Northwest Atlantic Fisheries Organization

Serial No. N4431 **NAFO SCR Doc. 01/ 53**

SCIENTIFIC COUNCIL MEETING – JUNE 2001

A New Tagging Program for Yellowtail Flounder on the Grand Bank, NAFO Divisions 3LNO

by

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Abstract

In 2000, a new 5-year tagging program for yellowtail flounder on the Grand Bank began. Approximately five thousand fish were tagged in Div. 3NO with a combination of single and double Petersen discs and 200 fish were tagged with 'dummy' archival tags and released at 25 selected stations. The purpose of the tagging experiments is to derive independent estimates of exploitation rate, mortality, growth and both large and small-scale movements.

Introduction

Yellowtail flounder, *Limanda ferruginea*, inhabits the continental shelf of the Northwestern Atlantic Ocean from Labrador to Chesapeake Bay at depths of 10-100 m, (Bigelow and Schroeder, 1953). This species has reached its northern limit of commercial concentrations on the Grand Bank off the east coast of Newfoundland (Walsh, 1992). Here, juveniles and adults overlap considerably in their distribution and the stock is generally concentrated on the southern Grand Bank, on and around the Southeast Shoal.

An important stock status indicator which characterizes the current health, growth potential and exploitability of the stock is the geographical distribution of the stock. Earlier observations from the 1970s tagging studies of yellowtail flounder from the northern region of the Southeast Shoal suggest that Grand Bank yellowtail flounder were relatively sedentary and made limited movements from their release sites (Walsh, 1987). Similarly, tagging studies along the 370 km trans-boundary line carried out in the early 1990s also showed that yellowtail flounder undertake limited movements mostly northward (Morgan and Walsh, 1999). These observations confirmed earlier studies of movements of adult yellowtail flounder tagged on the New England fishing grounds (Royce *et al*., 1959; Lux, 1993). However, neither of these Grand Bank tagging studies were extensive enough to cover the main stock area and the original design of these studies was to answer specific questions about movements in a localized area.

Within the past decade, other information has surfaced that may cast doubt on the sedentary hypothesis of Grand Bank yellowtail flounder. In the early-1990s, as the stock of yellowtail flounder declined, the northern extent of its range decreased substantially and the stock range was compressed to the area of the southern Grand Bank (Brodie *et al*., 1998). During the winters of 1997-99, the catch rates of yellowtail flounder in the annual DFO/FPI bottom trawl grid surveys were much lower in comparison to those taken during the spring, summer and fall surveys of the same years (Maddock-Parsons *et al*., 2001). Such changes in catchability imply a change in availability or accessibility. Following the winter grid survey of 1999, fishing gear trials were carried out aboard the same FPI vessel with the same gear to measure changes in catch rates with the addition of a tickler chain to ‘dig out’ and herd yellowtail flounder in front of the trawl. A comparison of catch rates of yellowtail flounder with and without a tickler chain attached ahead of the footgear resulted in no significant difference in catch rates being detected ($p>0.05$)(Walsh and McCallum; unpubl. data). This implies either a change in availability of fish in the area or accessibility to the trawl. Anecdotal information from a codend mesh selectivity study in the winter of 1990 and the comparative survey gear fishing trials carried out during the winter of 1996 also indicated that catches were low during this time of the year. Recent analysis of seasonal surveys in the Gulf of St. Lawrence have shown that yellowtail flounder migrate into warmer, deeper waters in the winter (Poirier *et al*., 1997). In the annual Canadian spring groundfish survey, small catches of yellowtail flounder have been taken along the southwest edge of the Grand Bank in depths up to 730 m; far deeper than previously known. This would imply that some fish either migrate off the plateau of the Bank or the range of the stock has extended to deeper waters.

Knowledge of yellowtail flounder movements is important in the assessment and management of this resource because they may explain anomalies in abundance indices and changes in fishing patterns of the commercial fleet. One such anomaly is that catch rates of yellowtail flounder are (statistically) significantly higher at night than during the day in the bottom trawl surveys (Walsh, 1988). Changes in trawl efficiency offers one explanation in which yellowtail flounder avoid the trawl better during the day then at night (Walsh, 1991), however, changes in accessibility due to vertical migrations have also never been investigated.

Mark-recapture studies can be used to estimate abundance of fish by using recaptures of the tag fish to estimate the exploitation rate together with total landings in the fishery. These studies can also be used to estimate movements, growth, and selectivity.

Tagging yellowtail flounder with traditional techniques, i.e. Petersen discs, can provide information on movements but may underestimate their true extent. Recent electronic data storage tagging (DSTs) studies of North Sea plaice used measurements of depth and temperature to reconstruct the tracks of plaice movements (Metcalfe and Arnold, 1997). It was discovered that the rates of movements are often ten times faster and farther than those deduced from conventional mark-recapture experiments.

In the winter of 2000, the Northwest Atlantic Fisheries Center (NAFC) and Fishery Products International Ltd, of St. John’s entered into a co-operative program to begin a 5-year tagging program on Grand Bank yellowtail flounder using traditional Petersen discs in a mark-recapture study. Archival data storage tags will be used to specifically to investigate vertical and horizontal movements at a finer scale of resolution. The objectives of this extensive tagging program are to estimate exploitation rates, growth rates, mortality, movements and to provide an additional estimate of population size. This paper summarizes the design of the experiment and reports on the recapture returns to date.

Materials and Methods

Tag reward design

Petersen disc tagging: A new triple tag reward scheme was introduced following the innovative design used in tagging Atlantic cod at NAFC (Brattey and Cadigan, 1998). Yellowtail flounder were tagged either with single red Petersen disc tags with a $20 reward, double red Petersen disc tags, each with a $20 reward or a single pink Petersen disc tag with a $100 reward. The tags were applied in a fixed sequence starting with 1 pink, 9 single red tags, 1 pink tag, 9 double red tags. The purpose of the high ($100 pink discs) reward tags was to estimate the tag reporting rate of the standard $20 red tags, assuming that all $100 tags captured would be returned. The double tags are used to estimated long-term tag loss based on changes over time in the proportion of doubled tagged fish that are captured with either one or two tags attached.

Data storage tags: yellowtail flounder were tagged with ‘dummy’ tags with a $100 reward and an additional single red Petersen disc tag with a $20 reward (see Fig. 1, Appendix I). The dummy tags which are the same dimensions (18 mm diameter, 48 mm length; 1 g weight in water) as the ‘real’ data storage tags were used to gauge their return rate. The extra Petersen disc tag was used to gauge tag loss.

The tag rewards were advertised using posters (Fig. 2, Appendix I), which illustrate the type of tags, color of tags, and reward values. Pre-addressed yellowtail flounder tag return envelopes (Fig. 3, Appendix I) were included with these posters. These were sent to all yellowtail flounder quota licensed Canadian vessels and their processing plants and as well to fishing companies in Spain and Portugal. Fishery observers on Canadian fishing vessels were also briefed about the tagging experiments and were supplied with posters and envelopes. All tag returns were sent a standard letter describing information about the tagged fish and included date tagged, size and location. A chart of the Grand Bank showing the released site and the recapture site was also included.

Experimental design

Yellowtail flounder were tagged and released in the area of the southern Grand Bank in NAFO Div. 3NO from a commercial fishing vessel, *FPI Atlantic Lindsey*, owned and operated by Fishery Products International of St. John's, a partner in the 5-year tagging program. The tagging was carried out in May 2000. Fish were captured using a Engel 95 otter trawl which was towed for 10-15 minutes at a speed of 3.0 knots. At each station, an XBT was used to gather information on the temperature profile of the water column that the fish would pass through upon capture and release. Fish were placed in holding tanks and subsequently measured (total length) and tagged. Only fish greater than 30 cm were tagged with Petersen disc and only fish greater than 40 cm were tagged with dummy data storage tags (DSTs). Any fish with excessive bruising or scale loss were not tagged. The fish were returned to a holding tank after tagging and held until the release position was reached. The temperature of the water in the tank was measured. Capture and release site were to be as close as possible in location.

The stock area of the southern Grand Bank, Div 3NO, was partitioned into 2 strata: one, which encompassed the 1998-99 Canadian fishing areas (stratum II) and one covering the majority of the remaining stock area (stratum I) (Fig. 1). The majority of the stock as estimated from annual NAFC bottom trawl surveys is encompassed by these two stratum (Simpson and Walsh, 1999). Our objective was to create a constant tag density through the stock area. By partitioning the stock area into two strata and knowing the number of tags released, the amount of fishing effort (log books) and the number of tags returned an estimate of exploitation and stock size using spatial models can be derived (Hoenig *et al*., 1998a, b). There were 25 release positions, 7 in stratum I and 18 in stratum II, both inside and outside the transboundary area (Fig. 1 and 2). At each capture position, 200 Petersen disc tagged fish (90 singles, 90 double tags and 20 high reward tags) and 8 dummy archival tagged fish were released. The release positions are given in Table 1 and shown in Fig. 2.

When tags were returned the information was entered into a database and the appropriate rewards sent to the person returning the tag. From this information, return position, distance and direction travelled were calculated. Return positions were plotted for each release position separately.

Results and Discussion

A total of 4996 yellowtail flounder were tagged with Petersen discs of which 3.9% have been returned (Table 2). Two hundred fish were tagged with archival tags of which 6% have been returned. The majority of the first year returns from the 2000 tagging experiment came from the Canadian fishery on the Grand Bank. Because of the 5% plaice and cod by-catch restrictions in the 2000 fishery, the activity of the fleet was confined to a smaller region of the whole stock area (Walsh *et al*., 2001). It was because of the difficulty of these restrictions and the no fishing policy during spawning season, June 15 to July 31, that the majority of the directed fishery for yellowtail flounder by the Canadian fleet activity ceased from early May to mid-September. This fishery cessation was beneficial to the tagging experiment in that it would allow fish (tagged in May) the opportunity to disperse throughout the stock area.

Tags were returned from every site[1] with the exception of one (Table 1). There was a marginally higher percentage of double tag (4.4%) returns than single tags (3.5%) (Table 2). In contrast there was a 6% return rate for the archival tags. Ninety-six percent of the Petersen tags and all but one archival tag were returned by Canadian fishers. Figures 3-5 shows the yellowtail flounder recapture positions for each release station separately. There was movement of tags across the trans-boundary line in both directions. Archival tags from 8 tagging positions were returned (Fig. 6). Although most of the tags were from stratum II, the fishery area of the design there were several returns from the non-fishing stratum I positions most of which had moved into stratum II (Fig. 7). The direction of return position relative to release position was

[1] Tags were returned from station # 1 in recent days but there was insufficient time to update the analyses.

calculated for the 198 tags for which a return position was given. Tags were returned from every compass direction. Tags were most frequently returned from positions south, SW, SE and east of the release position. This is different from a previous tagging experiment (Walsh MS 1987; Morgan and Walsh, MS 1999) but may reflect more the restricted geographical extent of the fishery rather than any change in movement patterns of the fish. For these 198 fish, the average distance traveled was 32.4 $\pm$ 1.7 nmi (mean $\pm$ S.E.) with the maximum distance being 137 nmi.

Year 2 of the tagging program will begin in June 2000 in which 5000 or more fish will be tagged with Peterson disc. In addition 300 fish will be tagged with "real" archival DSTs to measure depth and temperature on a daily basis. In March of 2001, long-term tank experiments were set up at NAFC to examine the effects of different DST attachment techniques on mortality and behaviour of yellowtail flounder. In addition, cage experiments in which tagged fish and untagged fish will be kept for 10 days on the ocean bottom to determine short term mortality rates related to the tagging process are planned for the inshore area.

Acknowledgements

We thank Bob Ennis, Paul Winger and Gerry Dawe and the crew of the FPI vessel Atlantic Lindsey who carried out the 2000 tagging experiment. Special thanks to Noel Cadigan and John. Brattey at NAFC and Carl Schwarz at Simon Fraser University in British Columbia for consultation on statistics and planning.

References

Bigelow, H.B. and W.C. Schroeder 1953. Fishes of the Gulf of Maine. US Fish Wildlife Serv. Fish. Bull., 74, 577p.

Brodie, W. B., S. J. Walsh and D. B. Atkinson 1998 The effect of stock abundance on range contraction of yellowtail flounder (*Pleuronectes ferruginea*) on the Grand Bank of Newfoundland in the northwest Atlantic from 1975 to 1995. J. Sea Res., 39: 132-152.

Hoenig, J.M, N.J. Barrowman, W.S. Hearn and K.H. Pollock 1998a. Multiyear tagging studies incorporating fishing effort data. Can. J. Fish. Aquat. Sci., 55: 1466-1476.

Hoenig, J.M, N.J. Barrowman, K.H. Pollock, E.N. Brooks, W.S. Hearn and T. Polacheck 1998b. Models for tagging data that allow for incomplete mixing of newly tagged animals. Can. J. Fish. Aquat. Sci., 55: 1477-1483.

Lux, F.E. 1963. Identification of New England yellowtail flounder groups. Fish. Bull., 63:1-10

Maddock- Parsons, D., W.B. Brodie and M. Simpson 2001. Update on cooperative surveys of yellowtail flounder in NAFO Divisions 3NO, 1996-2000, including an expanded survey in Divisions 3LNO in 2000. NAFO SCR Doc. 01/70:28 p.

Morgan, M.J. and S.J. Walsh. 1999. An update of results of tagging experiments with juvenile yellowtail flounder in NAFO Divisions 3LNO. NAFO SCR Doc. 99/23.

Metcalfe, J.D. and G.P. Arnold 1997, Tracking fish with electronic tags. Nature, 387: 665-6.

Poirier, G., R. Morin and D. Swain 1997: The status of yellowtail flounder in NAFO Division 4T in 1996. DFO Can. Stock Assess. Res. Doc. 97/70

Royce, W.F., R.J. Butler and E.D. Premetz 1959. Decline of yellowtail flounder (*Limanda ferruginea*) off New England. Fish. Bull., 59:169-267.

Walsh, S.J 1987. Some observations on the movement of tagged yellowtail flounder (*Limanda ferruginea*) on the Grand Bank, NAFO Divisions 3LNO. NAFO SCR Doc. 87/46:5 p.

Walsh, S. J.1992. Factors influencing distribution of juvenile yellowtail flounder (*Limanda ferruginea*) on the Grand Bank of Newfoundland Neth. J. Sea Res., 29:193-203.

Simpson M and S.J. Walsh 1999. Spatial variation in distribution and abundance of yellowtail flounder in NAFO Divisions 3LNO using geostatistics. NAFO SCR Doc. 99/60: 65p.

Walsh, S.J., M.J. Morgan, D. Power and C. Darby 2001. The 2001 assessment of Grand Bank yellowtail flounder in NAFO Divisions 3LNO. NAFO SCR Doc. 01/76.

Table 1. Release positions, number of tags and number of returns from the 2000 experiment.

STATION	LATTITUDE	LONGITUDE	No. released	No. recaptures
1	45 17.0	51 46.0	208	0
2	45 43.0	51 11.0	208	2
3	45 14.0	51 10.0	208	4
4	45 42.0	50 38.0	208	5
5	45 43.0	50 04.0	208	11
6	45 46.0	49 38.0	206	7
7	45 14.0	50 39.0	206	9
8	45 13.0	50 04.0	208	22
9	45 12.0	49 39.0	208	13
10	45 11.0	49 19.0	208	7
11	45 01.0	50 33.0	208	20
12	45 02.0	50 08.0	208	20
13	44 48.0	49 19.0	208	5
14	44 48.0	49 40.0	209	1
15	44 45.0	50 05.0	208	11
16	44 45.0	50 40.0	208	26
17	44 26.0	51 40.0	207	3
18	44 17.0	51 13.0	207	4
19	44 26.0	50 40.0	208	2
20	44 28.0	50 00.0	208	6
21	44 13.0	49 39.0	209	3
22	44 16.0	49 59.0	208	13
23	44 13.0	50 41.0	208	5
24	43 47.0	50 37.0	208	4
25	43 52.0	49 40.0	208	2

Table 2. List of the number of fish tagged and returned from the 2000 experiment.

Tag Type	No. Released	No Returned	% Return
Petersen disc			
Singles	2252	78	3.5
Doubles	2247	99	4.4
High rewards	497	16	3.2
Total	**4996**	**193**	**3.9**
Dummy archival			
DST + single Disc	200	12	6.0
Total	**5196**	**205**	**3.9**

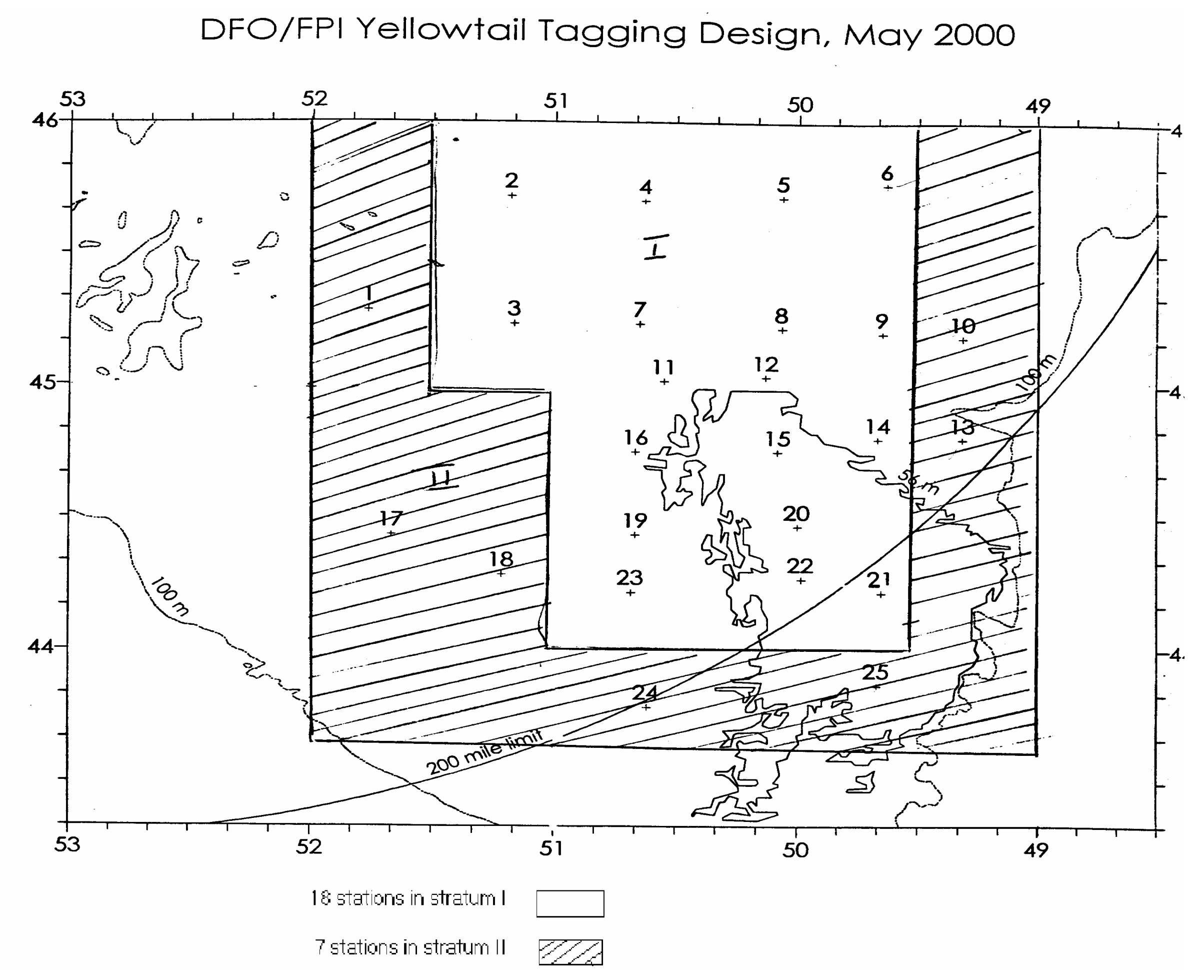

Fig. 1. Stratification design used to select tagging stations for the 2000 experiment based on the fishing patterns of

the Canadian fleet in 1998 and 1999

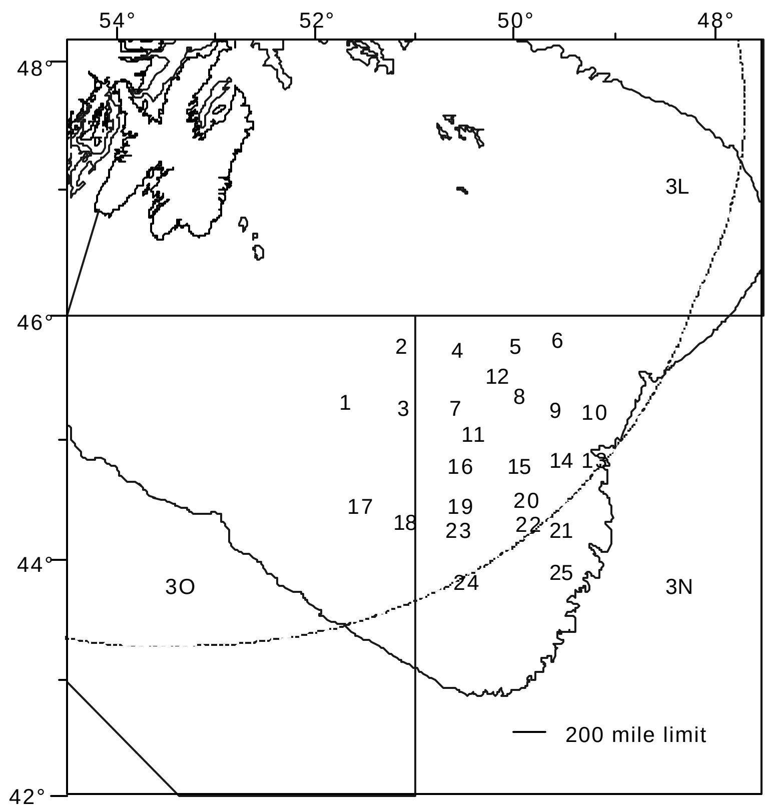

Figure 2. Release positions of tagged yellowtail flounder

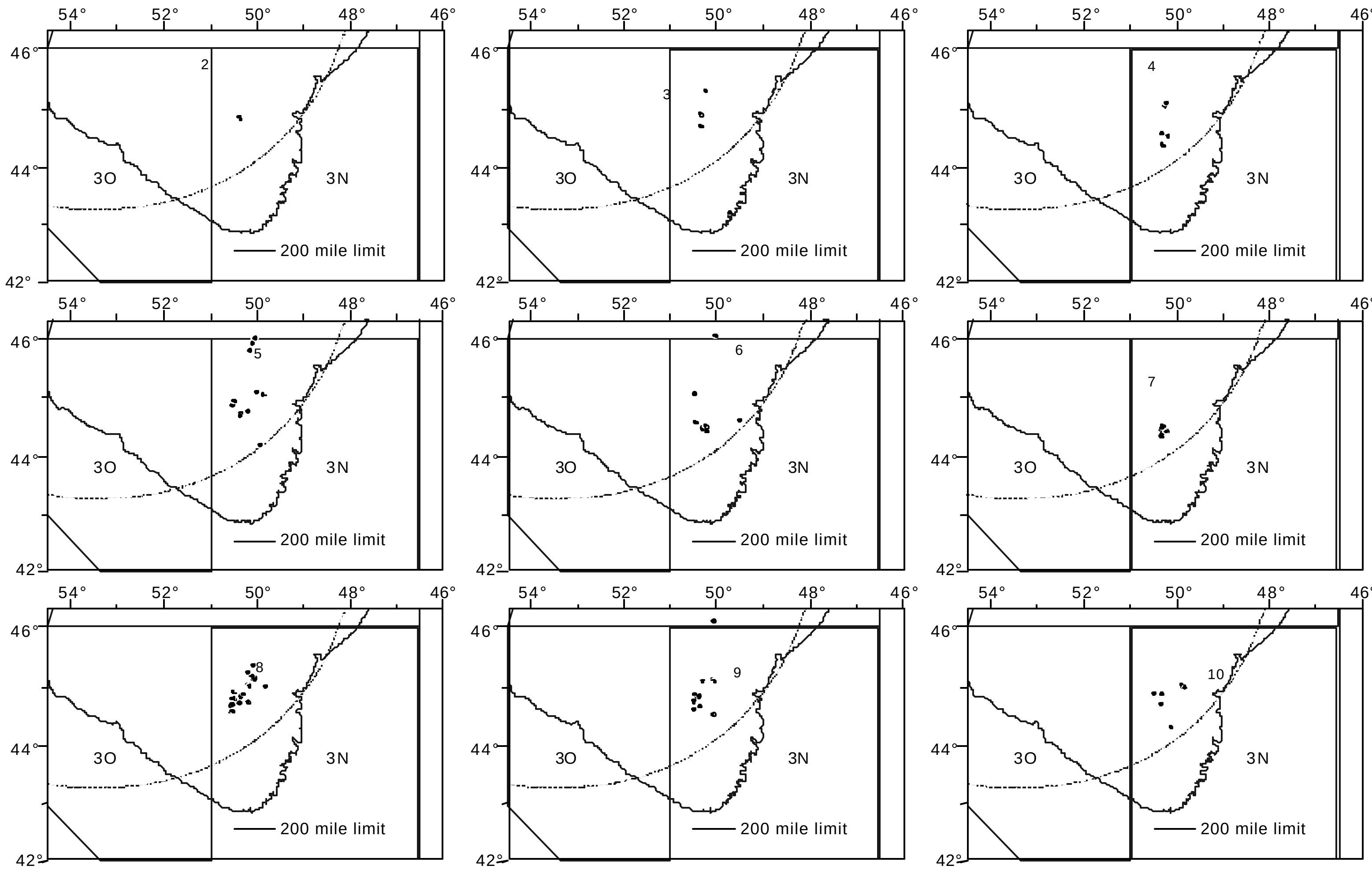

Figure 3. Returns of yellowtail flounder from each release position.

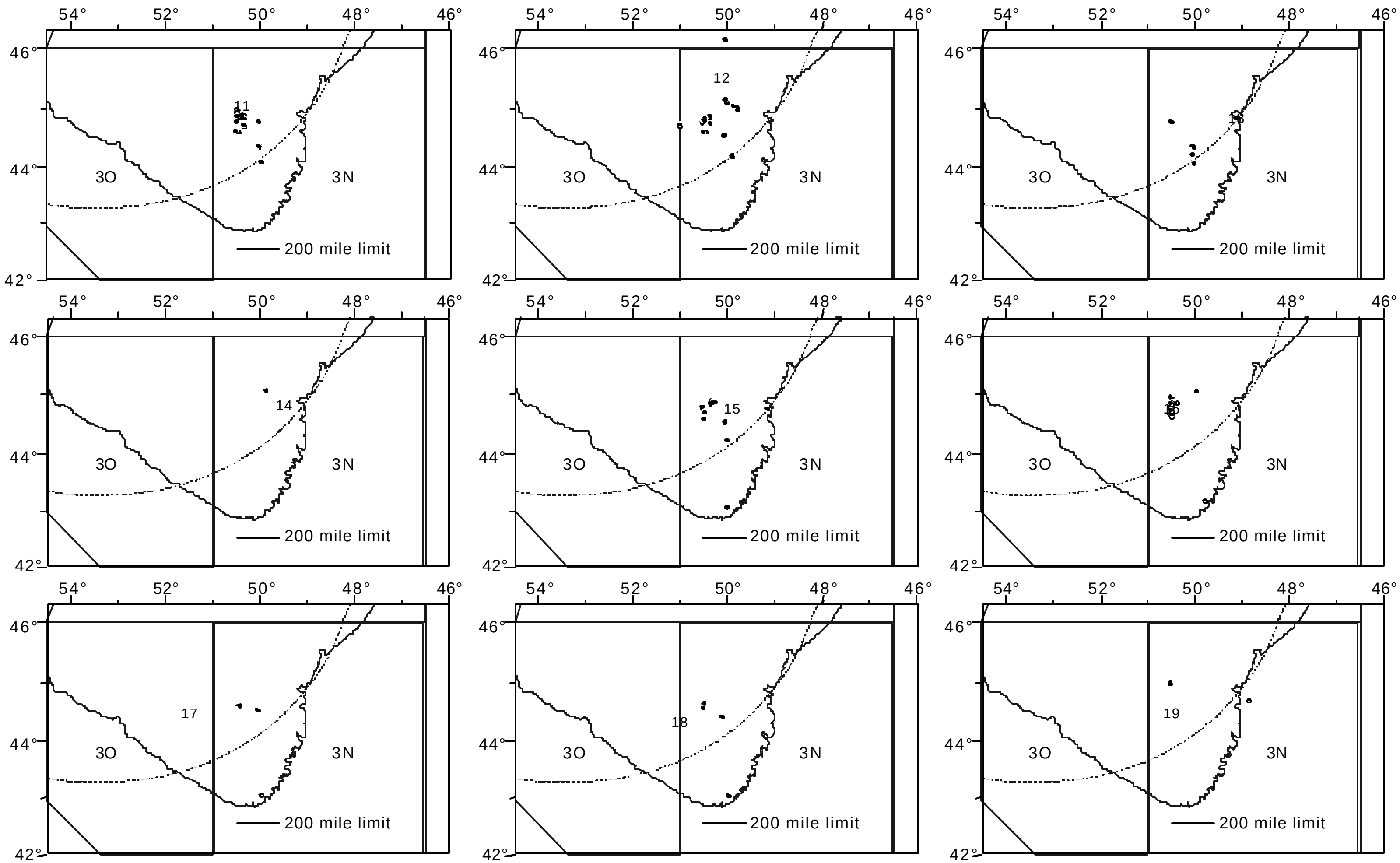

Figure 4. Returns of yellowtail flounder from each release position.

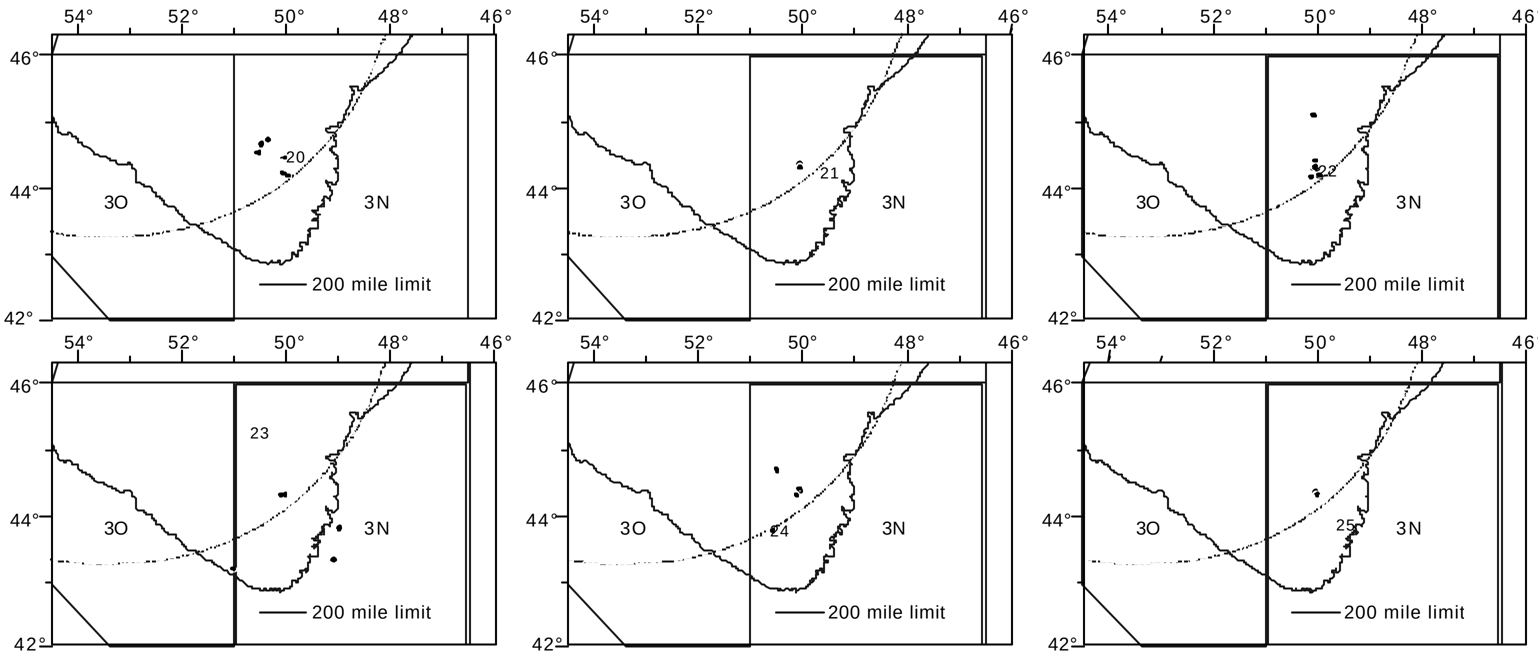

Figure 5. Returns of yellowtail flounder from each release position.

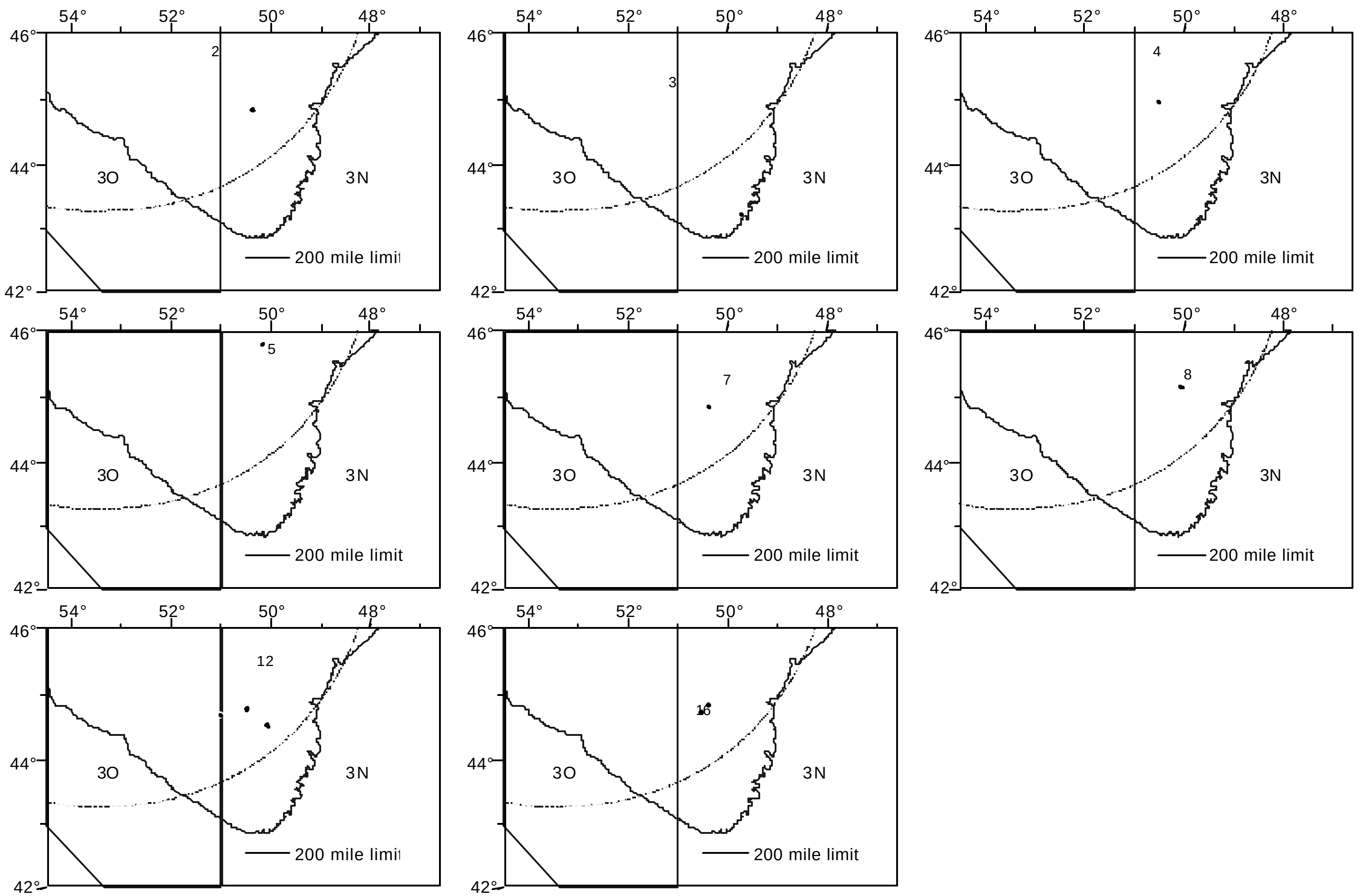

Figure 6. Returns of yellowtail flounder with DST tags from each release position.

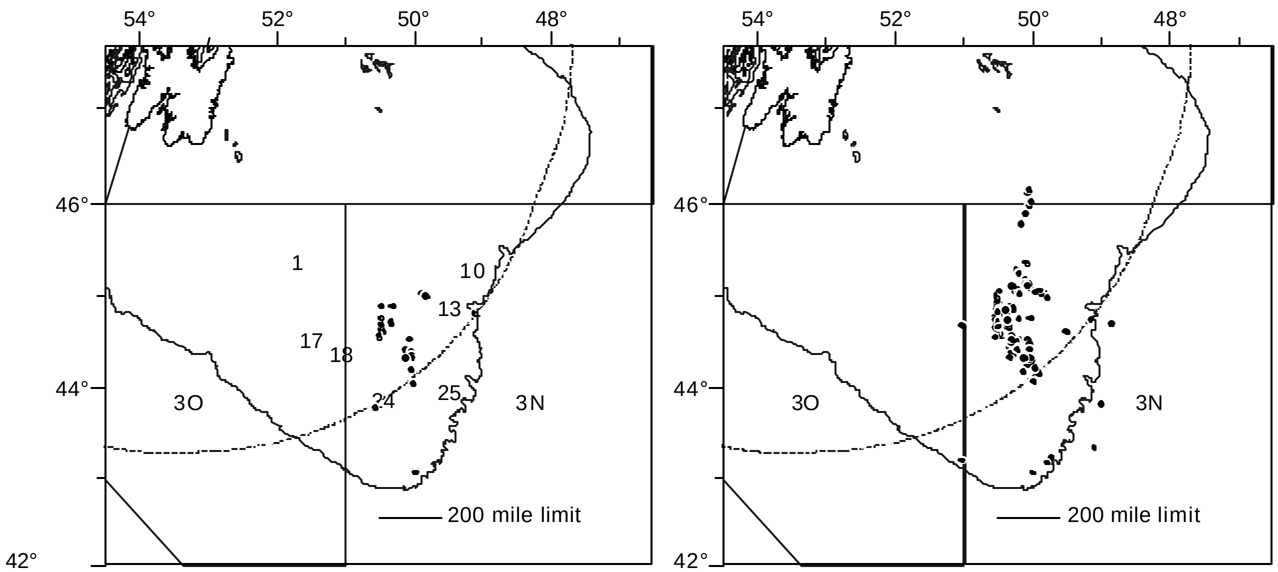

Fig. 7. Returns of yellowtail flounder released in non-fishing areas (Stratum II) and fishing areas (Stratum I), respectively.

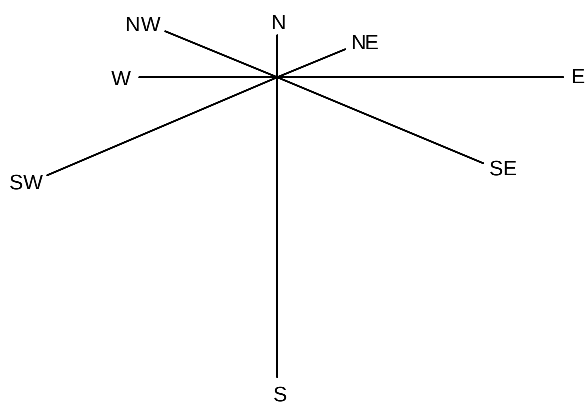

Figure 8. Frequency of direction of recapture position relative to release position for yellowtail flounder. Direction is relative to true north. Length of an arm indicates the relative frequency.

APPENDIX I.

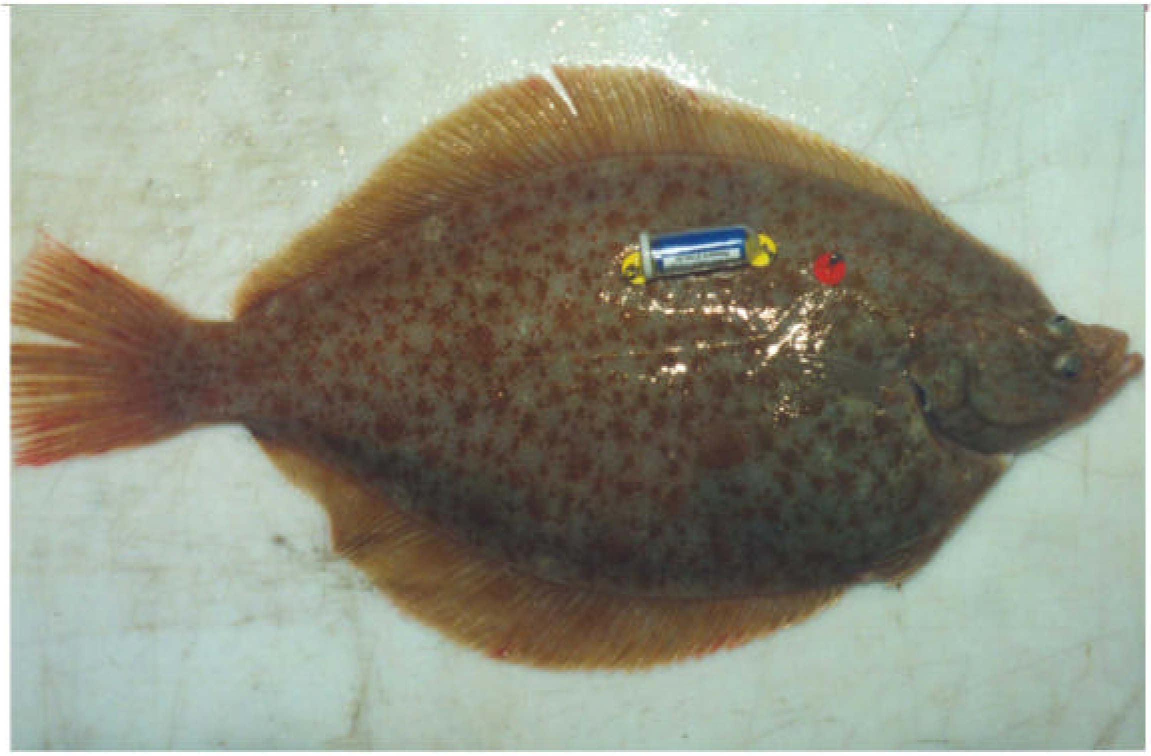

Fig. 1. Location of data storage tag and Petersen disc.

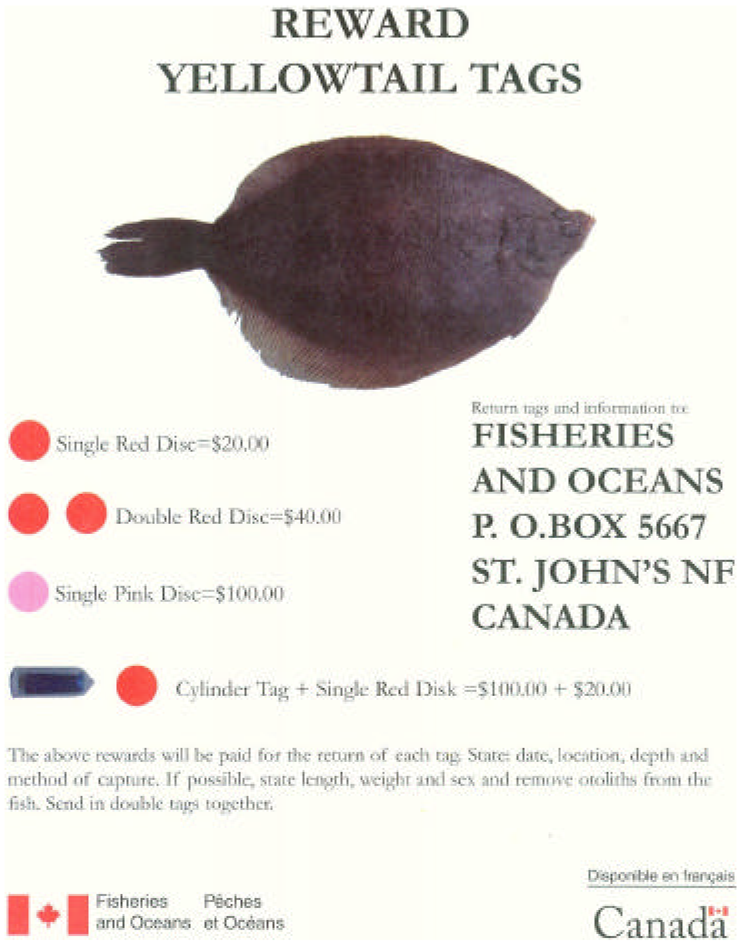

Fig. 2. Reward poster for yellowtail flounder tags.

FISH SPECIES:		TAG 1 NUMBER:		TAG 2 NUMBER (IF PRESENT):		
EXACT LOCATION OF CAPTURE LATITUDE: LONGITUDE:			NAFO DIVISION:	PLACE OF CAPTURE		
DATE OF CAPTURE: YEAR: MONTH: DAY:			SEX OF FISH:	DEPTH FISHED:		
GEAR USED:	VESSEL NAME:	TRIP#:	SET#:	LENGTH:	MEASURED EXACTLY (check one) ESTIMATED	
NAME:						
ADDRESS:						
CHECK ONE:	COMMERCIAL FISHER:			Check here if you would like more envelopes		
	PLANT WORKER:					
	RECREATIONAL FISHER:					
	SENTINEL FISHER:					
	OTHER:					

Fig. 3. Tagging envelope for yellowtail flounder tag returns.