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Migrations of Thorny Skate, *Raja radiata*, Tagged in the Newfoundland Area

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Abstract

From the taggings of 722 thorny skates, *Raja radiata*, in the Newfoundland area during 1962-65, returns were 19% from coastally-related taggings and 5% from offshore taggings in deep water. The usual patterns of migration were movements of less than 60 nautical miles from the tagging localities up to 20 years after tagging. Two were recaptured near the tagging sites after 15-16 years. Of 97 returns with known recapture locations, 13% were taken 100-240 miles from the tagging sites in 0.2-11 years. In the absence of a primary fishery for skates in the region, the recaptures came from fisheries for other species, usually for cod, *Gadus morhua*, in coastal and near-coastal waters and for various groundfish species in the offshore areas. Depth of recaptures ranged from 22 to 457 m but 77% were taken in 22-183 m. Bottom gillnets accounted for 68% of the returns, with 31% from longline and otter-trawl catches.

Introduction

The thorny skate occurs from the Barents and White seas to Iceland in the Northeast Atlantic (Andriyashev, 1954) and from West Greenland and southern Baffin Island southward to South Carolina in the western North Atlantic (Bigelow and Schroeder, 1953; Templeman, 1982). It was the most abundant skate encountered in otter-trawl surveys of the Gulf of St. Lawrence, Scotian Shelf and Gulf of Maine (McEachran and Musick, 1975; Scott, 1982). It is also the most abundant skate in Newfoundland waters, the largest individuals being found on the southern Grand Bank and St. Pierre Bank and those off Labrador being considerably smaller (Templeman, 1982). In recent years (1978-80), the nominal catches of skates in the Northwest Atlantic, taken entirely as by-catch in fisheries directed toward other species, have averaged slightly more than 5,000 tons annually, more than half of which were taken in the Newfoundland area, mainly NAFO Divisions 3N and 3P (NAFO, 1980-82), where thorny skates are large and numerous.

This paper describes the migration patterns of thorny skates in the Newfoundland area (Fig. 1) on the basis of tag returns, over a 20-year period, from 722 individuals tagged during 1962-65. The author found no literature references to tagging of thorny skates.

Materials and Methods

Thorny skates were tagged during operations directed mainly to tagging of Atlantic cod, *G. morhua*, and occasionally spiny dogfish, *Squalus acanthias*, in many parts of the Newfoundland area (Templeman, 1979, 1983), using bottom otter trawls and bottom longlines to capture the fish. The otter-trawl sets were 20-30 min duration and the longlines were set and retrieved on the same day. The skates were tagged through the base of the left pectoral fin dorsally with some white and some yellow numbered Petersen discs and ventrally with yellow blank discs. All discs were 12.7 mm in diameter and 0.9 mm thick and were attached with 0.81 mm diameter soft stainless wire. A reward of $1.00 (Canadian) was offered for the return of each tag. Typically, the fishermen provided information on the location, date, gear and depth of capture, all of which were requested on the tag.

All tagged skates were measured before liberation as total length to the nearest centimeter from tip of snout to end of tail. The tagged skates (length range 35-99 cm) were mainly large immature or mature fish, 48% being male, 51% female and 1% unsexed. Years after tagging in relevant tables and figures are actual years from the date of tagging, with periods greater than 0.8 year rounded to the nearest year.

Since most of the returns from the tagging groups were associated with the configuration of the coast or coastal shelves, the apparent directions of travel could usually be related to coastal axes and the formulae of Jones (1959) were used to calculate the resultant directional components of the skates' velocity of movement (V) and the mean square dispersion of movements or dispersion coefficient (a^2):

$$V = \frac{\Sigma r \cos\theta}{\Sigma t}$$

$$\text{and } a^2 = \frac{1}{n}\left\{\Sigma(r^2/t) - \frac{(\Sigma r \cos\theta)^2}{\Sigma t}\right\}$$

where r = shortest straight-line distance of possible travel, t = number of days free, θ = angle of direction of

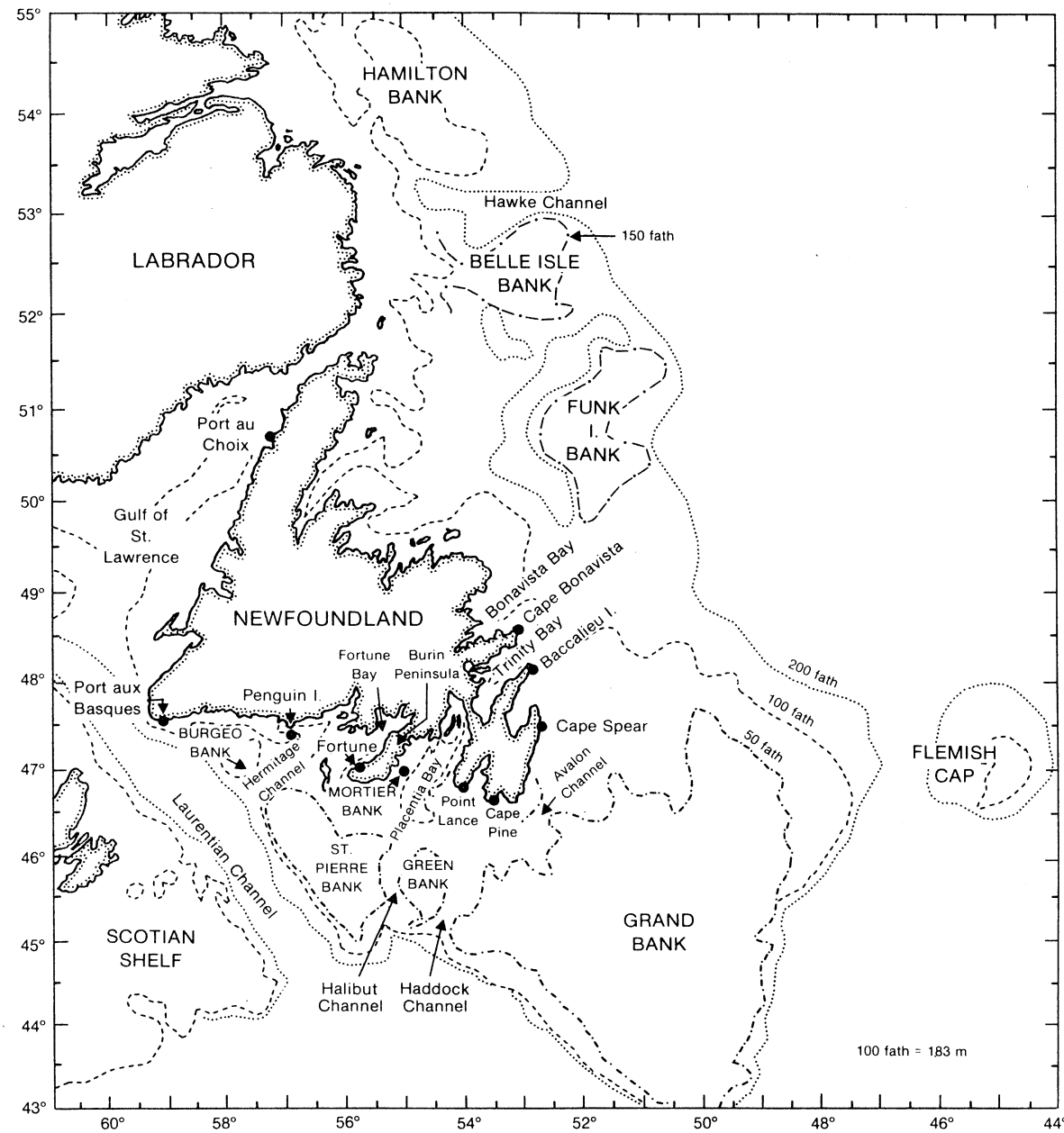

Fig. 1. Map of the Newfoundland area showing the tagging localities and place names mentioned in the text.

travel measured from a coastline axis, and n = number of returns.

For each of the five groups of recaptures used for this analysis, the axis was drawn approximately parallel to the immediate coastline through the tagging location. The angle θ was measured with the positive quadrant toward the north for the Cape Bonavista, Cape Spear and Fortune taggings and toward the west for the Point Lance and northwestern St. Pierre Bank taggings. Where land interfered with a direct measurement between the tagging and recapture sites, the angle θ was measured from the assumed initial direction of travel from the tagging site. Returns were too few from the remaining tagging to provide realistic values of the migration parameters. Also, further refinements of the parameters (V and a^2) by using the sine as well as the cosine of angle θ (Jones, 1959, 1976) were not considered feasible because the migrations were, in general, coastally related, and the true angle θ to some of the recaptures points was interfered with by land projections, thus reducing the precision of the calculations.

The method of Jones (1959), for haddock, *Melanogrammus aeglefinus*, off Scotland, was used by Saila (1961) for migrations of winter flounder, *Pseudopleuronectes americanus*, and by Johnson (MS 1979) for

migrations of little skate, *Raja erinacea*, in New England waters, and the methods of Jones (1976) were used by Bennett and Brown (1983) for crab, *Cancer pagurus*, migrations in the English Channel.

Information on the tagging of thorny skates in the Newfoundland area is given in Table 1. Nautical miles are used in this paper. The statute miles of Richards *et al.* (1963), where quoted, were changed to nautical

TABLE 1. Information on tagging of thorny skate in the Newfoundland area, 1962-65.

	Tagging localities	Position		Depth range (m)	Date of tagging	Gear used	Fish length (cm)	Number tagged	Percent returns
		Lat. N	Long W						
1.	Off Port au Choix	50°50′	57°20′	59-95	Aug-Sep 1964	LL	45-64	15	13
2.	Off Port aux Basques	47°33′	59°11′	106-117	Mar 1963	LL	55-74	3	0
3.	Off Penguin I.	47°20′	56°54′	59-165	Apr 1963	LL	40-89	21	10
4.	Burgeo Bank	47°11′	57°43′	66-117	Apr 1963	LL	50-74	8	50
5.	Off Fortune	47°04′	55°55′	46-110	Oct 1965	LL	45-94	55	25
6.	Mortier Bank	47°02′	55°00′	15-117	Sep 1965	LL	50-84	19	21
7.	NW St. Pierre Bank	46°45′	57°06′	44-110	May 1962-63	LL	50-94	71	14
8.	Off Point Lance	46°45′	54°04′	37-60	Sep 1965	LL	50-94	53	28
9.	Off Cape Pine	46°31′	53°33′	49-60	Nov-Dec 1963	LL	55-64	3	66
10.	Off Cape Spear	47°29′	52°38′	37-146	Nov-Dec 1965	LL	45-89	100	15
11.	Off Baccalieu I.	48°12′	52°48′	51-113	Nov 1964	LL	45-84	24	17
12.	Off Cape Bonavista	48°46′	53°05′	44-106	Oct 1964	LL	40-89	95	19
13.	SW slope St. Pierre Bank	46°24′	57°19′	174-220	May 1965	OT	40-99	18	17
14.	Hamilton-Belle Isle banks	**[a]	**[a]	128-194	Sep 1962	OT	35-59	55	2
15.	Hawke Channel area	**[b]	**	183-238	May 1964	OT	40-59	9	0
16.	Funk Island Bank	51°22′	51°04′	220-232	May 1964	OT	45-64	4	0
17.	N slope Grand Bank	48°21′	50°10′	177-192	Apr 1964	OT	40-84	36	8
18.	E slope Grand Bank	45°44′	48°25′	163-214	Apr 1964	OT	60-94	55	2
19.	Flemish Cap	46°56′	45°03′	155-157	Jun 1962	OT	55-59	1	0
20.	Avalon Channel	47°45′	51°39′	150-157	Jun 1963	OT	65-79	4	0
21.	W Grand Bank	46°19′	52°31′	88-152	May 1965	OT	45-74	5	0
22.	Halibut Channel	45°19′	55°05′	119-159	Jan 1963	OT	35-94	68	6

[a] 52°03′N, 54°27′W to 54°02′N, 55°25′W.
[b] 52°33′N, 53°13′W to 53°34′N, 53°20′W.

TABLE 2. Numbers of thorny skate tagged in the Newfoundland area during 1962-65, and percentages of returns by sex over a period of 20 years after tagging. (Length range pertains to fish sizes when tagged.)

Length range (cm)	Number of fish tagged by sex			Percentage returns						
				0-5 yr		6-20 yr		0-20 yr		
	M	F	Total	M	F	M	F	M	F	Total
A. W and SW Newfoundland coastal areas, 15-165 m (Table 1, No. 1-7)										
35-69	33	52	87[a]	12	17	9	2	24[b]	19	21[b]
70-94	58	47	105	14	9	5	6	19	15	17
Total	91	99	192	13	13	7	4	21	17	19
B. SE and E Newfoundland coastal areas, 38-146 m (Table 1, No. 8-12)										
40-69	52	100	152	12	16	8	5	19	21	20
70-94	78	45	123	24	7	1	0	26	7	19
Total	130	145	275	19	13	5	3	23	17	20
C. Offshore, Hamilton Bank-St. Pierre Bank, 88-240 m (Table 1, No. 13-22)										
35-69	56	72	134[c]	2	3	0	1	2	4	3
70-99	70	50	121[d]	6	4	3	0	9	4	7
Total	126	122	255	4	3	2	1	6	4	5
Grand Total	347	366	722	11	10	4	3	16	13	14

[a] Total includes two unsexed, no recaptures.
[b] Percentage includes one male, year of recapture unknown.
[c] Total includes six unsexed, no recaptures.
[d] Total includes one unsexed, not recaptured.

miles (1 nautical mile = 1° lat. = 1.15 statute miles = 1.85 km).

Results

Distribution of recaptures

From 722 thorny skates tagged at various inshore and offshore locations in the Newfoundland area during 1962–65, 102 tags (14%) were returned during the ensuing 20 years (Table 2). Except for one return with the year of recapture unknown, 78 recaptures (77%) occurred within 5 years after the fish were tagged. Returns were moderately good (19–20%) from taggings in coastal and near-coastal waters but were quite low (5%) from offshore taggings. Tagged males generally yielded higher returns than females, but there was no consistent trend in percentage returns by size-group in terms of fish lengths when tagged.

The spatial and temporal distribution of reported recaptures indicated great variation in movement of thorny skates. Of 32 recaptures from the three taggings shown in Fig. 2, 20 were less than 30 nautical miles and a total of 29 were less than 65 miles from the tagging areas within 16 years after tagging. The remaining three recaptures were 150, 170 and 240 miles from the tagging sites in 9, 7 and 3 years respectively. Twenty of 24 recaptures shown in Fig. 3 were 60 miles or less from the tagging areas, including one only 5 miles distant in 14 years. The remaining four recaptures were 100–110

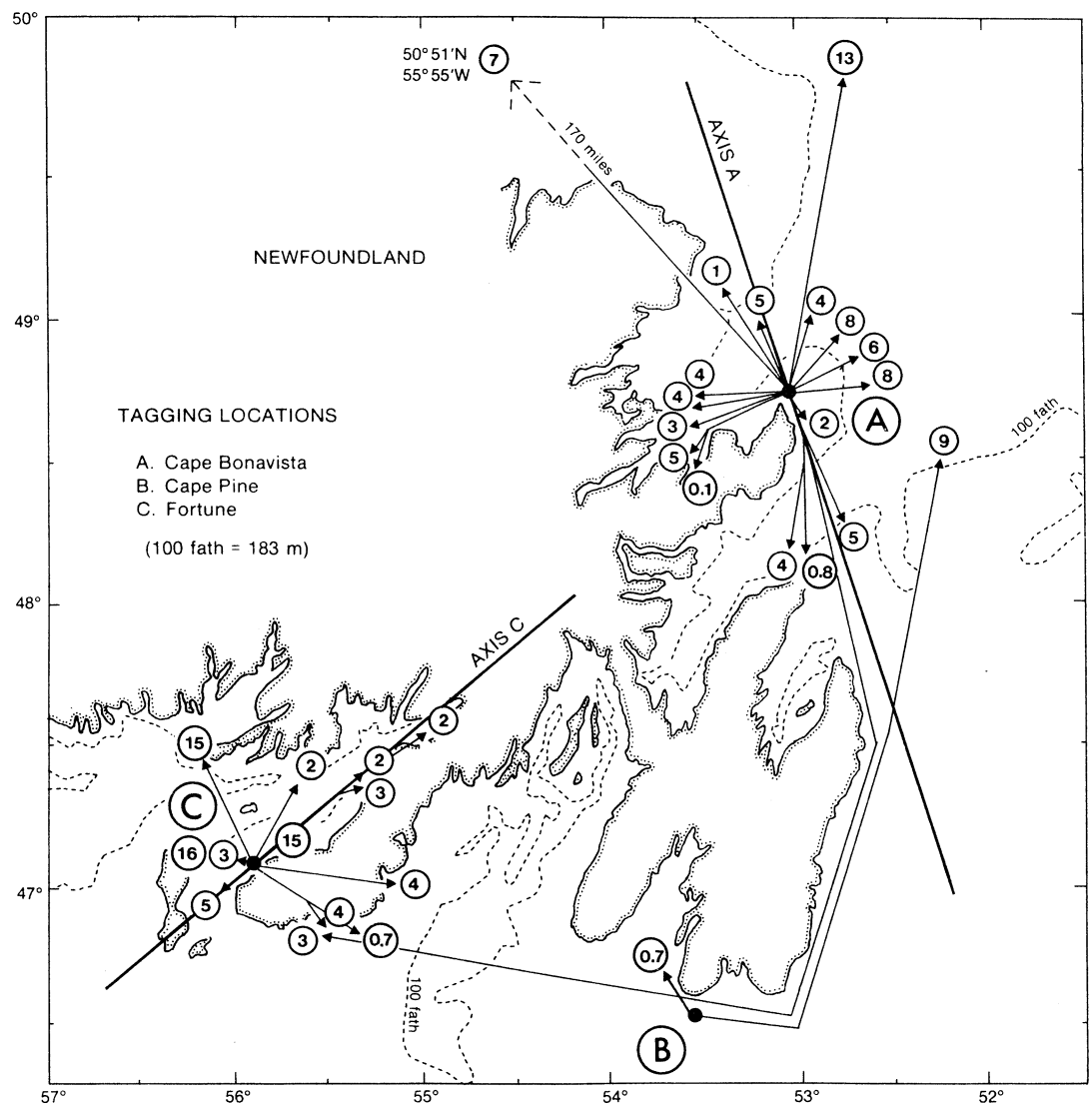

Fig. 2. Migrations of thorny skates tagged off Cape Bonavista (A), Cape Pine (B) and Fortune (C). Axis lines used for the angle of incidence θ of migration direction are shown for A and C. (Tips of arrows indicate recapture positions, and circled numbers refer to years at liberty.)

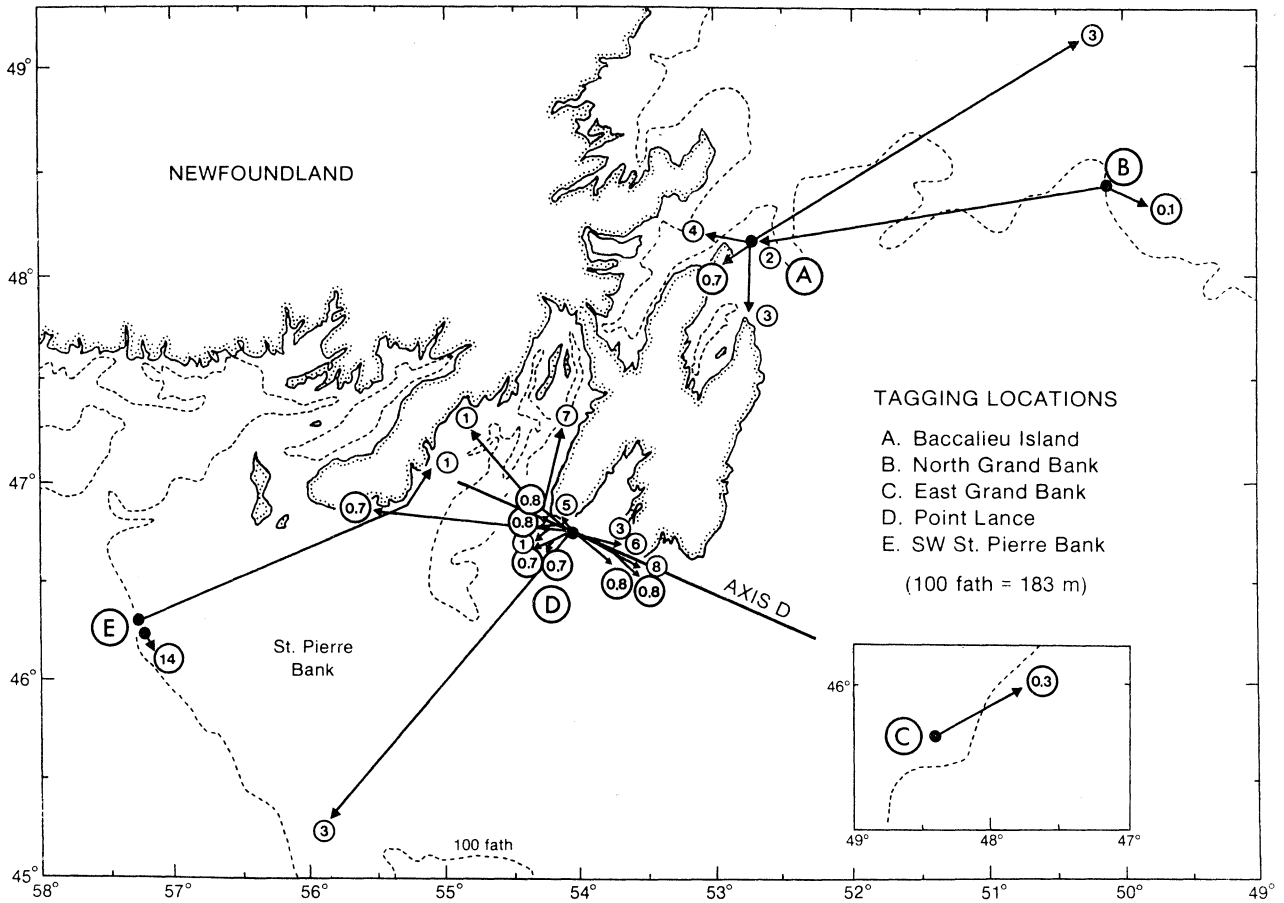

Fig. 3. Migrations of thorny skates tagged off Baccalieu Island (A), on northern Grand Bank (B), on eastern Grand Bank (C), off Point Lance (D) and on southwest slope of St. Pierre Bank (E). The axis line used for the angle of incidence θ of migration direction is shown for D. (Tips of arrows indicate recapture positions, and circled numbers refer to years at liberty.)

miles from the tagging sites within 3 years. Of 38 recaptures shown in Fig. 4, 24 were less than 40 miles and a total of 31 less than 65 miles from the tagging sites up to 20 years after tagging. The remaining seven recaptures were 80–140 miles from the tagging sites in 0.2–11 years. From the results illustrated in Fig. 2–4, some moderately long migrations of 100–110 miles occurred in 0.2–0.6 years in contrast to the recapture of several tagged skates very close to the tagging areas after 14–16 years.

Three recaptures noted in Table 1 are not shown in Fig. 2–4. From the tagging of 15 thorny skates off Port au Choix, one was recaptured 17 miles northeastward within 3 weeks and another 12 miles westward after 6 years. From the tagging of 55 thorny skates in the Hamilton Bank-Belle Isle Bank area in September 1962, the single recapture occurred 70 miles eastward on Hamilton Bank (53°58′N, 55°18′W) about 2 years after tagging. There were no reports of recaptures north of Hamilton Bank or south of the Laurentian Channel.

The migration patterns shown in Fig. 2–4 indicate no obvious trends in direction of movement from the tagging areas except for the easterly movement exhibited by all nine recaptures from the tagging on northwestern St. Pierre Bank (Fig. 4D). The apparent lack of westward movement of thorny skates from this area and of eastward movement from Burgeo Bank and vicinity (Fig. 4EF) indicates that the intervening deep Hermitage Channel (300–350 m) may be a barrier to migration, although bottom temperatures at these depths appear to be favorable (4° to 6° C) as judged from hydrographic observations reported by Templeman and Hodder (1965) for nearby areas. However, some thorny skates from the Cape Bonavista tagging (Fig. 2A) crossed Trinity Bay and Bonavista Bay, both with depths greater than 300 m and temperatures around 2° C at these depths. In most of these apparently deepwater crossings, it is unlikely that the skates migrated along the much longer coastal routes.

Directional movement and dispersion

The tagging results for five areas with the largest numbers of recaptures were selected for computation of directional components of velocity and dispersion coefficients (Table 3), according to the method of Jones (1959). Because of the small number of recaptures in each of the five groups and because 77% of the

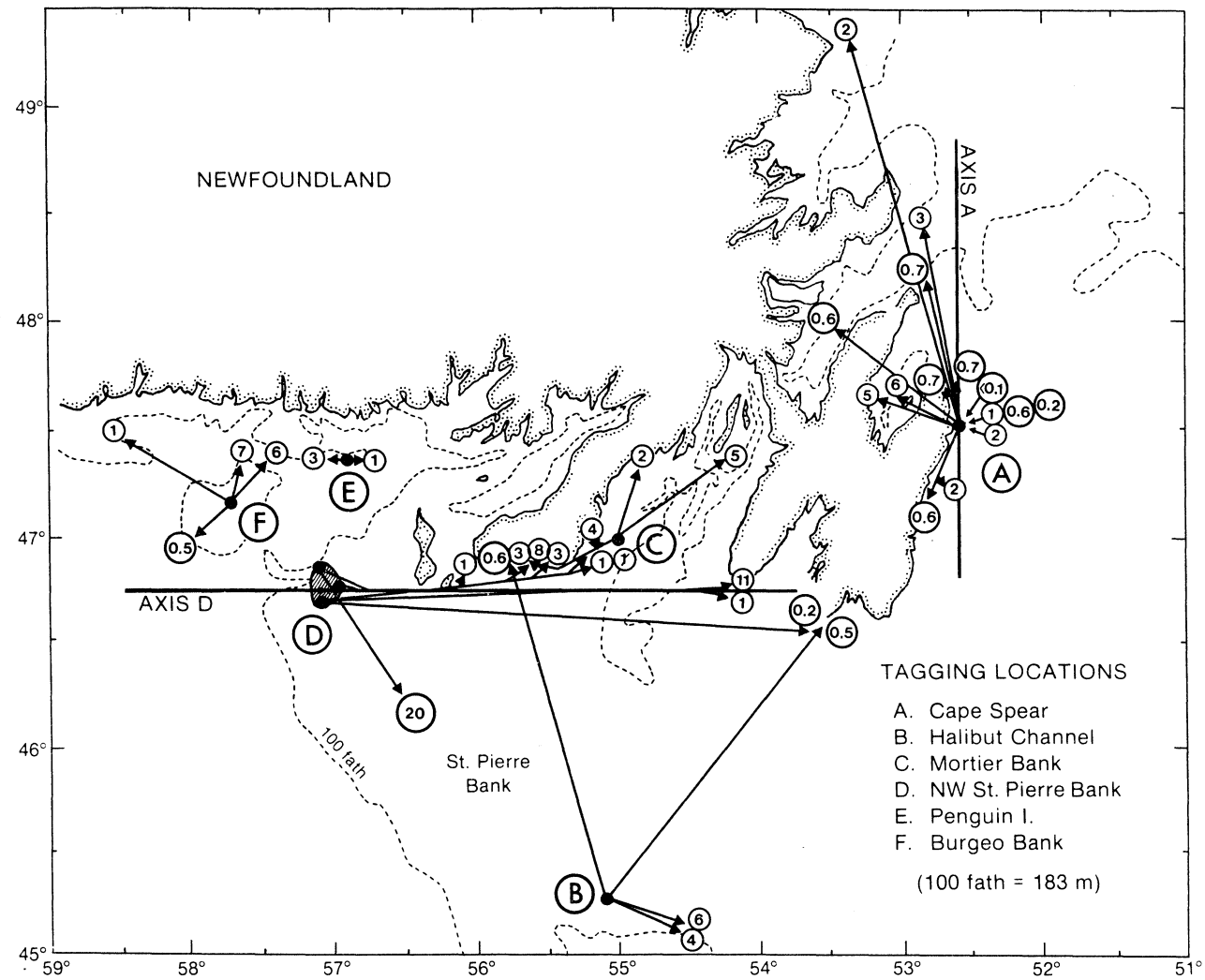

Fig. 4. Migrations of thorny skates tagged off Cape Spear (A), in Halibut Channel (B), on Mortier Bank (C), on northwestern St. Pierre Bank (D), off Penguin Islands (E) and on Burgeo Bank (F). Axis lines for the angle of incidence θ of migration direction are shown for A and D. (Tips of arrows indicate recapture positions, and circled numbers refer to years at liberty.)

recaptures occurred in May-September over many years, a meaningful seasonal comparison of migration and dispersal parameters was not feasible. Also, the small number of recaptures in each group precluded separation of the parameters by sex. However, on the basis of straight-line distances travelled for the 69 recaptures noted in Table 3, 41 males and 28 females averaged 0.13 and 0.05 miles/day respectively. If the two males with relatively long migrations in short periods (0.7 and 2.5 miles/day) are excluded, the average for 39 males (0.06 miles/day) is similar to that for females.

Directional velocities (V) ranged from negligible values of -0.001 and -0.002 miles/day (southward) for the Fortune and Cape Bonavista taggings to very small values of 0.036 and -0.049 miles/day (northward and eastward respectively) for the Cape Spear and northwestern St. Pierre Bank taggings (Table 3). Except for the very large value of 42.7 miles^2/day for the northwestern St. Pierre Bank tagging, the mean square rates of dispersion (a^2) were moderate (1.2 to 5.4 miles^2/day). However, when the number of recaptures is small, one or two with long migrations can determine the directional component of velocity, e.g. the change in V from -0.002 miles/day (southward) to 0.001 miles/day (northward) by the exclusion of the two longest migrations from the Cape Bonavista results (Table 3). Also, a recapture at a greater than usual distance from the tagging site in a short time can affect the dispersion coefficient greatly, e.g. the change from 42.68 to 6.86 miles^2/day for the northwestern St. Pierre Bank results by the exclusion of one recapture with a very long migration in 0.2 years.

TABLE 3. Estimated directional components of velocity (V) and dispersion coefficients (a^2) for five groups of thorny skate recaptures in the Newfoundland area (1 nautical mile = 1.85 km).

Tagging localities	Figure reference	No. of returns used	Velocity (V) (mi/day)	Dispersion (a^2) (mi²/day)	Direction of V
Fortune	2C	12	-0.001	1.20	Southward
NW St. Pierre Bank	4D	9	-0.049	42.68	Eastward
NW St. Pierre Bank	4D	(8)[a]	(-0.040)	(6.86)	(Eastward)
Point Lance	3D	15	0.008	2.49	Westward
Cape Spear	4A	15	0.036	2.71	Northward
Cape Bonavista	2A	18	-0.002	5.41	Southward
Cape Bonavista	2A	(16)[b]	(0.001)	(1.72)	(Northward)

[a] Longest migration (137 miles in 55 days) excluded from calculations.
[b] Longest two migrations excluded from calculations.

Depth, season and gear of capture

The recaptures of tagged skates occurred mainly in shallow areas (22–74 m) during May–October (Table 4), which coincide with the period of intense fishing for Atlantic cod in coastal and near-coastal waters. Recaptures in deeper water occurred throughout the year, the deepest being from 457 m.

Recaptures in coastal and near-coastal waters by Newfoundland fishermen were typically by bottom gillnets (68%) and longlines (15%). Otter-trawl recaptures (15%) were usually from offshore areas (Table 5). There was one handline recapture near St. Pierre in 48 m by a French fisherman. Along the southeast and east coasts of Newfoundland (i.e. Point Lance to Cape Bonavista), recaptures were almost entirely by bottom gillnet, which is the dominant gear for catching groundfish at depths greater than 35 m in the area. From Fortune Bay westward along the south coast, longlines became increasingly important as the gear to which the recaptures were attributable.

Discussion

The results of the Cape Bonavista tagging, with widespread recaptures around the tagging site and negligible resultant directional velocity, reflect the intense fishing activity mainly with bottom gillnets on the coastal banks and slopes. The recaptures from the Cape Spear tagging, with weak northward directional velocity, show negligible offshore movement compared with the Cape Bonavista tagging results. From Cape Spear southward along the Avalon Peninsula, fishing typically occurs on the narrow coastal shelf, with little activity in deeper water along the western slope of the Avalon Channel and in the Channel itself. Consequently, if tagged skates moved southward and into deep water beyond the narrow coastal shelf, they were unlikely to have been caught. Therefore, the northward directional velocity for recaptures from the Cape Spear tagging may be more apparent than real.

Recaptures from the Point Lance tagging showed small westward directional velocity, largely the result of westward migrations to Placentia Bay and St. Pierre Bank. Eastward movement of migrants from the Point Lance tagging site would ultimately result in some moving into deep water of the Avalon Channel, where, as explained for the Cape Spear tagging, they would unlikely be caught due to the lack of fishing activity there.

The results of tagging on northwestern St. Pierre Bank and on Burgeo Bank and vicinity provide no evidence of movement across the intervening Hermitage Channel where temperatures of 4° to 6° C occur at depths of 300–350 m. The apparent migration of thorny skates across Bonavista Bay and Trinity Bay, where bottom depths exceed 300 m and bottom temperatures are around 2° C and the lack of evidence for movement across the Hermitage Channel raise the possibility that the higher temperatures in the Hermitage Channel are a greater barrier to thorny skate migration in deep water than the lower temperatures of similarly deep water in the bays of eastern Newfoundland.

Jones (1959) obtained V values as low as 0.024 miles/day and a^2 values around 2.2 miles²/day for haddock in the non-migratory phase, with much higher values for the migratory phase (0.08 and 118.0 respectively). Comparable values for thorny skates (Table 3) were similar to or lower than those of the non-migratory phase of haddock. Because the dispersion coefficient (a^2) should indicate random undirected dispersal, Jones (1959) concluded that a^2 values should only be estimated from experiments for which there is no evidence of resultant directional movement. Therefore, the a^2 values of 42.68 and 6.86 miles²/day for the northwestern St. Pierre Bank data are too high, because a definite eastward movement is indicated. Johnson (MS 1979) reported V values of 0.012 and 0.021 miles/day for *R. erinacea*, compared with the range of 0.001–0.049 miles/day for *R. radiata* in this paper.

TABLE 4. Seasonal distribution of recaptures of thorny skates by depth intervals (depths were usually reported in fathoms).

Depth of recapture (m)	Recaptures by 2-month periods						
	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Total
22-37	—	—	5	12	2	—	19
38-74	—	—	6	9	4	3	22
75-110	—	1	4	2	2	1	10
111-147	—	3	—	—	2	1	6
148-183	1	4	1	—	1	—	7
184-220	—	—	—	1	1	—	2
221-256	1	1	1	—	1	—	4
257-293	—	—	—	4	1	—	5
294-330	—	—	2	2	1	—	5
331-366	1	—	—	1	—	—	2
457	—	—	—	—	—	—	1[a]
Total	3	9	19	31	15	5	83

[a] Month of recapture unknown.

TABLE 5. Recaptures by tagging locality and gear for thorny skates tagged in the Newfoundland area.

Tagging localities	Fig. ref.	Bottom gillnet	Bottom longline	Otter trawl	Hand-line
Port au Choix	—	—	—	2	—
Burgeo Bank-Penguin I.	4EF	—	5	—	—
Fortune	2C	7	4	—	—
Mortier Bank	4C	3	1	—	—
NW St. Pierre Bank	4D	5	1	2	1
Point Lance	3D	14	—	1	—
Cape Pine	2B	2	—	—	—
Cape Spear	4A	12	3	—	—
Baccalieu I.	3A	3	—	1	—
Cape Bonavista	2A	17	—	1	—
SW St. Pierre Bank	3E	1	—	2	—
Hamilton Bank	—	—	—	1	—
N Grand Bank	3B	1	—	2	—
E Grand Bank	3C	—	—	1	—
Halibut Channel	4B	1	1	2	—
Total (97)		66	15	15	1

Although most thorny skates moved only short distances (<60 miles) from the tagging sites after many years, a few recaptures indicated rapid movement over considerable distances (100-200 miles) in short periods of time. There appears to be considerable intermingling of thorny skates on St. Pierre Bank with those of Newfoundland, but this may not be as significant as shown by the recaptures, because the skates are probably much more vulnerable to capture by bottom gillnets and longlines in coastal waters than by otter trawls on St. Pierre Bank. The typical pattern of displacement from the tagging areas provides no evidence of seasonal migrations to and from distant spawning grounds as occurs for cod of the area (Templeman, 1979). Skates, residing in an area and depositing their egg capsules there, from which the young emerge to a bottom-related existence, have no need for such contranatant migrations as are required by cod to counteract denatant larval drift (Templeman, 1979, 1981).

Movements of other skate species have been reported by other researchers. Fulton (1893) tagged thornback skates, *Raja clavata*, and had two recaptures, one 13 miles from the tagging location in less than 3 weeks and the other 6 miles distant in 9 months. He also tagged *Raja batis* and had one recapture 10 miles distant in 10 days. From 614 mostly immature *R. clavata* tagged in English coastal waters, Steven (1936) had 203 returns (33%) within 4 years after tagging: 61% from the tagging area, 71% less than 5 miles away, 5% 20-50 miles distant, and none more than 50 miles from the tagging area. Richards *et al.* (1963) reported only 0.7% returns from the tagging of 641 *R. erinacea* (no reward offered) in Block Island Sound, four within 5 miles of the tagging site during 1 week to 8 months after tagging and one 44 miles away after 9 months. In a later tagging of 1,250 *R. erinacea* in Block Island Sound (Johnson, MS 1979), returns were 6.6% within 1 to 2 years of tagging. Of 70 individuals whose recapture position was known, 87% were within 5.4 miles of the tagging location and the greatest distance from the tagging site by an individual skate was 10.3 miles in over a year. From these limited observations, it appears that other species of skates are similar to *R. radiata* in being usually limited to short migrations. However, some longer migrations than those described for other skates were noted for *R. radiata*.

There was no primary fishery for thorny skates in the areas where they were tagged, and the recaptures were mainly from the fishery for cod and other groundfish species both in coastal waters and on the offshore banks. The pattern of recaptures coincides generally with the patterns of summer and early autumn cod fisheries in coastal waters and in deeper areas below the intermediate cold-water layer (Templeman and Fleming, 1963). The winter-early spring recaptures were from the cod fishery in intermediate depths off the south coast of Newfoundland. The depth range of recaptures (22-457 m), indicated by the data in this paper, was limited by the lack of returns from otter trawlers. McEachran and Musick (1975) reported a depth range of 27-439 m for *R. radiata*, but they were most abundant in 111-366 m from the southern Scotian Shelf to Long Island. Bigelow and Schroeder (1953) indicated a depth range of 26-615 m for *R. radiata* of the Northwest Atlantic and a greatest depth of 839 m near Spitzbergen. Du Buit (1970) found *R. radiata* moderately plentiful at 500-550 m on Tampen Bank in the Norwegian Sea.

Although there were 19 reported recaptures from 22 to 37 m, none were taken by codtraps or handlines used by Newfoundland fishermen. These gears are commonly used in the cod fishery at these depths and even to 70 m for handlines. The single report of a

recapture by handline was by a French fisherman from St. Pierre. Thorny skates possibly do not swim consistently enough to follow the leader of a codtrap into the mouth of the net and are not captured by handlines because this gear is typically fished a short distance off the bottom. However, these skates seem to be caught readily in synthetic gillnets and on the baited hooks of longlines set on the bottom. The low number of recaptures by otter trawl may be partly due to the low vulnerability of skates to capture by this gear equipped with rollers because they can avoid capture by remaining close to the bottom (Edwards, 1968).

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