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Spiny Dogfish Tagging and Migration in North America and Europe

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**Abstract**

The spiny dogfish is a valued food fish in Europe but in North America it has little or no economic value and is considered a nuisance species by commercial fishermen. Possible increased use of dogfish in North America, as a food fish and for fish protein concentrate, will require more biological information that can be used as a basis for sound management of the species.

Successful tagging experiments off the North American West Coast and in European waters have yielded information about the migrations and relative abundance of the dogfish. However, tagging experiments in the ICNAF areas off the United States and Canada have been hampered by fishery practices and the lack of readily recognizable tags.

Previous tagging studies are reviewed and the tags and their relative successes are discussed. Details of recent taggings off the New England and Middle Atlantic states are described and possible dogfish migration routes in these waters are mentioned.

Petersen disc tags, attached dorsally or through the snout, gave good returns over periods of up to 7 years. Streamer tags or spaghetti tags apparently are abraded by the

rough skin of the dogfish and thus lost. The best return of tags came from fisheries that sought the dogfish either for food or as an industrial species.

The pattern of tag recoveries in ICNAF waters suggests there are more or less resident groups of dogfish and migratory groups that move at least between Virginia and Newfoundland. A few trans-Atlantic recoveries of tagged individuals suggest that the dogfish off the coast of North America may be related to the dogfish off the Scottish-Norwegian coasts.

#### Introduction

At the present time, the spiny dogfish (Squalus acanthias L.) in the Northwest Atlantic has little economic value. It does, however, constitute a nuisance to fishermen. During certain times of the year, especially during the early spring and late fall, it may quickly fill the nets of trawlers. A catch per tow then of 5 to 10 thousand pounds is not unusual.

This situation is in contrast to that in European waters where the spiny dogfish is sought after as a valued food fish. The Norwegian fishery, for example, in 1964 landed 48 million pounds of dogfish for food, mostly for the British market (Aasen, 1964a). Other European nations, that same year, landed nearly 21 million pounds of dogfish for food.

The complaints of North American fishermen about the spiny dogfish and the possibility that we soon may want to manage and conserve the species indicate the need for information about the status of the dogfish populations in the Northwest Atlantic. It is my purpose here to summarize dogfish tagging experiments relative to success of tag types, and dogfish populations and migrations. This report will describe

some of the tags used, their relative successes, and, particularly, experiments carried on during the past 10 years in the ICNAF waters off New England.

#### Tagging Experiments

One of the earliest dogfish tagging experiments was reported by Clemens (1932) in which the fish were marked with aluminum strap tags attached to the caudal fin. The dogfish were marked incidentally during a salmon tagging program off British Columbia and only one fish (1.5 per cent) was recaptured. There is little other information available about the experiment. Since that time, however, many thousands of the species have been tagged off both coasts of North America and in the Northeast Atlantic. These experiments are summarized in Table 1.

The choice of tag and its place of attachment on the fish have varied from experiment to experiment. Most taggers, however, have favored Petersen discs, or an Atkins-type tag, attached through, or at the base of, the first dorsal fin. (See Rounsefell and Kask, 1945, for detailed descriptions of types of tags.) Templeman (1944, 1954, 1958) used an Atkins-type tag on dogfish tagged near Newfoundland and on the Grand Bank. It was made of red plastic, 32 mm long and 8 mm wide, attached to the first dorsal fin with a nickel wire. Even after more than 10 years on a fish (Templeman, 1958) the wire was essentially sound "and would probably have been in good enough condition to remain on the fish for another 10 years or more."

In an extensive tagging experiment off the state of Washington, nearly 10,000 dogfish were marked and released

(Bonham et al., 1949) Kaufmann, 1955; and Holland, 1957).

The fish were marked with Petersen discs attached to the base of the first dorsal fin with a nickel pin. The discs held up well but the pins tended to corrode internally and were weakened although two tagged dogfish were recaptured after 8 years and one after 10 years at liberty.

Beverton et al. (1959) tagged 75 dogfish in the Irish Sea incidentally during a hake (Merluccius merluccius) tagging experiment. The mark used was the so-called Lowestoft tag, an Atkins type with a soft plastic tab attached with a braided nylon loop through the base of the first dorsal fin. After two months, two tagged dogfish (2.7 per cent) were recaptured but no tag deficiencies were reported.

One of the largest number of dogfish tagged in European waters was the group marked and released by Aasen (1960, 1964b) near the Shetland Islands, north of Scotland. He marked 8,122 and as of 1964, 881 (10.8 per cent) had been recaptured. The tag was a Lea-type capsule attached with a stainless steel bridle anterior to the first dorsal fin. The capsule is formed from a strip of plastic 4 cm wide and 15 cm long imprinted with a message to the finder. The strip is wound about a bobbin and sealed in clear plastic. No tag deficiencies were noted and it seems to be a very successful tag. It should be noted here that the area in which the tagging experiment took place is the site of an intensive summer fishery by English and Welsh trawlers.

British interest in dogfish tagging experiments was sparked by their food fishery for the species in the waters around the British Isles. Holden (1965) summarized their experiments since 1960 and in a personal communication (1967) outlined some of the tag failures.

In the otter trawl fishery for dogfish north of Scotland, 5,830 dogfish were tagged by the British (5.9 per cent recaptured). In 1960, four tags were used; the Lowestoft tag mentioned above (Beverton et al., 1959); Petersen discs attached to the base of the first dorsal fin; plastic flags on a stainless steel wire bridle in the musculature between the dorsal fins; plastic flags inserted in the body cavity. (The tags are described in detail by Williams, 1963.) There is no breakdown of percentage returns by tag type but Holden (1965) reports 2.2 per cent returns (through 1963) with the Petersen discs giving the highest rate. In 1961, the fish were tagged mostly with Petersen discs; a few fish smaller than 60 cm long were marked with the flags on wire bridles. The total recaptures were 7.8 per cent. In 1962, Petersen discs only were used and yielded 2.3 per cent returns after 1 year.

In the line trawl fishery in the southern and middle North Sea, 2,890 dogfish were tagged by the British with 17.8 per cent returns (Holden, 1965). Petersen discs attached to the first dorsal fin were used almost exclusively in this experiment; a few Lowestoft tags were used very early in the marking experiment.

Holden (personal communication) reports that the Lowestoft tag was rapidly lost; "...after about a year fish which had been double tagged with this type and a Petersen disc were being recaptured with only the latter still attached." He concluded that the nylon was chafed by the dogfish's rough skin and eventually broke. It is not known for certain why the flags on the wire bridles gave such poor results, but he suspected the bridle was too large and tore out. The internal tags also gave poor returns and two factors are suggested here.

One is that some fish may have died as a result of inserting the tag in the body cavity. The second is that in those fish that survived and were recaptured the tags were not seen when the fish were dressed for market.

Some dogfish had been tagged with spaghetti sewn through the dorsal musculature between the first and second dorsal fins. In a comparison between dogfish tagged with Petersen discs and spaghetti tags, Holden (personal communication) reports the return rate for the Petersen discs was four times that for the spaghetti tags. He could offer no explanation for the poor return rate of the spaghetti tags.

In the waters off New England, nearly 1000 spiny dogfish were tagged incidental to the tagging of other species (Jensen, 1961, 1965). Four different tags were used on 844 fish. The tags were Petersen discs attached to the first dorsal fin; Petersen discs attached to the snout; a combination tag with a Petersen disc attached with yellow, plastic "spaghetti" tubing to the first dorsal fin; and yellow spaghetti through the first dorsal fin. All disc tags were attached with stainless steel pins (Jensen, 1958). Seventeen tagged dogfish (2.0 per cent) were recovered. Later, 63 more dogfish were tagged with Petersen discs through the snout bringing the total of marked fish to 907. So far, 27 tagged fish (2.9 per cent) have been recovered (Table 2).

The Petersen discs through the first dorsal fin yielded the highest rate of returns (10 per cent) but only 20 fish had thus been tagged and this is hardly a fair trial of the tag. Petersen discs on the snout were used on 442 fish and 22 (4.9 per cent) were recaptured. The fewest tagged fish recaptured

(0.7 per cent) were those marked with either the combination disc-spaghetti tag or the spaghetti alone, although 151 and 294 dogfish, respectively, had been marked with these tags.

None of the returned tags bore any sign of more than minor structural failures. A few of the Petersen discs had slightly separated laminations but were otherwise intact. Some on the underside of the fish's snout were scratched as though the fish had "rooted" in the bottom. The stainless steel pins were sound and intact even after 6½ years on the fish. The spaghetti tags were slightly darkened where they had been in contact with the fin tissue but the tubing was not abraded or weakened.

The most recent tagging experiments are underway in a cooperative program between the U.S. Bureau of Sport Fisheries and Wildlife, Narragansett, Rhode Island, and a graduate student at the University of Rhode Island (John G. Casey, personal communication). In 1966, 111 dogfish were marked with Rototags, a plastic bachelor button-type tag attached to the first dorsal fin. To date, two fish (1.8 per cent) have been recaptured, one after 28 weeks, 300 miles from the point of release, the other after 96 weeks, 287 miles from the point of release. More than 1000 additional dogfish have been tagged with the Rototag. The results are to be analyzed and reported elsewhere.

#### Factors that May Affect the Rate of Return of Tags

Probably the one factor that contributes most to success in any fish tagging program is to tag the fish in an area where there is an active fishery for the species, especially a food fishery where each fish is individually handled. Thus, a tag

on an individual is more likely to be noticed. This is certainly true of the spiny dogfish. The other factors considered here (fishing gear, season of capture) vary so much that it is difficult to try to separate them. Dogfish caught on hook and line gear -- long lines, angling -- tend to yield a higher rate of returns than dogfish caught in otter trawls or other trawl-net gear. A review of the literature suggests dogfish caught for tagging during the warm months (hence in shoal water ?) tend to yield a higher rate of returns than dogfish caught in the cold months (in deep water ?). A noticeable exception, however, is the extensive tagging by Aasen that was done mostly in the winter months. These dogfish, however, were caught on long lines.

How soon a tag is detected is an extremely important factor. In the absence of other evidence I suspect the snout tags (Jensen, 1961, 1965) were more easily and quickly noticed aboard ship. It may seem odd that a relatively small disc on the snout of a dogfish could be more visible than a yellow plastic loop in the dorsal fin. However, this same sort of differential rate of returns was noted in tagged haddock (Jensen, 1963). More haddock with Petersen discs on the operculum were found aboard ship compared to haddock with spaghetti tags attached dorsally. Some of the spaghetti tags escaped detection until the fish were bought by retail customers.

It was believed the dorsal spaghetti tag on the haddock was not noticed by the fishermen who routinely hold the fish belly up when dressing it aboard ship. In the case of the dogfish, it may be that the snout is more easily noticed aboard a trawler. This line of reasoning, admittedly, is weak but at the moment no other logical explanation is forthcoming. Since



the dogfish is unwanted by U. S. fishermen in the Northwest Atlantic, it is discarded at sea as quickly as possible. In the Pacific Coast, Canadian, and European fisheries, however, the dogfish was or is a wanted species and each fish received more or less individual attention. Thus, there was a greater likelihood of a tagged fish being seen and recovered from the catch.

#### Stocks and Migrations of Spiny Dogfish

Some of the several dogfish tagging experiments reviewed here have reported the existence of local as well as far-ranging dogfish stocks. Off the Pacific Northwest (Holland, 1957), the tagging data yielded evidence of an indigenous population in Puget Sound and the Strait of Georgia. There is also a migratory population off the coast that ranges at least from Baja California north and west to Japan. Holland suggests further separation between the dogfish in the Strait of Georgia and the dogfish in Puget Sound.

Holden (1965) reports three stocks of dogfish around the British Isles. One is the Channel Stock that overwinters in the English Channel and spends the summer between England and the Low Countries. The second is the Scottish - Norwegian Stock that overwinters in the deep waters between Scotland and Norway and in the summer concentrates around the Shetland and Orkney Islands. The third is the Atlantic Stock that overwinters off the Brittany Coast or farther south off the French coast and migrates north, possibly to the Barents Sea, in the summer. There may be further subdivisions between these stocks.

Two long-distance migrations are reported for the Scottish-Norwegian stock (Holden, 1967). One was a dogfish tagged north of Scotland in 1962 that was recaptured in 1966 just south of Newfoundland. Another dogfish from this stock, also tagged north of Scotland in June 1961, was recaptured in October of that year west of Iceland.

Returns from Canadian and U. S. dogfish tagging experiments (Templeman, 1954; 1958; Jensen, 1961; 1965) have done little to indicate the presence of definitive stocks in the Northwest Atlantic. Dogfish tagged in the Newfoundland area were recaptured mostly in the local waters or off the Maritimes. Two of the fish, however, were caught off Gloucester, Mass., and one was caught off Cape Henry, Va. Templeman (1954) postulated a southward movement in the late autumn and a northward movement in the spring and early summer. There is evidence also of the presence of dogfish that overwinter in the deep water of the Gulf of St. Lawrence. Templeman (1958) later reported a dogfish which was tagged off Newfoundland and recaptured off Iceland 10 years later.

Returns from dogfish tagged in the Gulf of Maine came mostly from nearby waters. Some of these have already been reported (Jensen, 1961; 1965). Later returns are listed in Table 3.

Two of the tagged fish had been at liberty for more than 6 years but were recovered only a few miles from the tagging location. While we have no idea where they went during that period of time it seems likely they followed some regular seasonal migration and returned to the same general area at about the same season of the year.

A possible path of migration is suggested by seven tag returns from the June 13, 1961 experiment on Stellwagen Bank. If we overlook the years involved in the returns and consider only the month, we can trace what may have been the path taken by the tagged individuals. In June and July, the fish frequented the waters off New England. With the coming of autumn and a cooling of the offshore waters, the fish moved southward, moving onto Nantucket Shoals, to the offing of Long Island, New York, and in December to off Delaware. Presumably these fish belong to the same group tagged by Templeman (1954) or mingle with them in the southern waters. Thus, they may have continued their journey southward to Virginia to overwinter.

I have already discussed the reproductive activity and movements of the overwintering populations (Jensen, 1965). Evidently the female dogfish that move to the waters off Delaware and Virginia give birth to the pups there. This may take place in deep water, although, as shown in other studies (Ford, 1921), some pregnant females move inshore to deliver. The Delaware-Virginia offshore area also may represent a nursery area for the young dogfish. There is strong evidence of such areas for some sharks (Springer, 1967). During a cruise of the R/V Albatross IV in the Middle Atlantic Bight in October 1967, hundreds of spiny dogfish 35 to 40 cm long were trawled 35 miles off the mouth of Delaware Bay. Edwin B. Joseph (personal communication) reports that research vessels from the Virginia Institute of Marine Science have caught up to 2000 pounds of spiny dogfish 35 to 40 cm long in the deep water of Norfolk Canyon in the summer through the fall. These fish would be about 1 to 2 years old. (Holden and Meadows, 1962).

The recaptures, however, also include fish such as the one that was tagged off Cape Ann, Mass. in July, 1961, and was recaptured off Cape Elizabeth, Maine, in December of the following year. This fish may be one of the group that overwinters in the deep water off the Gulf of Maine or off the Continental Shelf (Jensen, 1965).

#### Conclusions

The choice of an efficient tag for the spiny dogfish seems to be limited to a tag attached dorsally, preferably through a dorsal fin, or a tag attached through the snout. Both have yielded fair to good rates of returns. Streamers -- nylon loops or plastic tubing -- may be easily abraded by the rough hide of the dogfish and thus lost. Lea-type tags on wire bridles have been used successfully. But, in tests of several kinds of dorsal tags, the Petersen disc gave the best results.

In general, dorsal tags hold the most promise in experiments carried out in areas where there is a specific fishery for dogfish. In areas where the dogfish is unwanted and is discarded at sea as quickly as possible, the tag must be attached on the dogfish where it is easily noticed. In the usual fishing operation, whether otter trawling or some kind of hook and line fishery, the fish's snout is quickly and easily noticed. Thus, the best choice <sup>in</sup> ~~for~~ a non-dogfish fishery is the Petersen disc tag attached to the snout.

The recaptures of tagged spiny dogfish in the Northwest Atlantic are too few to permit any but speculative remarks about their possible migrations. A north-south, coastal migration at least between Canada and Virginia seems evident.

We could consider the few east and west trans-Atlantic migrants simply as stragglers, but I prefer to believe that they do indeed represent a percentage of the population that makes a journey across the North Atlantic. Thus, the dogfish in the Northwest Atlantic, off New England and Canada, may be related to, or at least mingle with, the dogfish from the Northeast Atlantic, the Scottish-Norwegian stock.

Evidence for a migration offshore in the winter is even less positive, but the few tagged fish that were recovered in the winter not far from the area of tagging may be part of a relatively non-migratory group or groups.

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Table 1. An historical summary of dogfish tagging experiments.

Tag	Gear	Number		Percentage	Area	Reference
		Tagged	Recaptured			
Aluminum strap (caudal)	Salmon troll	66	1	1.5	Off Br. Columbia	Clemens (1932)
Atkins-type (dorsal)	Gill net	279	15	5.4	Off Newfoundland	Templeman (1944, 1954, 1958)
Petersen (dorsal)	Otter trawl and trap	9,705	653	6.7	Vancouver Island	Bonham <u>et al.</u> (1949), Kauffman (1955), Holland (1957)
Atkins-type (dorsal)	Danish seine	75	2	2.7	Irish Sea	Beverton <u>et al.</u> (1959)
Lea-type (dorsal)	Longline	8,122	881	10.8	North of Scotland	Aasen (1960, 1964b)
<u>1/</u>	<u>2/</u>	844	17	2.0	Off New England	Jensen (1961, 1965)
<u>3/</u>	Otter trawl	1,438	32	2.2	Northeast of Scotland	Holden (1965)
Petersen (dorsal)	Otter trawl	5,830	346	5.9	North of Scotland	Holden (1965)
Petersen (dorsal)	Longline	2,890	515	17.8	North of Scotland	Holden (1965)
Rototags (dorsal)	Longline	111	2	1.8	Off New England	Casey (pers.comm.)

1/ Petersen discs on snout; Petersen discs on dorsal fin; combination spaghetti-Petersen disc on dorsal fin; spaghetti on dorsal fin.

2/ Otter trawl, longline, trap, hook and line.

3/ Petersen discs on dorsal fin; plastic flag on braided nylon loop through dorsum; plastic flag on wire bridle through dorsum; plastic flag in body cavity.



Table 2. A summary of United States dogfish tagging experiments, 1956-1964.

Tag	Number Tagged	Number Recovered	Percent Recovered
Petersen discs (dorsal fin)	20	2	10.0
Petersen discs (snout)	442	22	4.9
Combination (dorsal)	151	1	0.7
Spaghetti (dorsal)	294	2	0.7
Total	907	27	2.9

Table 3. Returns of dogfish tagged in the Gulf of Maine and recaptured after June 1962.

<u>Date and locality of --</u>		Time at	Distance
Tagging	Recapture	liberty (Weeks)	(Miles)
July 8, 1956; Cape Ann, Mass. (42°48'N - 70°15'W)	Oct. 8, 1962; Portland, Me. (43°31'N - 70°00'W)	326	60
Oct. 14, 1957; Browns Bank (42°36'N - 65°46'W)	July 1, 1964; Browns Bank (42°41'N - 66°07'W)	350	16
June 13, 1961; Stellwagen Bank (42°25'N - 70°21'W)	July 15, 1962; St. Johns Bay, Me. (43°53'N - 69°33'W)	57	106
June 13, 1961; Stellwagen Bank (42°25'N - 70°21'W)	June 23, 1963; Gurnet Pt., Mass. (42°02'N - 70°33'W)	106	25
June 13, 1961; Stellwagen Bank (42°25'N - 70°21'W)	July 22, 1963; Harpswell, Me. (43°44'N - 70°00'W)	109	85
June 13, 1961; Stellwagen Bank (42°25'N - 70°21'W)	Oct. 15, 1963; Shinnecock Inlet, N.Y. (40°40'N - 72°16'W)	111	154
June 13, 1961; Stellwagen Bank (42°25'N - 70°21'W)	Nov. 7, 1963; Nantucket Shoals (41°05'N - 69°55'W)	178	80
June 13, 1961; Stellwagen Bank (42°25'N - 70°21'W)	Dec. 9, 1965; Indian River Inlet, Del. (38°35'N - 75°00'W)	234	320
July 22, 1961; Cape Ann, Mass. (42°44'N - 70°36'W)	Dec. 24, 1962; Cape Elizabeth, Me. (43°21' - 70° 12'W)	74	60
July 22, 1961; Cape Ann, Mass. (42°44'N - 70°36'W)	Sept. 18, 1963; Ipswich Bay, Mass. (42°40'N - 70°41'W)	113	6