

**REVIEW OF TAGGING DATA FOR GAG GROUPER (*Mycteroperca microlepis*) FROM THE
SOUTHEASTERN GULF OF MEXICO REGION 1985-2005.**

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SUMMARY

Over 6,500 gag have been tagged with conventional tags and released in South Florida waters, primarily off the Florida west coast as part of Mote Marine Laboratory's Tagging Program and the NMFS SEFSC Miami Tagging Program from 1985 to 2004. Of these, more than 600 have been recaptured; 50% of recaptures were within 2 months of release and 80% of recaptures were caught within a 9 km radius of their release point. Recaptures showed no movement between the Gulf of Mexico stock and the Atlantic stock units. Fish tagged and released in the Florida Keys, the boundary area between stocks have been recaptured within the same area. Predominant movements observed were between the coastal areas and the adjacent continental shelf edge, probably associated with spawning and ontogenic related migrations. These data suggest that gag grouper do not mix substantially between Gulf of Mexico and Atlantic unit stocks. A relative high proportion (11%) of fish recovered has been recaptured multiple times, up to 10 times, which suggests a good survival rate for gag subjected to both the tagging process itself and hooking-release procedures. These results contrast with the movement patterns observed from gag tagged and released off the Atlantic coast reported by McGovern et al. (2005). In their study, of 3,876 gag releases and 435 recaptures, a larger proportion of fish (23%) moved over 185 km, primarily off the South Carolina coast towards the south to be recaptured off the Florida east coast, the Florida Keys, and in Gulf of Mexico waters. This difference in movement trends may partially be explained by differential behavior of fish associated with size and age.

Introduction

Gag grouper, *Mycteroperca microlepis*, are an important component of the reef-associated grouper species complex of the Gulf of Mexico and South Atlantic US waters. It is a protogynous hermaphrodite (McErlean and Smith, 1964) common along shallow reef tracks and shelf breaks off the west coast of Florida (Johnson and Koenig, 1994). Currently, the gag fishery is managed assuming two separate stock units: the South Atlantic stock extending from the mid-Atlantic coast to the lower Keys off the east coast of Florida, and the Gulf of Mexico stock ranging from the waters off the west Florida coast to Texas. Gag aggregate to breed in offshore areas, usually associated with deep reef structures along the continental shelf (Brule et al 2003). Studies suggest that individual fish exhibit fidelity to spawning sites (Coleman et al 1996). After a larval period of about 40-50 days (McErlean 1963), juvenile gag then settle in estuarine seagrass beds along the coast (McErlean 1963, Ross and Moser 1995, Coleman et al 1996). Juveniles spend between three to six months in bay grass beds, and then migrate to reef associated structures (Coleman et al 1996). Data provide evidence of ontogenic migration to deeper water with growth, and in general larger fish are found in deeper waters (Hood and Schlieder 1992).

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Sporadic tagging of gag grouper with conventional tags goes back to 1960s; however, most of the gag directed tagging research was conducted in the 1990s. A tagging program in the early 1960s (Schlitz Tagging Program, Florida State Board of Conservation Div of Salt Water Fisheries) tagged 811 gag and recaptured 216 fish between 1962 and 1966 off the Florida east and west coast (Beaumariage 1969). McGovern et al. (2005) reported results and trends from tagging studies of gag in the southeastern Atlantic waters. The objective of this document is to provide an overview of gag tagging data to explore the possibility of mixing between the current stock units. By reviewing tagging effort and recapture data using time and spatial factors, a general determination of fish movement can be inferred and evaluated against current stock unit boundary definitions.

Methods

A gag tagging database was developed from tag release and recapture information provided by various institutions. Mote Marine Laboratory (K. Burns, Fish Biology Program Manager) provided gag data for fish tagged and recaptured from 1991 to 2005. Data from Mote Marine Laboratory (MML) constituted the bulk of the gag tagging data reviewed. Tagging data were also extracted from the NMFS SEFSC MIA Tagging Program Database. Although this Program primarily targets highly migratory species, in the past, some recreational anglers tagged and released gag, particularly in the south Florida region. The NMFS MIA tagging database also serves as a repository for other agencies and organizations, which conduct tagging studies within the Atlantic and Gulf of Mexico. Boat US and the Florida Department of Natural Resources tagged gag during the 1990s and these data are also included.

Mote Marine Laboratory Gag Tagging Data

MML staff and volunteer taggers tagged and released about 6,353 gag grouper from 1991 to 2005. Annual releases peaked in 1998, with over a thousand fish tag-released, and have increased in the years since 1999 with over 400 tag-releases per year (Figure 1, Table 1). Of these, 586 tagged gags have been recaptured (Figure 1, Table 2). Several fish were recaptured more than once. A total of 11% of the recaptures were from tagged fish caught twice, and approximately 5% of the recaptures were tagged fish caught three or more times (Figure 2). One fish has been caught and released 10 times (Table 1). Nominal recapture rates oscillated between 3% (1991) and 11.7% (2004), with a mean of 8.3% for an annual recapture rate. Figure 3 shows the nominal recapture rates, which follow the proportion of releases by year after 1996. The higher release rate was the result of the participation of a larger number of volunteer taggers (made possible by Florida Sea Grant and federal MARFIN and CRP grants which increased funding for supplies, publicity and data management). Before 1996, all funding for the MML Tagging Program came from donations from commercial and recreational fishers. It is important to mention that these recaptures rates are nominal, and vary largely due to other factors (as indicated by scientists from the MML).

Gag tagged releases per month from MML were higher in spring and early summer (Apr-Jul) and fall (Oct-Nov) (Figure 4). By contrast, recaptures were higher from May through August and much lower during winter and spring months (Figure 4). By fishing sector, recreational fishers released the most tagged gag, until 1997 when more tagged fish were released off headboats. Since 1997, headboat releases were followed by charter and general recreational fishers; commercial fishers accounted for approximately 7-8% of gag first releases (Table 4, Figure 5). Recaptures followed a similar trend distribution by fishing sectors (Table 4, Figure 5), with higher recaptures reported by headboat fishers than recreational/charter components. By area, MML gag tagged releases predominantly occurred off the West Florida coast. On the Atlantic side, tagging began in 1997, and has increased in recent years, with up to 212 releases in 2004 (Figure 6). A map of the releases by fishing sector is shown as Figure 7. Off the Gulf east coast, most tagging took place off Tampa Bay. Figure 8 shows a map of all first recaptures of tagged gag from the MML Tagging Program. Recaptures were also highest off the central Florida west coast, but gag tagged fish have been caught off the Atlantic coast, Florida Keys and the north Apalachicola Bay area. A frequency distribution of the straight distance between point of release and point of recapture (Figure 9) shows that approximately 45% of fish were recaptured within 2 or less km from their respective point of release; only

9% of tagged fish moved 20 or more km from the point of release. The map of straight distance for recaptures with 18+ km shows that movements were restricted to the water body of origin, ie. no fish tagged in the Atlantic have been recaptured in the Gulf or vice versa. Fish tagged in the Florida Keys have been recaptured in that area, with no large movement out of that area. In both the Atlantic and Gulf of Mexico, some of the fish tagged close to shore showed a pattern of movement toward the continental shelf edge (Figures 8 and 10). In general, 30% of recaptures took place within the first 4 weeks following release, and 60% within 11 weeks at large. Within 6 months (26 weeks) 80% of recaptures had occurred. Approximately 8% of tagged fish were recaptured after 1 or more years at large. The longest time at large was 4 years for a gag tagged in May-1999 off Bradenton, FL and recaptured in May 2003, also off the central Florida west coast. Figure 12 shows the size (inches) frequency distribution of tagged and recaptured gag. Fish from 10 to 22 inches were the predominant size range tagged, with a peak at 18 inches fish. However, larger sized individuals have also been tagged (up to 44 inches). Recaptures show a slightly larger size frequency distribution, with the main size range between 12 and 26 inches, peak at 18-20 inches.

A plot of days at large versus straight distance travel, restricted to fish that moved 12 or more nm, is shown in Figure 13. There is no linear relationship between time at large and distance. Fish at large between 10 and 600 days moved up to 180 nm distance, with a mean straight distance between 20-60 nm. For fish at large over 1,000 days, mean straight distance displacement was about 40-60 nm. Scatter plots of estimated distance to shore at tagging against mean total length (for one inch class bins) show a positive correlation for both Atlantic and Gulf of Mexico gag stocks (Figure 14, provided by scientists at MML). This relationship corroborates the observation of larger gag moving further offshore and deeper. The slope of the relationship is lower for Gulf of Mexico tagged fish due to the wider continental Gulf shelf compared to that off the Atlantic coast.

NMFS SEFSC MIA Tagging Program

Gag are not a main target species for this tagging program. Only 168 gag have been tagged and released from 1971 through 1998 (Table 5, Figure 15). Most releases occurred in the early 1990s, with a peak of 50 tagged fish released in 1989. There have been 22 reported recaptures of tagged fish, primarily during the early 1990s. Figure 16 shows a map of the geographical distribution of tagged fish. Most fish were tagged in the Florida Keys and off the Florida Panhandle, with very few tagged fish off the Atlantic coast. Most releases occurred in November, while recaptures were reported in March and June (Figure 17). Length frequency plots of tagged fish indicate that gag between 10 to 20 inches were released most often, while slightly larger (16-30 inches) fish were recaptured, however, sample size was small (Figure 18).

Approximately 70% of gag were recaptured within the first 6 months at large (Figure 19). The longest time at large was for a fish released on Aug-1994 and recaptured on Mar-1998 (1,675 days at large), but it only moved 55 km from the point of release to the point of recapture (off the northern Florida Gulf coast area). Approximately 40% of recaptured tagged gags were caught within 10 km of their point of release, 77% within a 30 km radius, and only three fish over a 100 km radius of their release point. One gag was reportedly caught about 1,100 km from the release point in the Gulf of Mexico, however, the point of recapture is in doubt and no confirmation was possible. Figure 20 shows a map with trajectories between release and recapture points. Largest distances traveled were observed for fish off the Florida Panhandle, moving from inshore to offshore and vice versa. In the Florida Keys, recaptures had relatively limited displacements; only one fish was recaptured off the area, but again, no confirmation on the information was available. No recaptures have been reported for fish tagged in the Atlantic Ocean, nor has any movement between Gulf and Atlantic waters been observed.

Summary and Discussion

Over 6,500 gag have been tagged with conventional tags and released in South Florida waters, primarily off the Florida west coast as part of Mote Marine Laboratory's Tagging Program and the NMFS SEFSC Miami Tagging Program (1985 to 2004). Of these, more than 600 have been recaptured.

Approximately 50% of recaptures occurred within 2 months of release, and 80% of recaptures were caught within a 9 km radius of their release point. No movements between the current stocks units were recorded. Fish tagged and released near the boundary area (Florida Keys), were in almost all cases recaptured in the same area. Movements were predominantly between coastal areas and the adjacent continental shelf edge, probably associated with spawning and ontogenic related migrations. The tagging results from MML and the NMFS Miami Tagging Programs contrast with movement patterns observed for gag tagged and released off the Atlantic coast reported by McGovern et al. (2005). In their study, of 3,876 gag releases, mostly off the South Carolina coast, 435 were recaptured. Most recaptures occurred between 1995 and 1999 and a large proportion of recaptured fish (23%), moved over 185 km, almost all moving south to be recaptured off the Florida east coast (St Augustine and Cape Canaveral), the Florida Keys, and in the Gulf of Mexico. They also tagged gag off the Florida Keys (177), which were recaptured in the same area. The authors suggested that the southerly movement may be related to spawning migrations, although they could not demonstrate seasonal trends of movement (McGovern et al 2005).

Both the Gulf of Mexico and South Atlantic main tagging studies have comparable nominal recapture rates (10-12%). However, the mean size of gag recaptured (29 inches) in the South Atlantic was larger compared to gag recaptured by the MML Tagging Program in the Gulf waters (18 inches). This may indicate that large movements are associated with certain size and/or age groups of gag. McGovern et al (2005) found that the largest fish did not move from their release tagging point, and that the largest distances traveled were for gag between 27 to 32 inches (tagged between 20 to 40 m deep). Recaptures of Atlantic gag in the Gulf of Mexico indicate that, at least for the Atlantic stock, there is a transfer of fish to the Gulf stock, primarily of medium-large size fish (30-32 inches).

In the Schlitz Fish Tagging Program by the State of Florida (Beaumariage 1969) of 811 gag, released 216 were recaptured, for a nominal recapture rate of 26% (higher than recent tagging studies). In that tagging program, fish were released off both Florida coasts, with a greater number of fish tagged in the Gulf, at least for 1965 (when numbers by area were available). No recaptured fish tagged in the Atlantic were recaptured in the Gulf side or vice versa (Beaumariage 1969). Indeed, the author indicated that most recaptures were near or at the tagging site. Only 6 gag recaptured moved over 13 km from the point of release, although the average time at large was only 105 days (Beaumariage 1969).

Results from conventional tagging studies in the southeastern Gulf of Mexico suggest that current assumed gag grouper unit stocks do not mix, however, this is not the case for gag tagging studies from southern Atlantic waters (McGovern et al 2005). These studies show an influx of gag from the Atlantic to the Gulf. A relatively high proportion (11%) of gag tagged have been recaptured multiple times (up to 10 times), which suggests a high survival rate for gag subjected to the tagging process and hook-release procedures.

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Table 1. Gag tagged releases by year from the Mote Marine Lab Tagging Program.

Year	1st release	2nd release	3rd release	4th release	5th release	6th release	7th release	8th release	9th release	10th release	Total
1990	61	1									62
1991	426	11									437
1992	198	6	2								206
1993	122	6									128
1994	180	10	3	2	1						196
1995	81	3	1								85
1996	57	3									60
1997	346	20	4								370
1998	975	100	12	3							1090
1999	520	33	11	3							567
2000	399	18	1								418
2001	795	48	5								848
2002	559	49	3								611
2003	445	31	1	2							479
2004	635	51	10	2	1	1					700
2005	537	54	7	3	1		1	1	1	1	606
No date	17										17
Total	6353	444	60	15	3	1	1	1	1	1	6880

Table 2. Gag tag recaptures by year from the Mote Marine Lab Tagging Program.

Year	1st capture	2nd capture	3rd capture	4th capture	5th capture	6th capture	7th capture	8th capture	9th capture	Total
1990	1									1
1991	34	1								35
1992	27	2								29
1993	14									14
1994	11	1	2	2	1					17
1995	13	3	1							17
1996	6									6
1997	24	6								30
1998	109	20	6							135
1999	48	13	4	1						66
2000	27	1		1						29
2001	52	6								58
2002	44	4								48
2003	42	3	2							47
2004	61	8	2	1	1					73
2005	73	10	4	1		1	1	1	1	92
Total	586	78	21	6	2	1	1	1	1	697

Table 3. Gag monthly releases and recaptures all years of tagged fish Mote Marine Lab Tagging Program.

Month	Releases	Captures
Jan	504	27
Feb	453	34
Mar	484	50
Apr	656	60
May	593	88
Jun	562	65
Jul	578	71
Aug	403	61
Sep	444	19
Oct	746	42
Nov	615	43
Dec	298	26

Table 4. Gag tag releases and recaptures by fishing sector and year Mote Marine Lab Tagging Program.

Year	Charter		Commercial		Commercial Bandit		Commercial Longline		HeadBoat		Pier		Recreational		Unknown		Total	
	Rel	Cap	Rel	Cap	Rel	Cap	Rel	Cap	Rel	Cap	Rel	Cap	Rel	Cap	Rel	Cap	Rel	Cap
1990	27	1	34	1													61	2
1991	259	29	2		3		15	1	14	4			17	2	116	10	426	46
1992	99	2			2				9				16		72	4	198	6
1993	19	5							23	1	1		79	7			122	13
1994	62	12											106	2	12		180	14
1995	35	3											45	5	1		81	8
1996	7	2					16		1				16		17		57	2
1997	64	1							205	30	3	1	45	6	29	2	346	40
1998	60	4					1		867	104	4	1	38	1	5	2	975	112
1999	34	4	7	2					357	35	6		93	5	23	2	520	48
2000	62	2							180	17	3		125	2	29		399	21
2001	172	10	160	6					303	27	18		138	7	4		795	50
2002	22		37	1					174	22	10	2	314	23	2		559	48
2003	14	1	11						223	20	9	2	180	14	8		445	37
2004	60	2	157	24					319	39	5	1	83	7	11	1	635	74
2005	92	3	1						169	17	7	2	268	26			537	48
Total	1088	81	409	34	5		32	1	2844	316	66	9	1563	107	329	21	6336	569

Table 5. Gag tag releases and captures by agency from the NMFS SEFSC MIA Tagging database.

Year	NMFS SEFSC MIA		Boat US		FL DNR	
	Release	Captures	Release	Captures	Release	Captures
1971	2					
1985	2					
1989	50					
1990	5	2				
1991	3	2				
1992	5	3				
1993	22	2			1	
1994	32	4			10	
1995	25	7				
1996	3					
1997	1		6			
1998	1	1				
1999		1				
Total	151	22	6	0	11	0

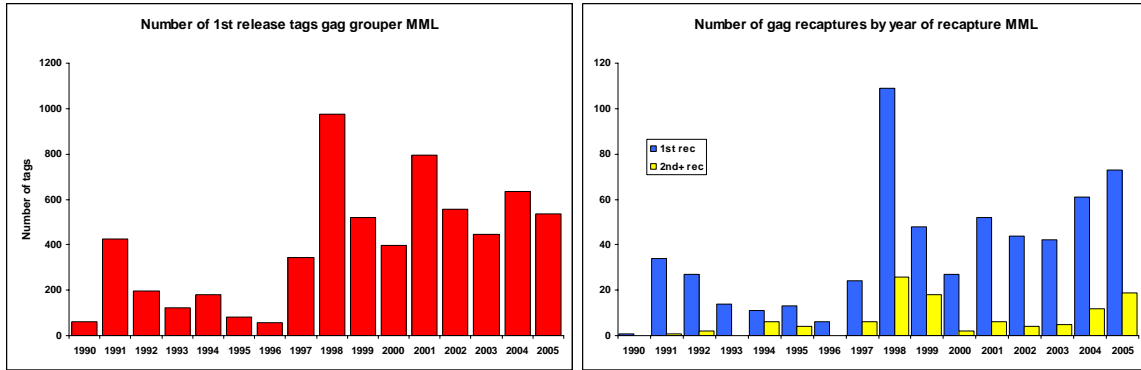


Figure 1. Gag 1st tag releases (left) and recaptures by year from the Mote Marine Laboratory Tagging Program.

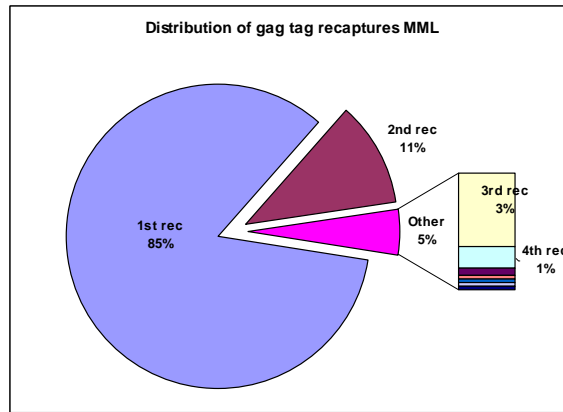


Figure 2. Percent distribution of gag tagged recaptures from the MML tagging program

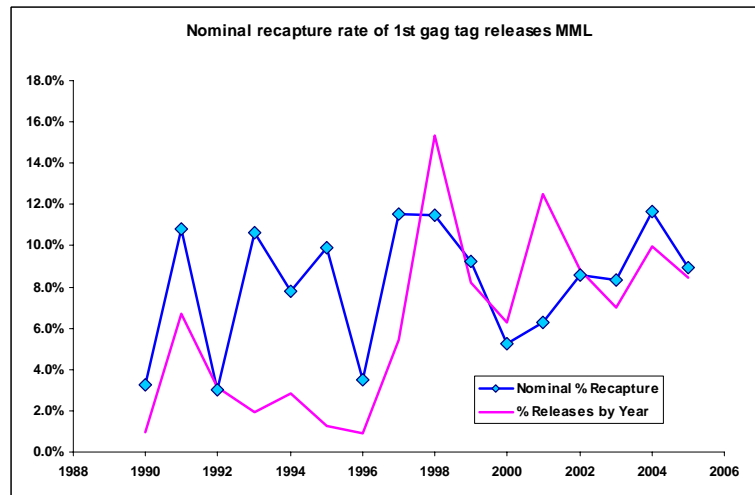


Figure 3. Nominal annual recapture rates of gag grouper (solid diamonds) and annual percent of tag releases (line) from the MML tagging program

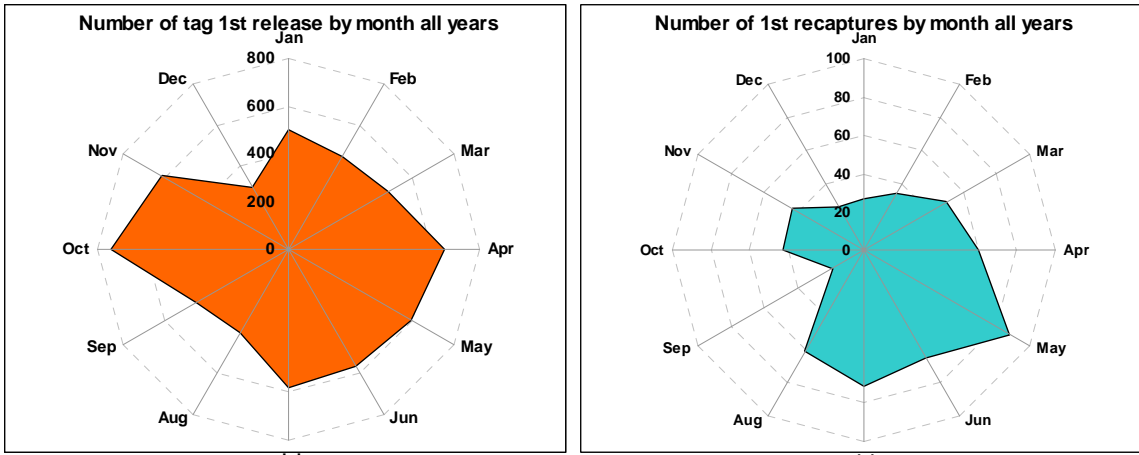


Figure 4. Monthly distribution of gag tag releases (left) and recaptures (right) from the MML.

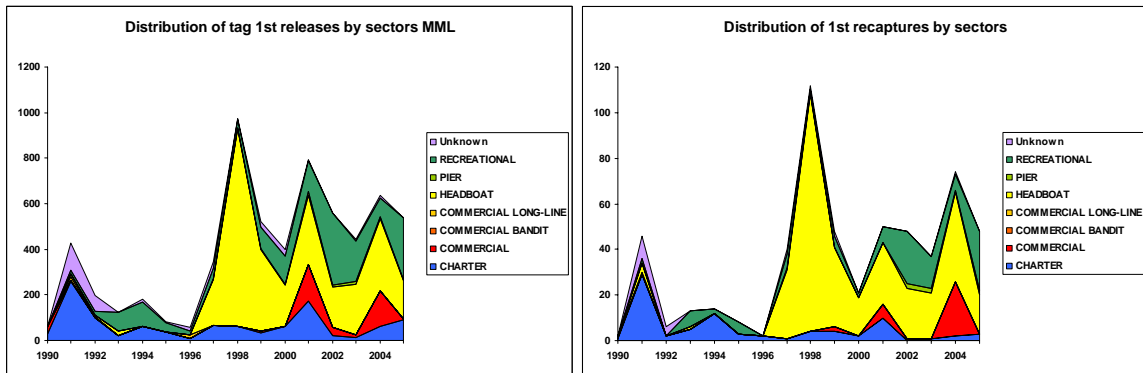


Figure 5. Distribution of gag tag releases (left) and recaptures by fishing sector from the MML tagging program.

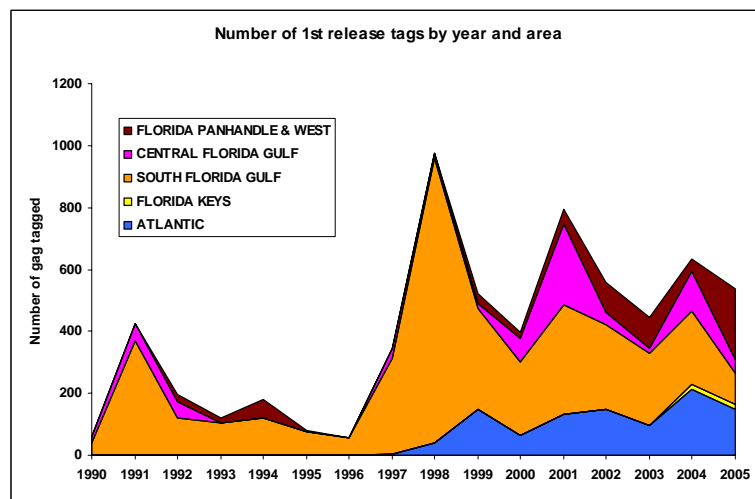


Figure 6. Distribution of gag tag releases by area from the MML tagging program.

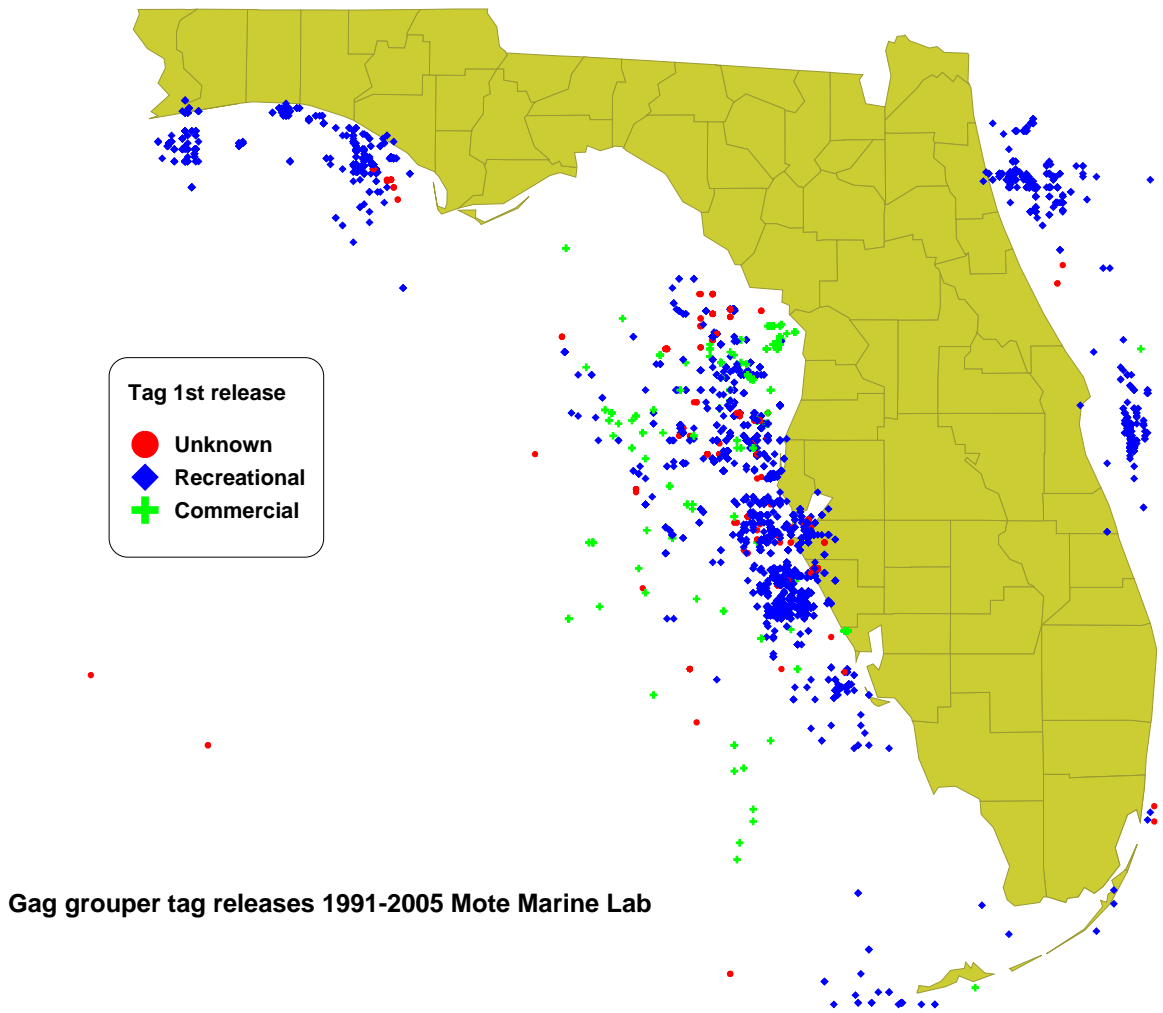


Figure 7. Geographic distribution of gag tag 1st releases by fishing sector from the MML tagging program 1981-2004.

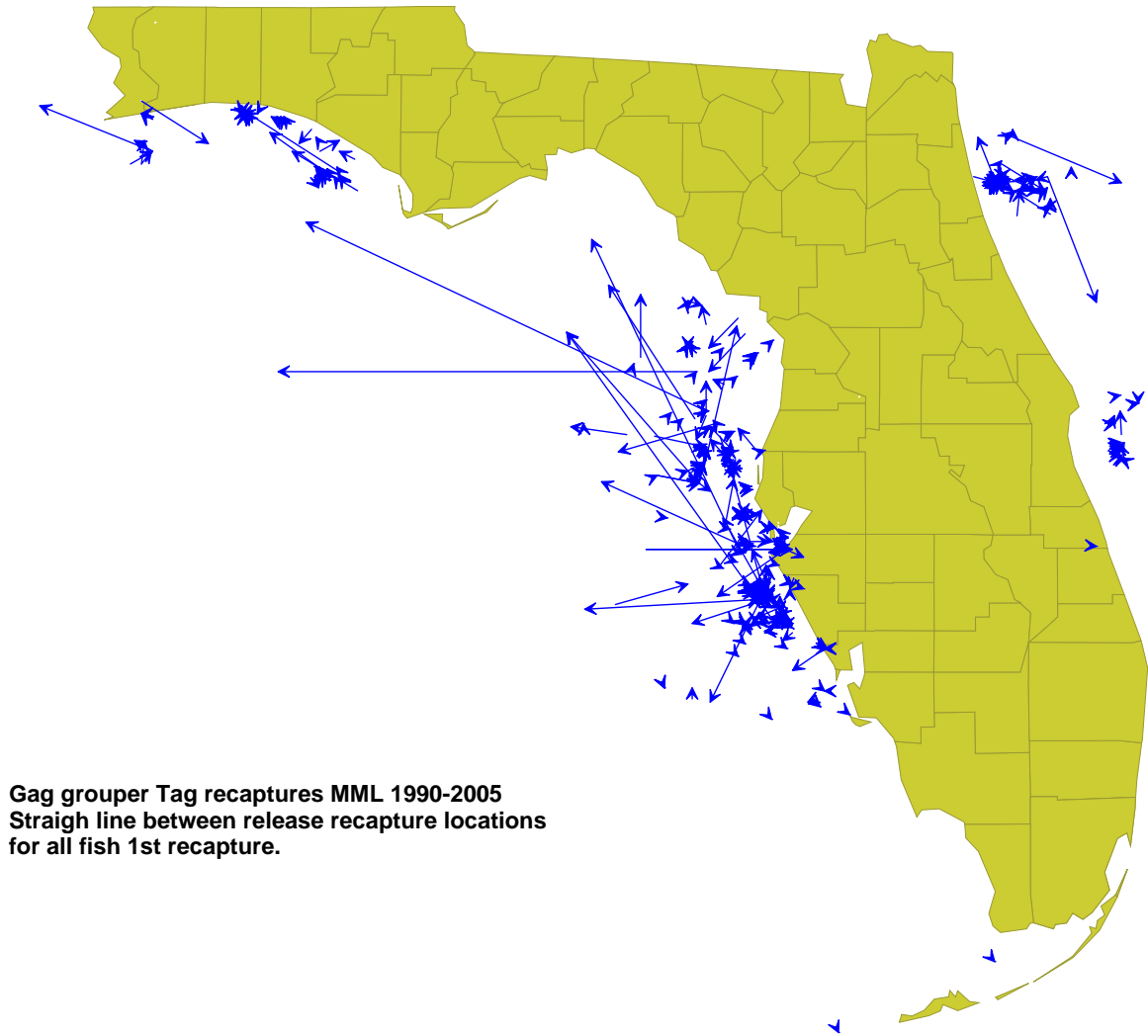


Figure 8. Straight line between point of release and recapture (arrow head) for 1st recapture of tagged gag grouper from the MML tagging program 1981-2004.

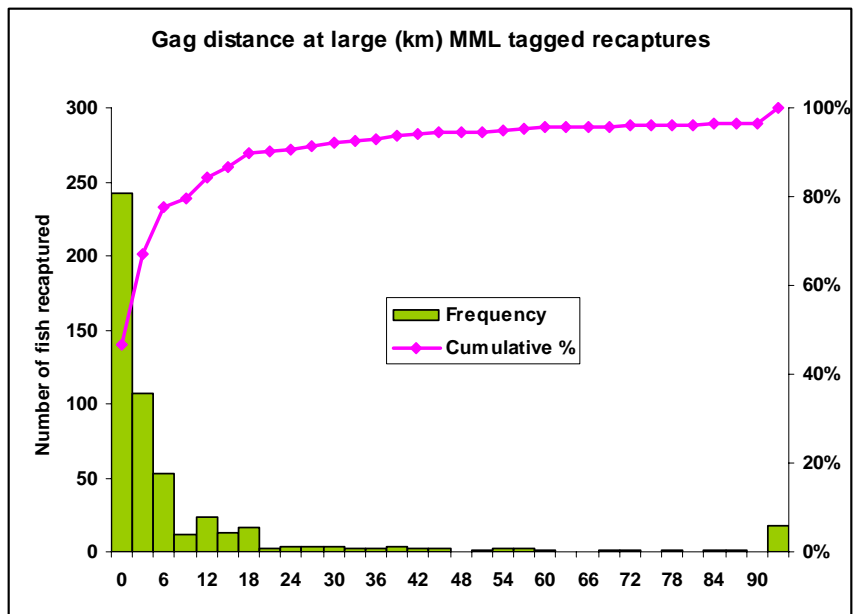


Figure 9. Frequency distribution and cumulative percent of straight distance (km) between points of release and recapture for 1st releases of gag grouper from the MML tagging program.

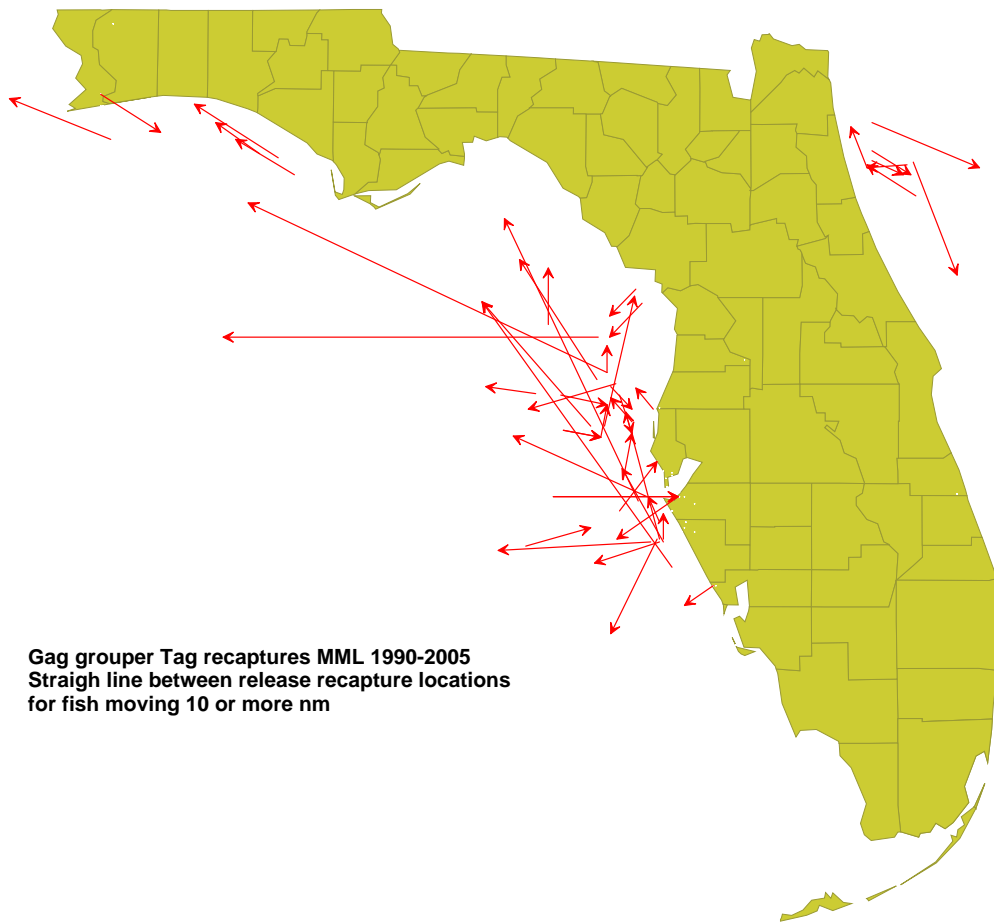


Figure 10. Map of straight line travel between points of release and recapture (arrow head) for tagged gag grouper that move 18 or more km.

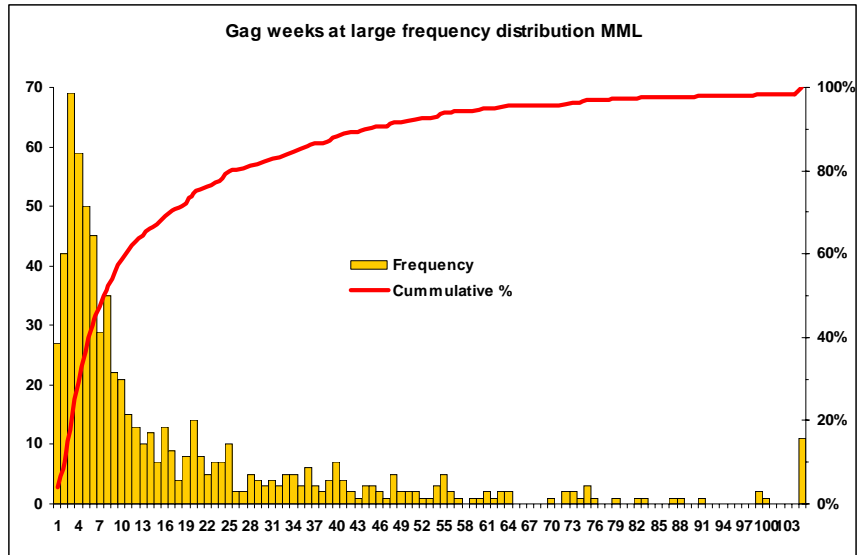


Figure 11. Frequency distribution and cumulative percent of days-at-large for 1st release of tagged gag grouper from the MML tagging program.

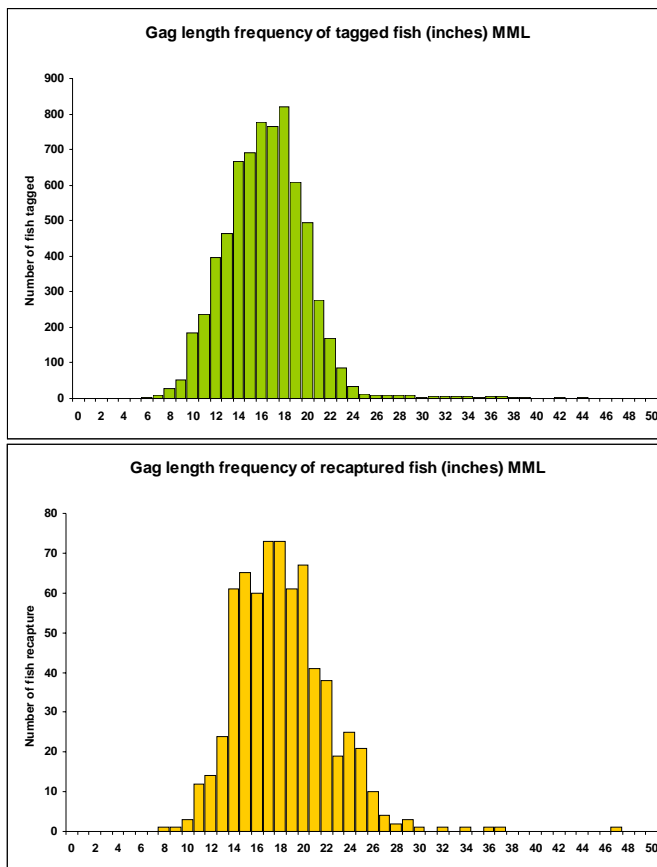


Figure 12. Size frequency distribution (inches) of gag tagged releases (top) and recaptures (bottom) from the MML tagging program.

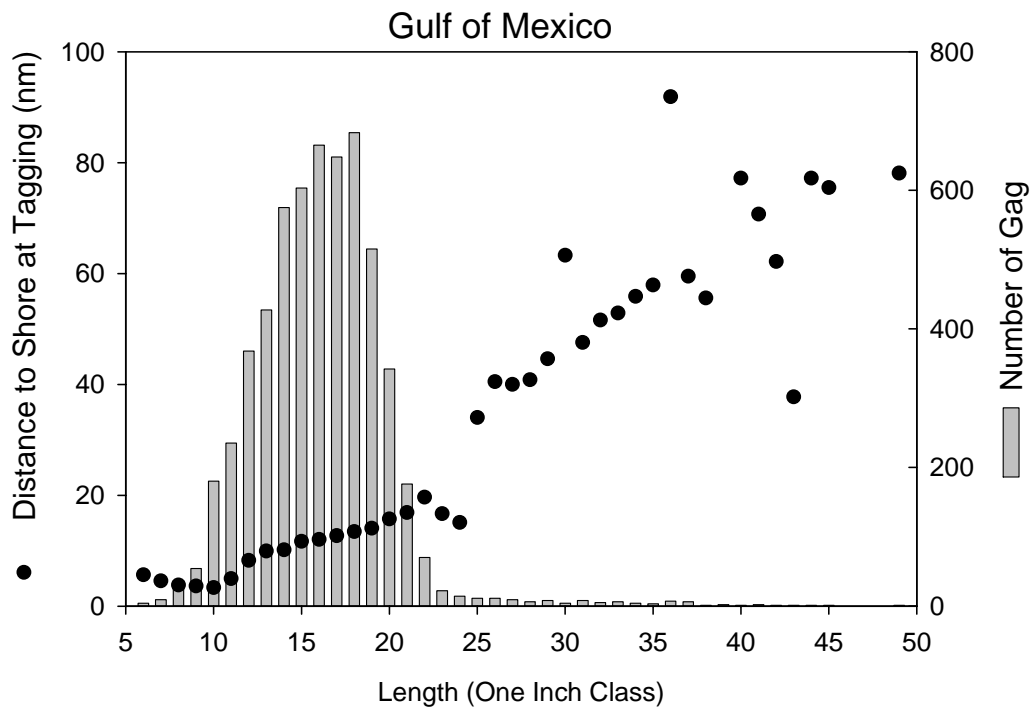
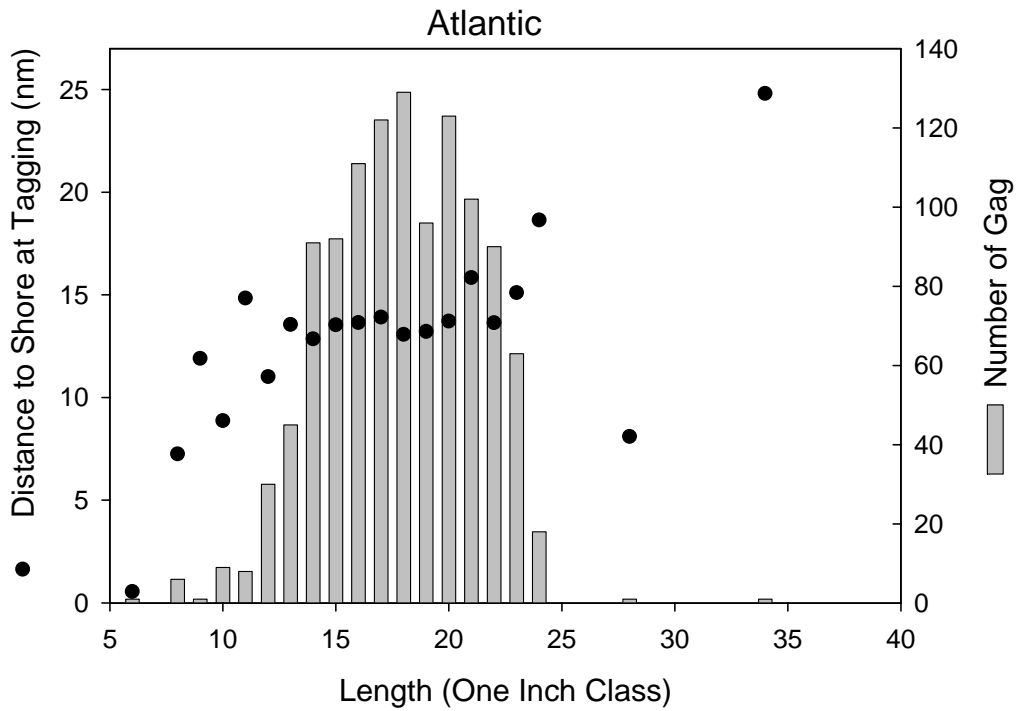


Figure 14. Scatter plot of distance to shore at tagging (nm) vs. mean length (one inch class) for gag Atlantic and Gulf of Mexico stock units. Bars represent the frequency of fish tagged by size class.

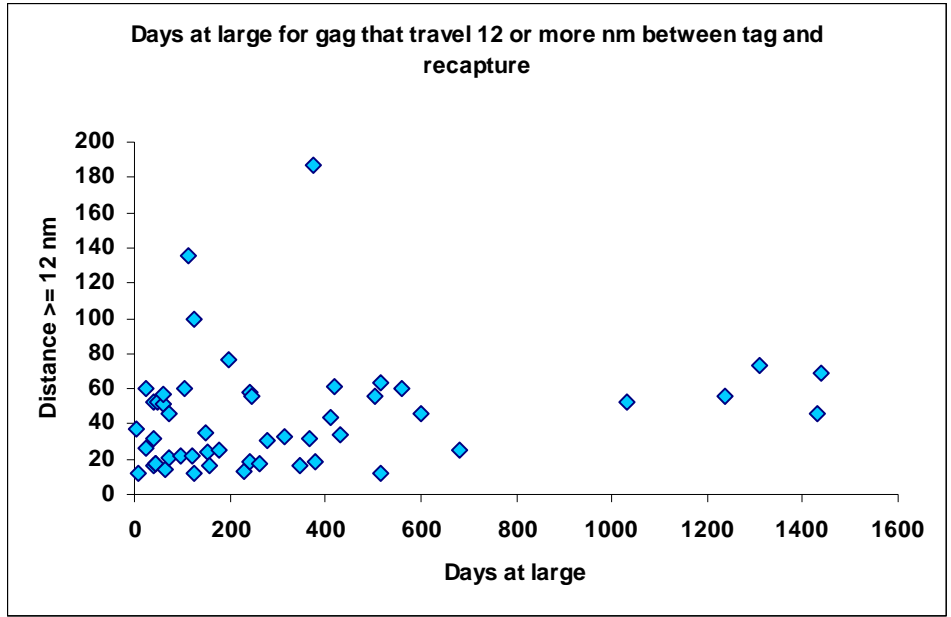


Figure 13. Scatter plot of days-at-large versus straight distance from release to recapture points for gag grouper 1st recaptures that moved 12 or more nm.

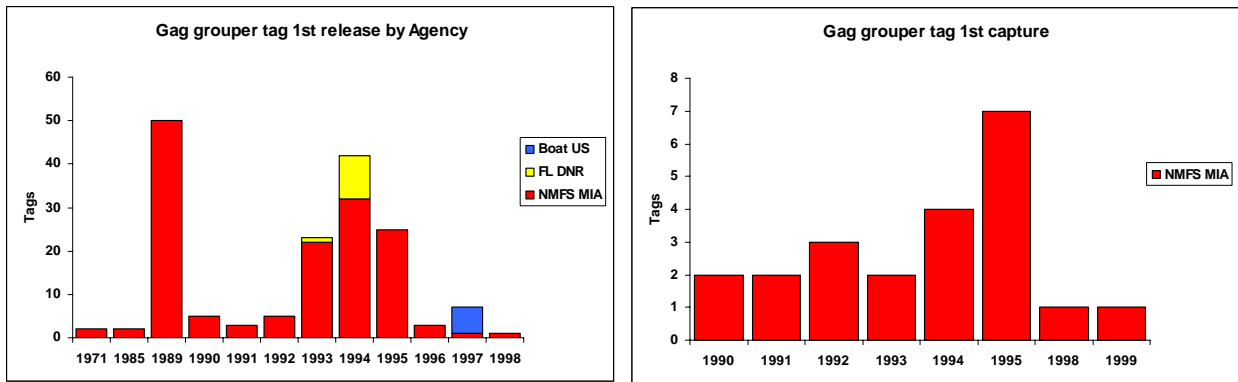


Figure 15. Annual distribution of gag tag releases (left) and recaptures (right) by agency from the NMFS MIA tagging database.

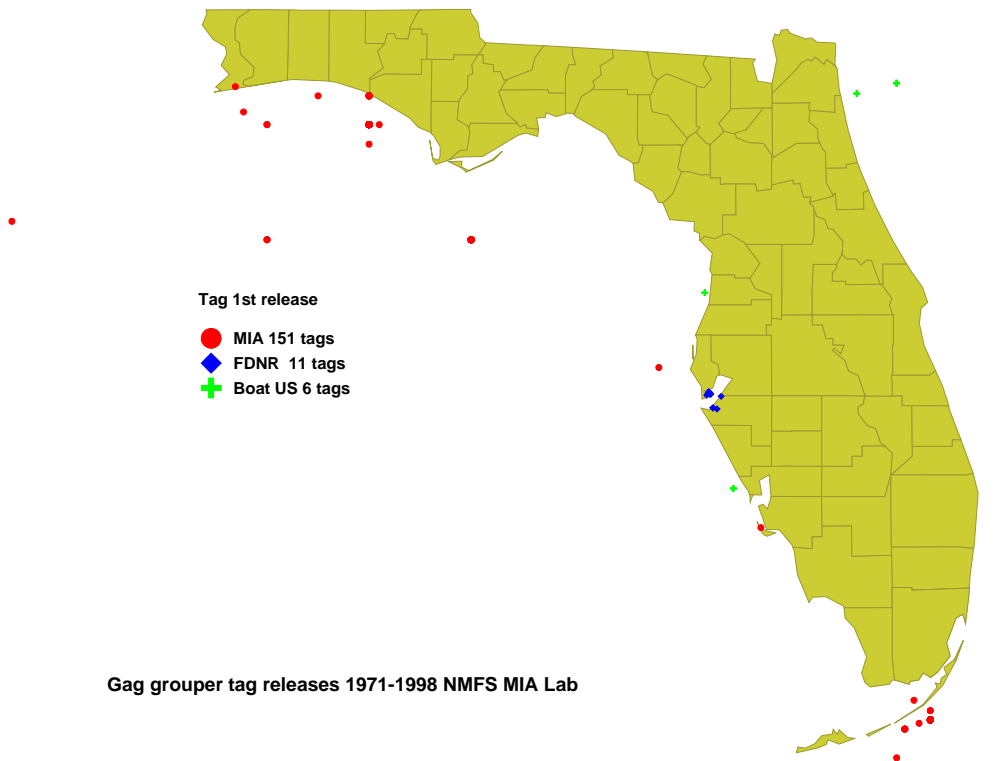


Figure 16. Geographic distribution of gag tagged releases by agency from the NMFS MIA tagging database.

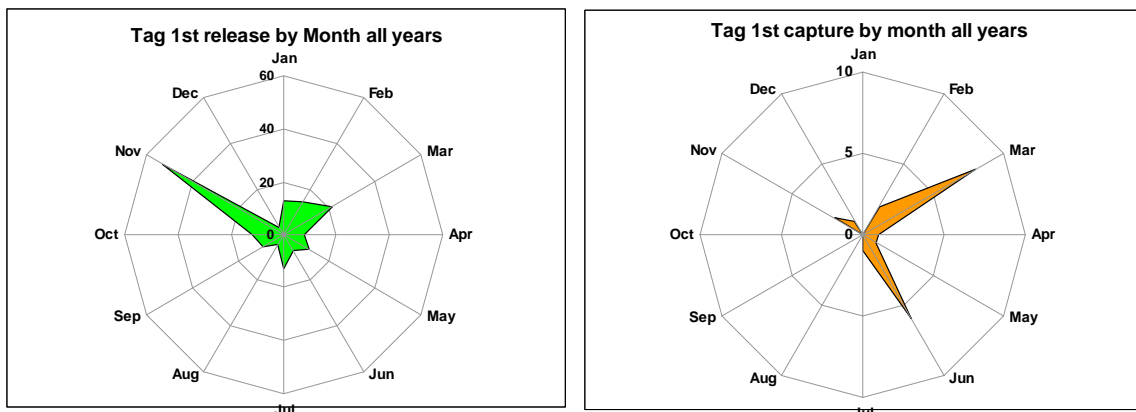


Figure 17. Monthly distribution of gag tagged releases (left) and captures from the NMFS MIA tagging database.

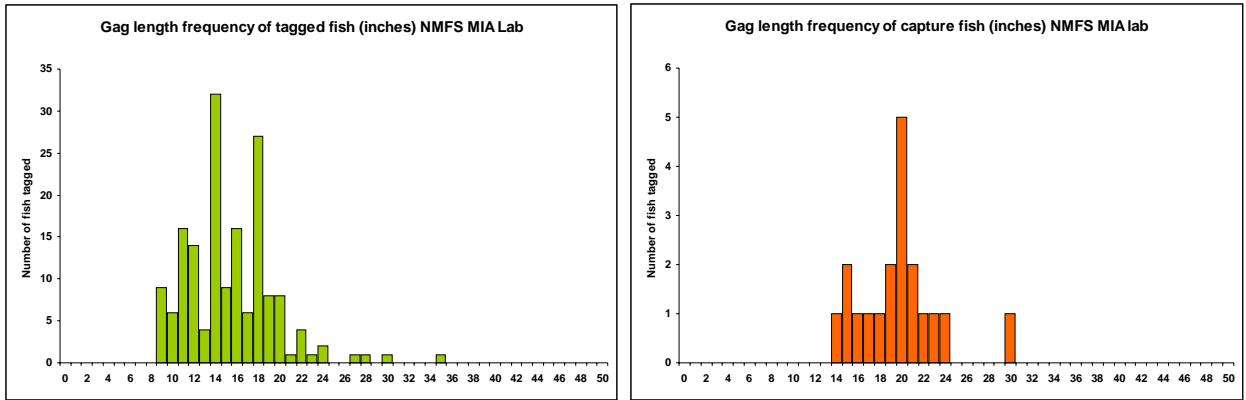


Figure 18. Size frequency distribution of gag tagged releases (left) and recaptures from the NMFS MIA tagging database.

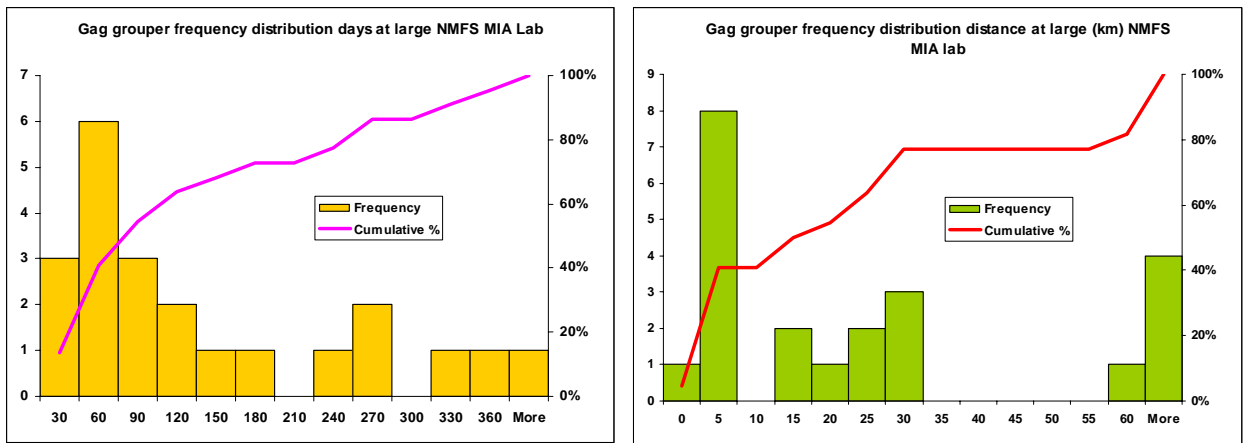


Figure 19. Frequency distribution of days-at-large (left) and straight distance travel (km) for gag recaptures from the NMFS MIA tagging database.

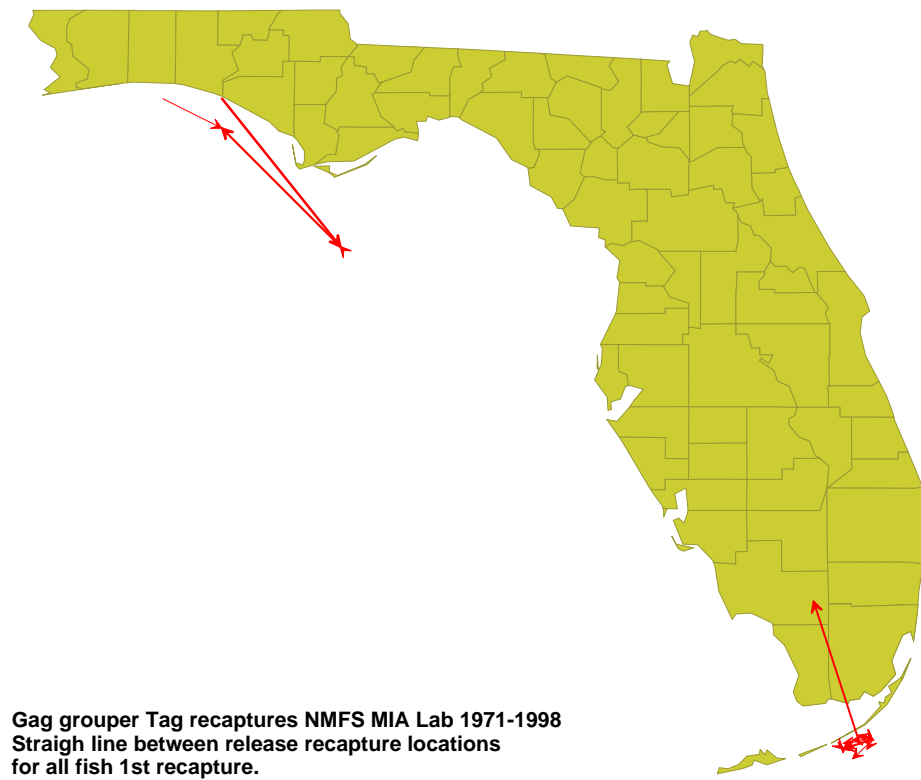


Figure 20. Straight line between point of release and recapture (arrow head) for recaptures of tagged gag grouper from the NMFS MIA tagging database.