, in part, to the Gulf Stream/Florida Current flow pattern which travels at a higher speed through the channel formed by the US continental shelf and the Bahamas Banks compared to the northern portion of the SAB where the current tends to spread out and slow down. The other hydrological feature affecting the travel rate in the SAB is the Charleston Gyre that occurs intermittently on the north side of the Charleston Bump (in the vicinity of 32°N to 33°N latitude and 79°W to 77°W longitude). Dolphin may become entrained in this gyre, remaining there for two months or longer. This time spent going in circles would explain the longer time periods for in-zone recoveries off South Carolina and the slower overall rate of travel northward exhibited by fish tagged in this area.

Recaptures during spring and summer indicated dolphin movements from the Straits of Florida to Cape Hatteras, North Carolina, and into the Mid-Atlantic Bight as far north as Martha's Vineyard, Massachusetts. This provided the first substantial evidence on the domestic route northward. However, the route(s) used by these fish in the summer/fall as they leave US Territorial waters remain obscure. Winter recoveries of east coast dolphin have occurred in such widely separated areas as the eastern Atlantic, West Indies, Caribbean Sea and southeast Florida which indicates multiple migratory routes. Four recaptures of fish tagged and recovered on the east coast whose liberty period spanned winter suggests that at least some portion of the east coast dolphin population will return in subsequent years.

The large difference in the tag recovery rate of dolphin tagged in the first half of the calendar year versus the second half suggests that outside factors are influencing recovery rates. Higher water temperature could play major role in the survival of fish tagged from July through September in the SAB. With less than 50% of the fish recovered having temperature-at-time-of-release data, no correlation could be drawn between temperature-at-tagging and survival. Fish tagged in zone 2 and 3, Straits of Florida and south Florida, after July 1 had lower recovery rates similar to other areas, but the 7 recoveries that resulted from these second-half fish showed similar movement patterns to fish marked in the first half of the year.

Northward movements of dolphin along the eastern seaboard appear to be closely associated with the Florida and Gulf Stream currents. Florida fishermen commonly report tagging dolphin that were caught while swimming southwest/west against the current but recoveries have clearly shown a net northward movement. The ocean currents in the SAB commonly flow northward at speeds of 1 to 4 knots which translates into daily water-mass movement of 28 to 111 miles per day. Fish instinctively face into and swim into a prevailing current, but do not necessarily swim faster than the flow, thus there could be a net movement over the ground to the north. This could help explain why the overall calculated travel rate for dolphin ranged 5 to 14 miles per day which is far less than potential current transport alone.

Gulf Stream eddies are another major influence in the occurrence and movements of dolphin in the SAB. Upwellings associated with this region with their nutrient rich waters and concentrations of

baitfish attract and can hold aggregations of dolphin. During spring and early summer it is normal for large eddies to develop on the western side of the Gulf Stream in the northern section of the SAB. These will commonly push up over the continental shelf slowing the water mass's northward movement as well as that of any entrained dolphin. However, in 2005 virtually all eddies formed within the main body of the Gulf Stream which kept these water masses moving at the same pace as the Stream and thereby probably contributing to the fastest annual rate of travel observed (11 to 14 miles per day). The other impact that eddies within the Gulf Stream have is to keep the largest concentrations of dolphin further off the coast than in most normal years.

Origins of dolphin caught off South Carolina are not clear. While we assume that dolphin off the Palmetto State come from Florida, no fish tagged off the Sunshine State has been recaptured off South Carolina. However, twelve dolphin tagged off Florida have been recovered off the North Carolina coast in to the Mid-Atlantic Bight, possibly reflecting the greater fishing effort off North Carolina. Another area likely to contribute to the east coast dolphin population would be the eastern side of the Bahamas Islands. Fish in this area could use the Antilles Current as a transport mechanism to the Gulf Stream. A tag recovery from a fish tagged off the east side of Eleuthera, Bahamas and recaptured east of Sapelo Island, Georgia, supports this hypothesis.

Dolphin movements and migrations appear very complex. While their movements can not be correlated to any single factor, the dynamics of the major ocean currents, in this case the Florida, Gulf Stream and Antilles currents probably have the greatest impact on dolphin distribution on the US east coast. The spring/summer northward movements in the SAB appear to follow the flow patterns of the major currents. Movements into the MAB are less predictable due to the higher variability in the behavior of the Gulf Stream and its associated eddies in these waters.

The summer/fall exodus of dolphin from US Territorial waters is most likely multi-directional with many factors figuring into these movements. Behavior of the Florida and Gulf Stream currents, and availability of food and water temperature probably have the most influence on their movements. Tag recovery data provided no evidence to support a fall southerly movement by dolphin along the US east coast. Dolphin most likely depart east coast waters by moving east into Atlantic waters where they use various southerly currents beyond the eastern wall of the Gulf Stream to aid their movement to warmer southern waters where they spend the winter period.

Distribution of tag recovery reports between the recreational boats (87%) and commercial vessels (8%) supports the harvest allocation set by the South Atlantic Fisheries Management Council in their management plan for the domestic dolphin fishery, recreational 87% and Commercial 13%. Annual landings data collected by NOAA Fisheries programs, commercial and recreational, for 2000 through 2004 indicated a fishery even more weighted toward the recreational sector with 95.5% of the landings coming from that user group. Private boat anglers accounted for 63.6% of the recreational dolphin harvest in the SAB while the for-hire vessels produced the other 32.9% of the recreational harvest. This data set showed commercial fishing producing less than 5% of the harvest during this period in the SAB.

Recommendations:

This study has been very successful in gathering data to begin the process of defining the movements and migrations of dolphin fish found off the east coast of the United States. The information gathered indicates a very complex movement behavior. The initial links shown between dolphin off the US east coast and those in the eastern Atlantic Ocean and the Caribbean Sea could alter the multi-stock hypothesis currently accepted for the Western North Atlantic. To understand the impact that ocean currents, climatic conditions and prey abundance have on east coast dolphin stocks will require more long-term research.

This project has demonstrated how recreational fishermen can be effectively employed in studying movements of highly migratory species. The willingness by anglers to provide specific data and follow specific guidelines shows them to be a valuable resource in such studies. Recreational fishermen should be involved in more research on marine species of recreational importance.

The study on the movements and migrations of dolphinfish present off the US Atlantic and Gulf coasts should be continued to fully define their movements in US waters as well as their relationship to dolphin stocks found in other parts of the North Atlantic Ocean, Gulf of Mexico and Caribbean Sea.