

**A MARK-RECAPTURE EXPERIMENT ON BLUEFIN TUNA (*THUNNUS THYNNUS* L.) FROM THE
BROWNS-GEORGES BANKS REGION OF THE CANADIAN ATLANTIC: 1993 UPDATE**

Porter, J.M., M.J.W. Stokesbury*, C.A. Dickson*, W.E. Hogans***

** Pelagic Fisheries Section, Department of Fisheries and Oceans, Biological Station,
St. Andrews, New Brunswick, E0G 2X0, Canada*

*** Atlantic Reference Centre, Huntsman Marine Science Centre,
St. Andrews, New Brunswick, E0G 2X0, Canada*

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INTRODUCTION

Population estimates for Atlantic bluefin tuna stocks have previously been calculated using virtual population analyses on catch-at-age data collected during the commercial fisheries (Anon. 1992). In the past, mark and recapture experiments have provided information on growth and migratory behavior of bluefin tuna (e.g. Beckett 1970). More recently, advanced population assessment models have made multiple mark-recapture tagging experiments feasible for determining population size and have been the basis for the assessment of some fish populations (Majkowski and Murphy 1983; Majkowski et al. 1984).

The tagging project conducted on bluefin tuna in the Canadian Atlantic consisted of two components, a multiple mark-recapture experiment and an investigation using ultrasonic telemetry. The tagging portion of the mark-recapture study was initiated in August 1990 and completed in September 1992. The objectives were to use tag return information to estimate the population size of the bluefin tuna school off southwest Nova Scotia, to examine movements of bluefin tuna, to evaluate tag retention through double tagging, and to determine the susceptibility of marked fish to recapture. In response to very low initial recapture rates, an ultrasonic telemetry investigation was conducted in 1991 to determine the effects of the capture and tagging procedure on survival of released bluefin tuna (see Porter and Hogans 1992 for details of the ultrasonic investigation). This project was conducted by scientific staff from the Department of Fisheries and Oceans (Scotia-Fundy Region) and from the Huntsman Marine Science Centre, in cooperation with the Southwest Nova Tuna Association.

MATERIALS AND METHODS

The tagging project was conducted in the Hell Hole on the eastern edge of the Fundian Channel, between Browns and Georges banks (approx. 42°04'N, 65°35'W; Fig. 1). During 1990, four tagging trips (22-24 August, 12-14, 24-26, 28-30 September) were made from a 15-m commercial tuna fishing vessel. The three tagging trips in 1991 (28 August-1 September, 16-21 September, 3-7 October) and the two tagging trips in 1992 (4-9 August, 8-23 September) were made from the CSS E.E. PRINCE, a 40-m Department of Fisheries and Oceans research vessel.

CAPTURE AND TAGGING OF TUNAS

Fishing was performed daily from 0800-1800 h using tended line gear, characteristic of the gear employed in the commercial fishery. The tended line gear consisted of 600-800 m of 1.25-cm diameter braided line coiled in a large tub. This line was connected to a 6- to 16-m monofilament leader of 400- to 600-lb test using a swordfish clip secured by a crimp (0.8 mm) and thimble attachment. A 9/0 galvanized tuna hook or a special bronzed release type hook (Mustad Model #7731BR, size 9/0 or 10/0) was attached to the end of the leader by crimp and thimble attachments. A float was attached to each line 4-40 m from the hook, depending at

SUMMARY

The tagging portion of the multiple mark-recapture experiment on bluefin tuna from the Brown-Georges banks region of the Canadian Atlantic initiated in 1990 was completed in 1992. Although 1992 was the final year of tagging, analysis of population size has not been completed due to the delay in recapture of tags. This paper is a summary of the methods and results to date.

RESUME

L'aspect marquage du projet multiple de marquage-recapture sur le thon rouge dans la région des bancs Browns et Georges de l'Atlantique canadien, qui a débuté en 1990, s'est achevée en 1992. Bien que 1992 ait été la dernière année de marquage, l'analyse de la magnitude de la population n'a pas pu être complétée à cause de délais dans la récupération des marques. Le présent document récapitule les méthodes employées et les résultats obtenus jusqu'à cette date.

RESUMEN

La actividad de marcado del experimento múltiple de marcado-recaptura de atún rojo de la región de los bancos Browns-Georges en el Atlántico canadiense, se inició en 1990 y se completó en 1992. Si bien 1992 fue el último año de marcado, el análisis del tamaño de la población no ha finalizado debido al retraso en la recuperación de marcas. Este documento es un resumen de los métodos y resultados obtenidos hasta la fecha.

which depth the line was to be fished. Whole or halved Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*) or breal squid (*Illex illecebrosus*) were used to bait the hooks. Three lines were fished simultaneously from the vessel: two lines were set off the windward side (to prevent the vessel from drifting over the lines) and one off the stern. Lines were set 10-50 m from the boat. As in the commercial fishery, tuna were attracted by "chumming" the area in which the lines were fishing. Between 180 and 700 kg of herring per day were used for chum.

After capture, the tuna was played by hand and brought close to the boat for tagging. Rubber "nippers," worn on the hands, were used to haul the monofilament leader. When the fish reached the side of the boat, the length and weight were estimated and two tags were harpooned into the musculature at the base of its first dorsal fin (Porter and Hogans 1991). The fish were released by cutting the monofilament line close to the hook. The average capture period (from hook to release) in 1991 was 8 min (range 1.5-18 min) and in 1992 was 12 min (range 5-42 min). Capture periods were not recorded in 1990.

The spaghetti tags used had stainless steel (WHOI tags) or hydroscopic nylon (Billfish Program-type tags) anchors and were mounted on metal pins. Both pins were anchored in wooden bases which were attached by two hose clamps to a hollow, 3-m metal harpooning pole. Electrical tape was wrapped around the hose clamps to lessen the risk of accidental snagging. Two elastic bands were used to keep the tags in position on the tagging pole prior to use. Information included on the tags were a sequential tag number, the mailing address of the Biological Station, St. Andrews, New Brunswick, Canada, and notification of reward. Atlantic fishermen had previously been notified by mail of the project and the procedure to follow if tags were recovered.

RESULTS AND DISCUSSION

POPULATION ESTIMATE OF HELL HOLE TUNA

In 1990, 62 bluefin tuna were tagged during four tagging trips, 69 were tagged in 1991 during three trips (including three fish tagged with ultrasonic transmitters), and 23 in 1992 during two trips, for a total of 154 tagged bluefin tuna (Table 1; Fig. 1).

As of 08 September 1993, there have been 19 recaptures of bluefin tuna tagged in the Hell Hole, although the tag number of one was lost before it was noted (Table 2). Because the 1993 fishery is ongoing and further recaptures are expected in 1993 and future years, a Jolly-Seber multiple mark-recapture analysis (Seber 1982) to estimate the population size would be premature at this time.

However, it should be noted that to date 18% (11) of the 62 fish tagged in 1990 have been recaptured, 10% (7) of the 69 fish tagged in 1991 have been recaptured, and 4% (1) of the 23 fish tagged in 1992 have been recaptured. This relatively high recapture rate over a short time period reflects the fishing mortality rates reported in ICCAT assessments (Anon. 1992). It is premature to draw conclusions from these data.

MOVEMENTS OF BLUEFIN TUNA TAGGED IN THE HELL HOLE

The recaptures were in two geographical areas: the location of tagging in the Hell Hole (10) and off the New England coast (9) (Fig. 1). This is consistent with Mather (1979) who describes these areas as the summer-fall feeding range of bluefin. Seven of the 10 Hell Hole recaptures were within a month (30 d) of when they were tagged, although 1 or 2 yr later, an indication that some giant bluefin display a strong seasonal homing tendency to this feeding area each year. The recaptures from New England (one in the year of tagging, four after 1 yr, two after 2 yr, and one after 3 yr) could be of tuna which were caught when returning to northern feeding areas in subsequent years or tuna beginning migration to southern wintering areas in October.

TAG RETENTION

Six of 18 of the recaptured tunas for which there are records had only one tag attached (Table 2). Again, it is premature to do a full analysis of tag retention.

SUSCEPTIBILITY TO RECAPTURE

Few conclusions can be drawn at present. No tagged fish have been sighted or recaptured immediately after tagging and only one of the 19 recaptures was in the same year as tagging, although in a different location. This may indicate a behavioral response to tagging, supported also by the telemetry investigation (see Porter and Hogans 1992).

CONCLUSIONS

The number of tagged tuna released during this study (154), although below our original expectations, will allow calculation following the 1993 harvest of an estimate of the size of the bluefin population fished off southwest Nova Scotia using the Jolly-Seber model (Seber 1982). It is premature to draw conclusions from this experiment at the present time as many of the tagged fish may still be at large.

ACKNOWLEDGMENTS

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Table 1. Details of releases in the Canadian bluefin tuna tagging experiment in the Hall Hole 1990-92. Tag types: 3 = spaghetti tag with metal dart; 7 - Billfish Program-type tag with nylon dart. All fish were captured using tanded line gear.

Tag no.	Date d mo yr	Latitude	Longitude	Tag type	Est. length fork (cm)	Est. round weight (kg)	Recapture
B05301-B05302	23-08-90	42°04'N	65°35'W	3	183	127	X '91
B05303-B05304	23-08-90	42°04'N	65°35'W	3	198	125	
B05305-B05306	23-08-90	42°04'N	65°35'W	3	183	137	
B05307-B05308	23-08-90	42°04'N	65°35'W	3	183	146	
B05309-B05310	13-09-90	42°04'N	65°35'W	3	183	159	X '92
B05311	13-09-90	42°04'N	65°35'W	3	188	181	
B05313-B05314	13-09-90	42°04'N	65°35'W	3	183	170	
B05315-B05316	13-09-90	42°04'N	65°35'W	3	191	205	
B05317-B05318	13-09-90	42°04'N	65°35'W	3	183	159	
B05319-B05320	13-09-90	42°04'N	65°35'W	3	183	159	
B05321-B05322	13-09-90	42°04'N	65°35'W	3	185	181	
B05323-B05324	13-09-90	42°04'N	65°35'W	3	178	137	
B05325-B05326	13-09-90	42°04'N	65°35'W	3	183	181	X '91
B05327-B05328	13-09-90	42°04'N	65°35'W	3	193	205	
B05329-B05330	13-09-90	42°04'N	65°35'W	3	193	227	
B05333-B05334	13-09-90	42°04'N	65°35'W	3	183	159	
B05335-B05336	13-09-90	42°04'N	65°35'W	3	196	227	X '91
B05344-B05345	13-09-90	42°04'N	65°35'W	3	173	114	
B05343-B05346	13-09-90	42°04'N	65°35'W	3	177	159	
B05347-B05348	13-09-90	42°04'N	65°35'W	3	193	227	
B05349-B05350	13-09-90	42°04'N	65°35'W	3	177	148	
B05351	13-09-90	42°04'N	65°35'W	3	183	205	
B05353	13-09-90	42°04'N	65°35'W	3	177	150	
B05355-B05356	13-09-90	42°04'N	65°35'W	3	185	192	X '91
B05359-B05360	13-09-90	42°04'N	65°35'W	3	183	181	
B05361-B05362	13-09-90	42°04'N	65°35'W	3	183	181	
B05363-B05364	13-09-90	42°04'N	65°35'W	3	183	170	
B05365-B05366	13-09-90	42°04'N	65°35'W	3	183	146	
B05368	13-09-90	42°04'N	65°35'W	3	183	146	
B05369-B05370	13-09-90	42°04'N	65°35'W	3	183	150	
B05371-B05372	13-09-90	42°04'N	65°35'W	3	188	249	X '91
B05373-B05374	13-09-90	42°04'N	65°35'W	3	183	170	X '92
B05375-B05376	13-09-90	42°04'N	65°35'W	3	183	148	
B05377-B05378	13-09-90	42°04'N	65°35'W	3	183	159	
B05379-B05380	13-09-90	42°04'N	65°35'W	3	177	148	
B05381-B05382	13-09-90	42°04'N	65°35'W	3	183	170	
B05383-B05384	13-09-90	42°04'N	65°35'W	3	188	181	
B05385-B05386	13-09-90	42°04'N	65°35'W	3	196	228	
B05387-B05388	13-09-90	42°04'N	65°35'W	3	183	159	
B05389-B05390	13-09-90	42°04'N	65°35'W	3	183	170	
B05391-B05392	25-09-90	42°04'N	65°35'W	3	177	159	X '91
B05393-B05394	25-09-90	42°04'N	65°35'W	3	185	181	X '91
B05395-B05396	25-09-90	42°04'N	65°35'W	3	190	205	
B05397-B05398	25-09-90	42°04'N	65°35'W	3	177	159	
B05399-B05400	25-09-90	42°04'N	65°35'W	3	183	181	
B05401-B05402	25-09-90	42°04'N	65°35'W	3	183	170	
B05404	25-09-90	42°04'N	65°35'W	3	188	192	
B05405-B05406	25-09-90	42°04'N	65°35'W	3	177	159	
B05407-B05408	25-09-90	42°04'N	65°35'W	3	183	181	
B05410	25-09-90	42°04'N	65°35'W	3	177	159	
B05411-B05412	25-09-90	42°04'N	65°35'W	3	183	181	
B05413-B05414	25-09-90	42°04'N	65°35'W	3	183	181	
B05415-B05416	25-09-90	42°04'N	65°35'W	3	188	192	
B05417-B05418	25-09-90	42°04'N	65°35'W	3	177	170	
B05419-B05420	29-09-90	42°04'N	65°35'W	3	177	137	
B05421-B05422	29-09-90	42°04'N	65°35'W	3	183	181	
B05423-B05424	29-09-90	42°04'N	65°35'W	3	180	170	
B05425-B05426	29-09-90	42°04'N	65°35'W	3	185	192	
B05426-B05428	29-09-90	42°04'N	65°35'W	3	177	170	
B95429-B05430	29-09-90	42°04'N	65°35'W	3	177	148	
B05431-B05432	29-09-90	42°04'N	65°35'W	3	188	192	
B05433-B05434	29-09-90	42°04'N	63°35'W	3	193	227	X '93

Table 1. (cont'd)

Tag no.	Date d mo yr	Latitude	Longitude	Tag type	Est. length fork (cm)	Est. round weight (kg)	Recapture
B05437-B05438	28-08-91	42°03'N	65°34'W	3	-	270	
7926(sonic)	28-08-91	42°03'N	65°34'W	-	-	320	
B05439-B05440	30-08-91	42°02'N	65°32'W	3	-	170	
B05441-B05442	30-08-91	42°02'N	65°32'W	3	-	230	
B05443-B05444	30-08-91	42°04'N	65°37'W	3	-	205	
B05445-B05446	30-08-91	42°02'N	65°32'W	3	-	160	
B05447-B05448	30-08-91	42°02'N	65°32'W	3	-	160	
B05449-B05450	30-08-91	42°02'N	65°32'W	3	-	230	X '92
B05451-B05452	30-08-91	42°02'N	65°33'W	3	-	250	
B05453-B05454	30-08-91	42°02'N	65°33'W	3	-	215	X '93
B05455-B05456	30-08-91	42°02'N	65°33'W	3	-	90	
B05457-B05458	30-08-91	42°04'N	65°33'W	3	-	70	
B05459-B05460	30-08-91	42°04'N	65°34'W	3	-	205	
B05461-B05462	30-08-91	42°04'N	65°34'W	3	-	135	
B05463-B05464	30-08-91	42°04'N	65°34'W	3	-	180	X '92
B05466	30-08-91	42°05'N	65°34'W	3	-	135	
B05467-B05468	30-08-91	42°05'N	65°34'W	3	-	180	
B05469-B05470	30-08-91	42°05'N	65°34'W	3	-	230	X '92
B05471-B05472	30-08-91	42°05'N	65°33'W	3	-	135	
B05473-B05474	30-08-91	42°06'N	65°33'W	3	-	135	
B05475-B05476	30-08-91	42°06'N	65°33'W	3	-	135	
B05477-B05478	30-08-91	42°06'N	65°33'W	3	-	180	
B05479-B05480	30-08-91	42°06'N	65°33'W	3	-	250	
B05481-B05482	30-08-91	42°06'N	65°32'W	3	-	135	
B05483-B05484	30-08-91	42°06'N	65°32'W	3	-	160	
B05485-B05486	31-08-91	42°06'N	65°33'W	3	-	180	
B05487-B05488	31-08-91	42°06'N	65°33'W	3	-	205	
B05489-B05490	31-08-91	42°06'N	65°33'W	3	-	180	
B95501-B05502	31-08-91	42°03'N	65°34'W	3	-	180	
B05503-B05504	31-08-91	42°03'N	65°36'W	3	-	90	
B05505-B05506	31-08-91	42°03'N	65°36'W	3	-	180	
B05507-B05508	31-08-91	42°03'N	65°36'W	3	-	180	
B05509-B05510	31-08-91	42°04'N	65°36'W	3	-	205	
B05511-B05512	31-08-91	42°04'N	65°36'W	3	-	230	
B05513-B05514	31-08-91	42°05'N	65°35'W	3	-	135	
B05515-B05516	31-08-91	42°03'N	65°36'W	3	-	90	
B05517	31-08-91	42°03'N	65°35'W	3	-	160	
B05519-B05520	16-09-91	42°05'N	65°36'W	3	-	180	
B05521-B05522	16-09-91	42°05'N	65°36'W	3	-	160	
B05523-B05524	16-09-91	42°05'N	65°36'W	3	-	135	
B05525-B05526	16-09-91	42°06'N	65°36'W	3	-	160	
B05527-B05528	16-09-91	42°06'N	65°36'W	3	-	250	
B05529-B05530	16-09-91	42°07'N	65°36'W	3	-	115	
B05531-B05532	16-09-91	42°08'N	65°36'W	3	-	160	
B05533-B05534	17-09-91	42°05'N	65°35'W	3	-	365	
B05535-B05536	17-09-91	42°06'N	65°33'W	3	-	180	
B05537-B05538	17-09-91	42°05'N	65°34'W	3	-	230	
B05539-B05540	17-09-91	42°05'N	65°34'W	3	-	180	
B05543-B05544	17-09-91	42°05'N	65°33'W	3	-	160	
B05545-B05546	17-09-91	42°05'N	65°33'W	3	-	160	
B05547-B05548	17-09-91	42°05'N	65°34'W	3	-	70	X '92
B05550	18-09-91	42°05'N	65°37'W	3	-	80	X '92
B05551-B05552	18-09-91	42°04'N	65°37'W	3	-	115	
B05553-B05554	18-09-91	42°04'N	65°37'W	3	-	90	
B05555-B05556	18-09-91	42°04'N	65°37'W	3	-	135	
B05557-B05558	18-09-91	42°04'N	65°37'W	3	-	115	
B05559-B05560	18-09-91	42°04'N	65°37'W	3	-	160	
B05561-B05562	18-09-91	42°04'N	65°37'W	3	-	70	
B05563-B05564	18-09-91	42°04'N	65°37'W	3	-	170	
B05565-B05566	18-09-91	42°04'N	65°37'W	3	-	125	
B05567-B05568	18-09-91	42°04'N	65°37'W	3	-	160	X '92
7925(sonic)	18-09-91	42°04'N	65°38'W	-	-	135	

Table 1. (cont'd)

Tag no.	Date d mo yr	Latitude	Longitude	Tag type	Est. length fork (cm)	Est. round weight (kg)	Recapture
B05569-B05570	04-10-91	42°02'N	65°33'W	3	-	160	
B05571-B05572	04-10-91	42°02'N	65°33'W	3	-	205	
B05573-B05574	04-10-91	42°02'N	65°33'W	3	-	205	
B05575-B05576	04-10-91	42°02'N	65°33'W	3	-	270	
B05577-B05578	04-10-91	42°01'N	65°33'W	3	-	180	
7927(sonic)	04-10-91	42°04'N	65°33'W	-	-	115	
B05579-B05580	04-10-91	42°04'N	65°33'W	3	-	180	
B05581-B05582	05-08-92	42°03'N	65°33'W	3	-	205	
B05586-B05587	07-08-92	42°03'N	65°33'W	3	-	181	
B05588-B05589	07-08-92	42°03'N	65°31'W	3	-	196	
B05592-B05593	08-08-92	42°04'N	65°35'W	3	-	137	
B05594-B05595	08-08-92	42°04'N	65°35'W	3	-	181	
B05597	08-08-92	42°04'N	65°35'W	3	-	181	
B05601	08-08-92	42°03'N	65°32'W	3	-	159	
B05602-B05603	08-08-92	42°03'N	65°32'W	3	-	159	
B05600-B05604	08-08-92	42°02'N	65°32'W	3	-	148	X '93
B05605-B05606	08-08-92	42°01'N	65°33'W	3	-	148	
B05607-B05608	08-08-92	42°00'N	65°33'W	3	-	170	
JP07001-B05612	13-09-92	42°04'N	65°35'W	7-3	183	181	
JP07002-B05613	14-09-92	42°04'N	65°35'W	7-3	183	192	
JP07703-B05614	14-09-92	42°04'N	65°35'W	7-3	183	250	
JP07005-B05616	14-09-92	42°04'N	65°35'W	7-3	183	148	
JP07006-B05617	14-09-92	42°04'N	65°35'W	7-3	183	273	
JP07007-B05618	15-09-92	42°04'N	65°35'W	7-3	167	148	
JP07008-B05619	16-09-92	42°04'N	65°35'W	7-3	144	159	
JP07009-B05620	16-09-92	42°04'N	65°35'W	7-3	115	81	
JP07010-B05621	19-09-92	42°04'N	65°35'W	7-3	183	159	
JP07011-B05623	21-09-92	42°04'N	65°35'W	7-3	183	159	
JP07012-B05624	21-09-92	42°04'N	65°35'W	7-3	115	114	
JP07013-B05625	21-09-92	42°04'N	65°35'W	7-3	183	181	

Table 2. Details of recaptures in the Canadian bluefin tuna tagging experiment in the Hell Hole 1990-93. Gear codes are as follows: H - harpoon, HL - handline, PS - purse seine, RR - rod and reel, TL - tanded line.

Tag no.	Date d mo yr	Recapture					Release		
		Lat.	Long.	Gear	Length (cm)	Round wt (kg)	Date d mo yr	Lat.	Long.
B05 *	25-09-90	41°40'N	69°18'W	PS	-	166	7-90	42°04'N	65°35'W
B05301-B05302	14-09-91	42°55'N	70°30'W	HL	224	188	23-08-92	42°04'N	65°35'W
B05309-B05310	26-08-92	43°10'N	69°40'W	HL	-	159	13-09-90	42°04'N	65°35'W
B05325	08-08-91	43°08'N	70°04'W	HL	224	166	13-09-90	42°04'N	65°35'W
B05335-B05336	22-10-91	41°11'N	69°12'W	PS	218	188	13-09-90	42°04'N	65°35'W
B05355-B05356	10-10-91	42°04'N	65°35'W	TL	-	180	13-09-90	42°04'N	65°35'W
B05371-B05372	15-10-91	42°04'N	65°35'W	TL	-	125	13-09-90	42°04'N	65°35'W
B05373-B05374	06-09-92	42°02'N	65°42'W	TL	-	190	13-09-90	42°04'N	65°35'W
B05389-B05390	14-09-91	42°04'N	65°35'W	TL	-	-	13-09-90	42°04'N	65°35'W
B05391-B05392	24-09-91	42°04'N	65°35'W	TL	-	-	13-09-90	42°04'N	65°35'W
B05433-B05434	25-08-93	43°00'N	70°10'W	RR	180	229	25-09-90	42°04'N	65°35'W
B05449-B05450	21-08-92	42°25'N	70°25'W	RR	229	210	29-09-90	42°04'N	65°35'W
B05453	30-06-93	43°06'N	69°57'W	H	-	233	30-08-91	42°03'N	65°33'W
B05463-B05464	03-09-92	42°03'N	65°33'W	TL	-	199	30-08-91	42°02'N	65°33'W
B05470	26-08-92	42°00'N	65°34'W	TL	-	258	30-08-91	42°04'N	65°34'W
B05545-B05546	13-10-92	42°00'N	70°25'W	RR	-	162	17-09-91	42°05'N	65°33'W
B05550	20-08-92	42°03'N	65°35'W	TL	-	212	18-09-91	42°05'N	65°37'W
B05567	23-08-92	42°04'N	65°37'W	TL	-	144	18-09-91	42°04'N	65°38'W
B05604	01-09-93	42°03'N	65°34'W	TL	-	211	08-08-92	42°02'N	65°32'W

*The tag was lost before the recapture information was recorded.

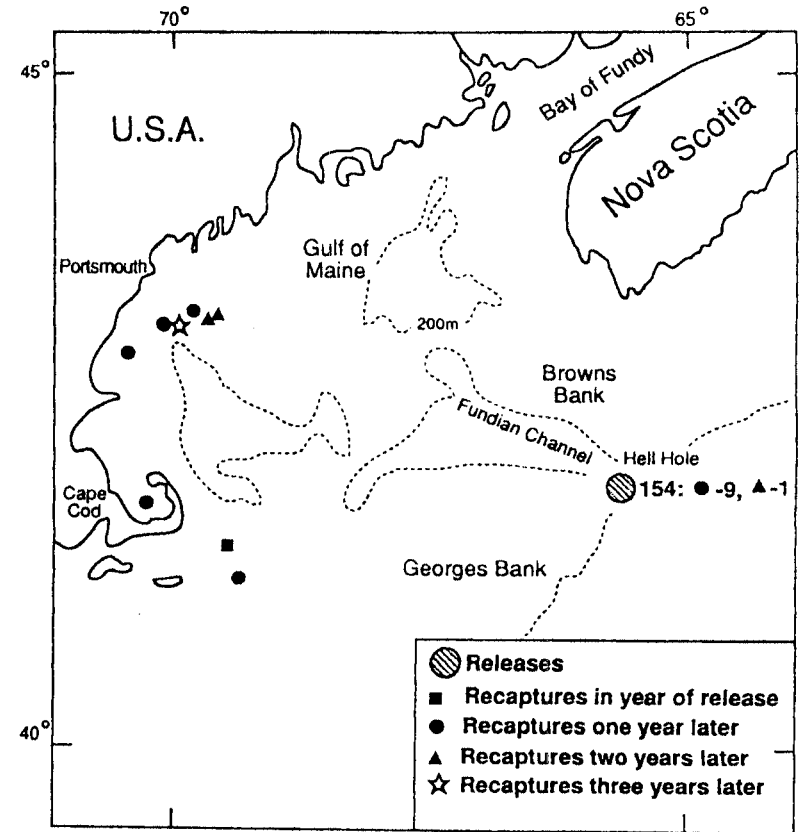


Fig. 1 Map showing locations of releases of tagged bluefin tuna in the Hell Hole (1990-1992) and subsequent recaptures (1990-1993).