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Results of the International Herring Tagging Program Conducted by USA
in the Gulf of Maine, Georges Bank and Contiguous Waters from 1976-78.

by

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INTRODUCTION

In May 1976, an Ad hoc planning group, under the auspices of ICNAF, met to organize an international herring tagging program (ICNAF, Redbook, 1976, p. 153). The program was initiated later that same year. The purpose was to coordinate Atlantic herring (Clupea harangus harangus L.) tagging in ICNAF Subareas 4 and 5 and Statistical Area 6 (Figure 1). The objectives of tagging were to describe the seasonal migration and intermixture of adult and juvenile stages of herring by:

1. Defining feeding, spawning and overwintering areas.
2. Defining recruitment migrations from the coastal fisheries.
3. Defining quantitatively the proportion of intermixing of stocks present in feeding and overwintering areas.
4. Estimating mortality rates.

Tagging of juvenile herring, predominantly age 2, were conducted in 1957 and 1958 in the Passamaquoddy Bay Region (McKenzie and Skud 1958) and along the Maine coast in 1960 (Watson 1963). Recoveries from these studies were in the vicinity of the tagging sites and it was assumed that juvenile herring migrated little during the summer months. These data were analyzed in Anthony (1972).

The offshore herring fisheries off southwestern Nova Scotia, Georges Bank and the western Gulf of Maine did not develop until the early 1960's, so extensive migrations of juvenile herring captured in inshore fisheries could not really be determined. Tagging studies conducted along the Maine coast by Maine's Department of Marine Resources (DMR) in connection with the Maine Sardine Council in 1976 and 1977 (Speirs 1977) and from 1977-1979 (Chenoweth et al. 1980) have

confirmed the limited movement of juvenile herring during the summer months. In autumn these juveniles moved south from Maine waters into the coastal waters of Massachusetts and Rhode Island where they overwintered and returned to coastal Maine waters in the spring. A few tags were also recovered in New Brunswick waters the following spring and summer after tagging.

Results of Canadian tagging studies on juveniles and adults conducted during 1973-1974 in the Bay of Fundy and along southwestern Nova Scotia were reported by (Stobo et al. 1975 and Stobo 1976a). Returns from these studies indicated substantial movement of fish from both sides of the Bay of Fundy into Chedabucto Bay (NAFO Division 4Wa - Figure 1) in winter. Additionally, tags were recovered in the coastal waters from Maine to Rhode Island as fish moved to and from their overwintering areas. Based on results of the tagging study, the International Herring Tagging Program was formed.

The preliminary results of the NMFS, NEFC coordinated International Herring Tagging Program conducted in May 1977 in the Great South Channel (Figure 2) of Georges Bank (5Ze) and in the vicinity of Jeffreys Ledge (5Y) (Figure 2) were reported by Almeida and Burns (1978). These studies showed herring moved from the tagging sites into the coastal waters of Maine into the Bay of Fundy and along southwestern Nova Scotia during summer and early autumn returning to Massachusetts and Rhode Island coastal waters in late autumn and winter. Additionally, some fish from the 1977 (Jeffreys Ledge) tagging overwintered in Chedabucto Bay.

Information on movements of tagged herring on Georges Bank and the offshore waters south of Rhode Island is limited by a lack of a commercial fishery in this region since the spring of 1977 coincident with the collapse of the Georges Bank resource. Therefore, there was no fishery to recover tags.

This paper presents the results of all NEFC Herring Tagging studies conducted between September 1976 to November 1978, which includes an update of (Almeida and Burns 1978). The results are compared to (1) the stated objectives and (2) to the preliminary findings in ongoing Canadian and Maine's (DMR) programs and additionally, proposed models of stock intermixing are discussed.

MATERIALS AND METHODS

During the period September 1976 to October 1978 six NEFC coordinated international herring (INT) studies were conducted in the waters of the Gulf of Maine, Georges Bank and contiguous waters. These were conducted in cooperation

with ICNAF member countries and biologists from the states of Massachusetts and Maine.

The tag sites, dates, participants, numbers tagged and tag serial numbers are presented in Table 1, Figure 2. The length frequencies from each tag site are given in Appendices 1-3.

The estimated numbers of fish to tag in each region to ensure adequate returns in addressing the herring stock intermixture problems was determined by Anthony (1976).

Herring were tagged using Floyd FDM-68 tagging guns and yellow t-bar "spaghetti" tags labelled INT HER followed by a six digit number. Stainless stain needles with an outside diameter of 0.089" and 0.073" were utilized. The larger needles made a bigger wound but were more durable than the smaller needles. The handling and tagging procedures utilized were those outlined by Stobo (1976b). Stobo (1976b) and Speirs (1977) determined that the mortality due to tagging wounds was not substantial on aquarium held fish. Additionally, fish which suffered 10% or more scale loss were discarded and tagging operations were ceased when 90% of the fish dipped for tagging (8-12 per dip) were discarded due to scale loss.

Fish tagged during the periods 15-28 September 1976, 1-15 May 1977, and 23-25 September 1977 utilized the USSR R/V's YUBILEINY and BELOGORSK, NOGLIKI, and YUBILEINY, respectively. The NOGLIKI and YUBILEINY are purse seiners while the BELOGORSK served as a support vessel for personnel and equipment in 1976. Tagging conducted during the periods 8-31 October 1976 and 16 October to 11 November 1978 utilized the chartered US purse seiners SILVER LINING and EVA GRACE, respectively. Herring tagged on 10 November 1976, 21 February 1978, 21 and 31 August 1978 and 7 September 1978 were collected during commercial fishing operations in fixed gear fisheries. This 1978 tagging was conducted by Maine's DMR personnel in cooperation with the NMFS, NEFC.

Tags were recovered in the herring processing plants in Maine, Massachusetts, and Canada. In a seeding experiment conducted by Spiers (1977) he obtained an 80% recovery rate. Tags from the 1976 operation on Cultivator Shoals were returned by Poland, GDR, and the USSR recovered from commercial fishing activities coinciding with the tagging.

A \$3.00 reward was paid for each tag and reward posters were distributed to all herring processors.

RESULTS

Recoveries from fish at large at least two weeks after tagging from each tagging site (Figure 2) have been summarized by month and region (Figure 3) of recapture. Region 1 encompasses the area south of Cape Cod and east of Georges Bank. Region 2 includes the waters between Cape Cod Bay and the southern edge of Jeffreys Ledge. Region 3 runs from Jeffreys Ledge up to the territorial waters of Maine. Regions 4 to 6 along the Maine coast are subdivided into western, central and eastern sections given in (Anthony 1972). Region 7 includes Grand Manan and the New Brunswick side of the Bay of Fundy and Region 8 runs from the Nova Scotia side of the Bay of Fundy to Chedabucto Bay. These regions coincide with reporting areas for commercial catch statistics. Additionally, the monthly return per/(10⁻⁷) fish (age 3 and older) landed by region for the 1977 tagging in the Great South Channel and in the vicinity of Jeffreys Ledge, and the 1978 tagging in the Jeffreys Ledge - Cape Ann regions are presented (Tables 2-4).

Tagging Sites

Cultivator Shoals 16-28 September 1976 - In this area 29,403 "ripe and running" fish were tagged. There were 14 (<1%) tags returned, 12 of which were recovered during October and November 1976 by ICNAF member countries fishing in the vicinity of the tagging site (Figure 4). Two recoveries came from first quarter 1977 fishing in Cape Cod Bay.

Jeffreys Ledge - Cape Ann areas 8-11 October 1976 - A total of 19,693 predominantly "ripe and running" fish were tagged. There were 12 (<1%) recoveries and most were made in Region 2 the location of the tagging site (Figure 4).

Jeffreys Ledge - Cape Ann area 1 May 1977 - A total of 10,973 presumably migrating and overwintering fish were tagged off Thatchers light of which 509 (4.6%) were recaptured (Figure 5). In summer and early autumn the fish moved eastward along the coast of Maine, into the Bay of Fundy and along southwest Nova Scotia. Additionally, some fish remained near the tagging region. The number of tags returned during 1977 was highest in Region 7 (178), followed by Region 5 (137), and Region 8 (65). In late autumn (1977) and winter (1978) the distribution of returns was westward into Massachusetts and Cape Cod Bays and coastal southern New England and mid-Atlantic waters. Three returns were from the Pt. Judith, Rhode Island, winter fishery off southern New England and one return

was from a gill net fishery in the mouth of the Hudson River. Additionally, three returns were from the 1978 winter fishery in Chedabucto Bay. Returns from the summer of 1978 (4) and 1979 (2) reflect the same eastward migrations previously described. Return rates per/(10⁻⁷) fish (age 3 and older) were generally highest in Region 5 for the period May to October 1977 (Table 2). The monthly catch at age data for Regions 7 and 8 were not available for comparison purposes. Return rates during August to October 1977 in Region 2; the area of tagging, were higher than those obtained from December 1977 to April 1978 (Table 2).

Great South Channel 7-15 May 1977 - There were 22,882 presumably overwintering and migrating fish tagged of which 268 (1.2%) were recaptured (Figure 6). In early summer these fish moved northward into Cape Cod and Massachusetts Bays and then displayed the summer/autumn distributional patterns similar to fish tagged near Jeffreys Ledge in May 1977. The largest number of returns in 1977 was in Region 5 (89) followed by Region 4 (53) and Region 2 (29). From January to March 1978 the movement was westward into Regions 1 and 2 followed by an easterly distribution into Regions 3 to 5 in spring and summer which is similar to the patterns observed in the 1977 recoveries. Recoveries per/(10⁻⁷) fish (age 3 and older) were highest in Region 4 from June to September but the largest numbers of fish processed were in Region 5.

Chatham 23-25 September 1977 - There were no returns from 943 "ripe and running" fish tagged in this area.

Jeffreys Ledge and Cape Ann areas 16 October; 1-9 November 1978 - A total of 1,500 "ripe and running" fish were tagged on 16 October and 8,500 predominantly "spent" fish were tagged during the first two weeks of November. There were 272 (2.7%) recoveries (Figure 7). The seasonal distribution of the returns suggest most of the fish remained in the western portion of the Gulf of Maine (Regions 2-3). However, some movement eastward had occurred as observed by five recoveries made during the summer/autumn fishery in the New Brunswick side of the Bay of Fundy (Region 7). Recovery rates per/(10⁻⁷) fish (age 3 and older) processed were highest during January to March and September to November in Region 2 (Table 4). During July and August the rates were highest in Region 3.

Coastal Maine Tagging 1978 - On 21 February and 31 August 1978, 1,500 and 513 fish were tagged in the Passamaquoddy Bay area (Region 6), respectively. There

were six (<1%) and three (<1%), respectively, from each site. The distribution of the returns indicated little or no movement away from the tagging region (Figure 8). On 21 August 1978, 537 fish were tagged in Region 5 and there were no recoveries. On 7 September 2,450 fish were tagged in Region 4 and 7 (<1.0%) were recovered (Figure 8). The distribution of returns in the winter of 1979 were in the tagging region and westward, whereas returns in the summer and autumn were east of Region 4.

Distance Traveled, Rates of Movement, Time at Large

The greatest distance traveled was approximately 932 kilometers (km) for fish tagged near Jeffreys Ledge in May 1977 and recovered in Chedabucto Bay in 1978.

Minimum swimming speeds for fish tagged on 1 May 1977 near Jeffreys Ledge and recaptured on 17 May 1977 off Boon Is., Mass., and on 6 June 1977 on Trinity Ledge, NS, were 4 and 6 km/day, respectively. For fish tagged on 5 May 1977 and recovered on 9 June 1977 off Monhegan Is., Maine, and 11 June on Trinity Ledge, respectively, were 16 and 23 km/day.

The longest time at large was 950 days for a fish tagged in May 1977 in the vicinity of Jeffreys Ledge and recovered in the same area (Region 2) in December 1979. A total of 42 tags were recovered from fish at large one year or more from all six tagging sites.

DISCUSSION

Fisheries:

The distribution of recoveries reflects in part the seasonality of the regional herring fisheries conducted between southern New England and Chedabucto Bay. The fishery in Region 1 is conducted in the winter/spring period by pair trawlers. In Region 2, a winter/spring pair trawl fishery has existed since 1975. This area and Region 3 are also exploited by purse seines principally during the summer/autumn seasons. In Regions 1 to 3 the effort is predominantly directed on age 3 and older fish. The fishery in Regions 4 to 6 usually begins in late May and generally extends into November. The fishery is generally most intense during the months July to September in all three areas. In Regions 4 and 5 stop seines and purse seines are utilized whereas in Region 6 stop seines and weirs are the dominant gear types and purse seines are used occasionally. The fishery in these three regions (4-6) are selective to age 2 fish although all ages

are harvested. In Region 7 purse seines are operating from January to April with the weir fishery beginning in mid-April and usually ending by November (Stobo et al., 1975). These fisheries harvest mostly ages 2 and 3 fish although the purse seine fishery exploits large amounts of age 1 herring at times. Fish older than three are also taken in this region. The fisheries on the Nova Scotia side of the Bay of Fundy and along southwest Nova Scotia (Region 8) are conducted utilizing weirs, purse seines, and gill nets. The weir fishery is concentrated in St. Mary's Bay and usually operates from mid-April to November (Stobo, et al., 1975). The purse seine fishery is generally operating from June to October and the gill net fishery during the autumn spawning season (Stobo et al., 1975). The weirs are selective for juveniles (ages 1-3) while the purse seines and gill nets usually harvest age 3 and older fish. Additionally, a winter purse seine fishery in Chedabucto Bay principally exploits age 3 and older fish.

Movements:

The negligible recoveries from "ripe and running" fish tagged in 1976, 1977, and October 1978 may in part be indicative of higher handling and tag induced mortality on spawning versus nonspawning fish. Recoveries from the 1976 and 1977 tagging on Cultivator Shoals and off Chatham, respectively, were probably also limited by a lack of a commercial fishery on Georges Bank since 1977.

The distribution of returns in 1979 from spawning and "spent" fish tagged in the vicinity of Jeffreys Ledge in 1978 were similar, which indicates that the "spent" fish were part of the Jeffreys Ledge spawning stock. This suggests that the yearly migrations of some component of this stock are entirely within the region between Jeffreys Ledge and Cape Cod Bay. The movement of herring from Jeffreys Ledge in autumn southward into Cape Cod Bay during winter has been documented by an observer aboard a commercial vessel in 1978 (Chenoweth et al. 1980).

The preliminary results of the 1977 spring tagging in the vicinity of Jeffreys Ledge and in the Great South Channel (Almeida and Burns 1978) and recoveries made since their analysis suggest these overwintering fish were probably components of several spawning "stocks." The basis for this statement lies in the fact that during the peak feeding period (June to August) and spawning season (September to October) recoveries were made in the

Jeffreys Ledge area along the coast of Maine, in the Bay of Fundy and off southwestern Nova Scotia. It is also suggested that a greater proportion of fish tagged in the vicinity of Jeffreys Ledge were part of the southwest Nova Scotia stock than were fish tagged in the Great South Channel. This is supported by the higher number of returns, in proportion to number tagged, in Regions 7 and 8 from the 5Y tagging versus the 5Ze tagging. This implies that a proportion of the herring migrating westward from southwest Nova Scotia to their overwintering grounds, do not move as far west as fish spawning in the western Gulf of Maine. Again the lack of a fishery on Georges Bank hampers analysis of intermixing between this region and the Gulf of Maine.

The seasonal movements of herring between NAFO Areas 4WX, 5Y and 5Zw observed from the spring 1977 tagging were also found by (Stobo et al 1975; and Stobo 1976) on Canadian tagging conducted in August 1974 in the Bay of Fundy and off southwestern Nova Scotia. However, based on additional tagging in the autumn of 1977 on the Lurcher Shoals-Trinity Ledge spawning grounds, Stobo (1977) concluded that the majority of these fish overwinter to the north in Chedabucto Bay whereas the 1974 tagging also indicated substantial movement westward. He noted that fish tagged in 1977 were "ripe and running" while those tagged in 1974 were prespawners. He suggested that some fish which spawn along the Maine coast and possibly Jeffreys Ledge are feeding and mixed with Nova Scotia spawners during the summer and early autumn in the waters of southwest Nova Scotia.

Recoveries from tagging juvenile and adult herring in 1978 along the Maine coast were close to the tagging region. Thus provide not information on recruitment from the Maine juvenile¹ fishery to the adult¹ fisheries.

Chenoweth et al. (1980) analyzed returns from tagging herring (ages 2 and 3) conducted along the Maine coast for the years 1976, 1977, and 1978. During the season of tagging most recoveries were made in the tagging region. In late autumn these fish migrated westward and overwintered in Massachusetts and Cape Cod Bay and in southern New England waters. In summer the reverse migration showed a strong easterly pattern with most recoveries in Region 6 (this document).

Based on recaptures made between August to November in the year following each

¹Adults are taken in the juvenile fisheries as are juveniles taken in the adult fisheries. The term adult fishery was applicable during the 1960's when the fishery was prosecuted during the autumn on the spawning grounds.

tagging, he hypothesized a model for recruitment to the Gulf of Maine spawning stocks. He suggested that the Gulf of Maine comprises one stock and that sexually mature ages 3 and 4 herring first recruit to eastern Maine and spawn in the Grand Manan/Passamaquoddy Bay region and then to Jeffreys Ledge as they grow older.

The results of all these studies confirmed the hypothesis of the ICNAF Herring Working Group that mixing occurs among the herring stocks between southwest Nova Scotia and the Mid-Atlantic Bight. However, the extent of this mixing is difficult to quantify due to the seasonality of the fisheries. Mixing during the overwintering period occurs both in the western Gulf of Maine and southern New England waters and in Chedabucto Bay. During the summer feeding period mixing occurs along the Maine coast, in the Bay of Fundy and along southwestern Nova Scotia. Mixing of "ripe and running" fish from one spawning ground to another has not been confirmed since only the tag is returned and the gonadal stage of the fish is unknown. Therefore, it is difficult to discern whether a "ripe and running" fish tagged on i.e. (Jeffreys Ledge) was "ripe and running" if recaptured the following year i.e. (Lurcher Shoals).

Ridgway (1975) hypothesized that herring spawning stocks are discrete and these fish return to spawn in the region they were born. Based on the incidence of parasite tags, Sindermann (1961) concluded that herring spawning on Georges Bank were distinguishable from Nova Scotia spawners and any interchange between the spawning groups would be limited.

The limited tagging conducted to date has yet to confirm or disprove the hypothesis for discrete spawning stocks. The low return rates from tagging "ripe and running" fish and uncertainty as to the gonadal condition of fish recaptured the following spawning "season" compounds the problem. However, insight into this problem was provided by Stobo (1981) discussing the migrating patterns of prespawning and feeding, and spawning fish off southwestern Nova Scotia in 1980. He stated that only a component of the feeding and prespawning fish moved into the Lurcher Shoals and Trinity Ledge spawning ground with another component moving westward and presumably spawning on coastal Maine sites or on Jeffreys Ledge. Thus, a "ripe and running" fish tagged on Jeffreys Ledge and recovered off southwestern Nova Scotia, but prior to movement into the spawning grounds in this region may be interpreted as spawning in both localities.

The results, to date, cannot be used to quantify the mixing between stock or to define the recruitment mechanism between the regional juvenile and adult

fisheries. Additionally, these data have not been sufficiently analyzed for estimating mortality rates.

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Table 1. Summary of release data for Atlantic herring tagged during the international cooperative herring tagging program in Subarea 5.

Release Site		NAFO Div.	Fish Tagged			Participants
Latitude	Longitude		Date	Number	Series ¹	
41° 45'N	68° 58'W	5Ze	16/9/76	4800	1-4800	US(NMFS, NEFC)
41° 43'N	68° 56'W	"	17/9/76	5132	4801-9950	USSR (AtlantNIRO)
41° 35'N	68° 55'W	"	18/9/76	3524	9951-13500	CAN (Div. Fish +
41° 44'N	68° 49'W	"	19/9/76	5443	13501-19000	Oceans, St.
41° 38'N	68° 51'W	"	23/9/76	5993	19001-25000	Andrews)
41° 35'N	68° 57'W	"	27/9/76	2142	25001-27150	
41° 35'N	68° 58'W	"	28/9/76	2369	27151-29250	
					29501-29525	
					29751-30000	
42° 50'N	70° 19'W	5Y	8/10/76	3466	29251-29500	(NMFS, NEFC)
					29526-29750	Maine Dept. Mar.
					30001-33000	Res.
42° 39'N	70° 30'W	"	9/10/76	3661	33001-36675	Mass. Div. Mar.
42° 39'N	70° 30'W	"	11/10/76	3566	36676-40277	Fish.
41° 29'N	71° 14'W	5Zw	10/11/76	32	40400-40425	
					40492-40500	
42° 41'N	70° 29'W	5Y	1/5/77	10973	40501-51500	US (NMFS, NEFC)
40° 31'N	69° 12'W	5Ze	7/5/77	6430	51501-58000	USSR (AtlantNIRO)
40° 28'N	69° 09'W	"	11/5/77	2507	58001-60000	CAN (Div. Fish +
					60476-60500	Oceans, St.
					60501-61000	Andrews)
40° 33'N	69° 20'W	"	15/5/77	3508	60001-60475	
					61001-64050	
40° 27'N	69° 20'W	"	15/5/77	10437	64051-74500	
41° 38'N	69° 41'W	"	23/9/77	645	74551-75200	
41° 32'N	69° 45'W	"	25/9/77	298	75201-75500	
45° 10'N	67° 00'W	5Y	21/2/78	1500	75501-77000	Maine Dept. Mar.
45° 59'N	69° 07'W	"	21/8/78	537	77001-77537	Res.
44° 51'N	66° 58'W	"	31/8/78	513	77538-78050	
45° 52'N	69° 40'W	"	7/9/78	2450	78051-80500	
42° 38'N	70° 34'W	5Y	16/10/78	1500	93001-94500	NMFS, NEFC
42° 53'N	70° 12'W	"	1/11/78	500	96501-97000	Maine Dept. Mar.
42° 50'N	70° 12'W	"	2/11/78	2000	94501-96500	Res.
42° 50'N	70° 15'W	"	3/11/78	2000	97001-99000	Mass. Div. Mar.
42° 52'N	70° 15'W	"	9/11/78	4000	99001-103000	Fish.

¹ Discrepancies between numbers tagged and tag series resulted from damaged or missing tags.

Table 2. Summary of INT HER tag returns (R) by recapture region, year, and month and return rate per 10⁻⁷ (R/C) of fish (age 3 and older) landed (C) from fish released in May 1977 in the Jeffreys Ledge - Cape Ann area.

Year/Month		Region							
		1	2	3	4	5	6	7 ^{1/}	8 ^{1/}
1977									
May	R		1			2			
	C		5901			527			
	R/C		2			38			
June	R				33	17		6	10
	C				6905	9652			
	R/C				48	18			
July	R					22	6	44	12
	C					20634	612		
	R/C					11	98		
Aug.	R		7	2	2	63		95	26
	C		5435	1823	1739	17982			
	R/C		13	11	12	35			
Sep.	R		7		12	29	10	27	16
	C		4553		658	10891	2792		
	R/C		15		182	27	36		
Oct.	R		4	1	2	4		6	1
	C		2288	510	5239	2043			
	R/C		17	20	4	20			
Dec.	R		1						
	C		1715						
	R/C		6						
1978									
Feb.	R		6					2 ^{3/}	
	C		23085						
	R/C		3						
Mar.	R	4 ^{2/}	9					1 ^{3/}	
	C	5458	16648						
	R/C	7	5						
Apr.	R		3						
	C		1268						
	R/C		24						
June	R			1					
	C			1424					
	R/C			7					
Aug.	R			1	2				
	C			159	16917				
	R/C			63	1				
Sep.	R							1	
	C								
	R/C								
Oct.	R		2						
	C		5834						
	R/C		3						
Nov.	R		1						
	C		6397						
	R/C		2						
Dec.	R		1						
	C		4393						
	R/C		2						
1979									
Mar.	R		2						
	C		14779						
	R/C		1						
Sep.	R		2		1			1	
	C		30641		1462				
	R/C		1		7				
Dec.	R		1						
	C		112						
	R/C		89						

1/ Monthly age composition data currently not available.

2/ One return from Hudson River.

3/ Chedabucto Bay.

Table 3. Summary of INT HER tag returns, (R) by recapture region, year, and month, and return rate per 10^{-7} (R/C) of fish (age 3 and older) landed (C) from fish released in May 1977 in the Great South Channel area.

Year/Month		Region							
		1	2	3	4	5	6	7 ^{1/}	8 ^{1/}
1977									
June	R				37	11			2
	C				6905	9652			
	R/C				54	11			
July	R				2	12	2	4	2
	C				262	20634	612		
	R/C				76	6	33		
Aug.	R		14	3	7	40		10	
	C		5435	1823	1739	17982			
	R/C		26	16	40	22			
Sep.	R		9		6	24	1	2	
	C		4553		658	10891	2792		
	R/C		20		91	22	4		
Oct.	R		1	1	1	2			2
	C		2288	570	5239	2043			
	R/C		4	18	2	10			
Nov.	R		3	2				2	
	C		1824	1216					
	R/C		16	16					
Dec.	R		2					2	
	C		1715						
	R/C		12						
1978									
Jan.	R		1						
	C		16406						
	R/C		1						
Feb.	R	9	6			2		1	
	C	8190	23085						
	R/C	11	3						
Mar.	R	5	10	1					
	C	5458	16648	1665					
	R/C	9	6	6					
June	R			1	3	1			
	C			1424	3339	6214			
	R/C			7	9	2			
July	R					5		1	
	C					3188			
	R/C					16			
Aug.	R			6					
	C			377					
	R/C			159					
Sep.	R		2	2		1			
	C		4818	3210		3200			
	R/C		4	6		3			
Oct.	R		2						
	C		5834						
	R/C		3						
Nov.	R			2					
	C			6397					
	R/C			3					

^{1/} Monthly age composition data currently not available.

Table 4. Summary of INT HER tag returns (R) by recapture region, year and month and return rate per 10^{-7} (R/C) of fish (age 3 and older) landed (C) from fish released in October and November 1978 in the vicinity of Jeffreys Ledge and Cape Ann.

Year/Month		Region							
		1	2	3	4	5	6	7 ^{2/}	8 ^{2/}
1978									
Nov. ^{1/}	R		4	6	4				
	C		4265	6397	1959				
	R/C		9	9	20				
Dec.	R		34						
	C		4393						
	R/C		77						
1979									
Jan.	R		63						
	C		18469						
	R/C		34						
Feb.	R	1	19		2				
	C	669	7905		783				
	R/C	15	24		26				
Mar.	R	2	63	1	2				
	C	7209	13301	1478	1045				
	R/C	3	47	7	19				
Jul.	R		5	9					
	C		3887	2173					
	R/C		13	41					
Aug.	R		23	4	1			1	
	C		32517	1512	405				
	R/C		7	26	25				
Sep.	R		31	3					
	C		27577	3064					
	R/C		11	10					
Oct.	R		4					4	
	C		164						
	R/C		244						
Nov.	R		3						
	C		112						
	R/C		268						
1980									
Feb.	R		1						
	C		34496						
	R/C		< 1						

^{1/} 16 October 1978 tagging.

^{2/} Monthly age composition data currently not available.

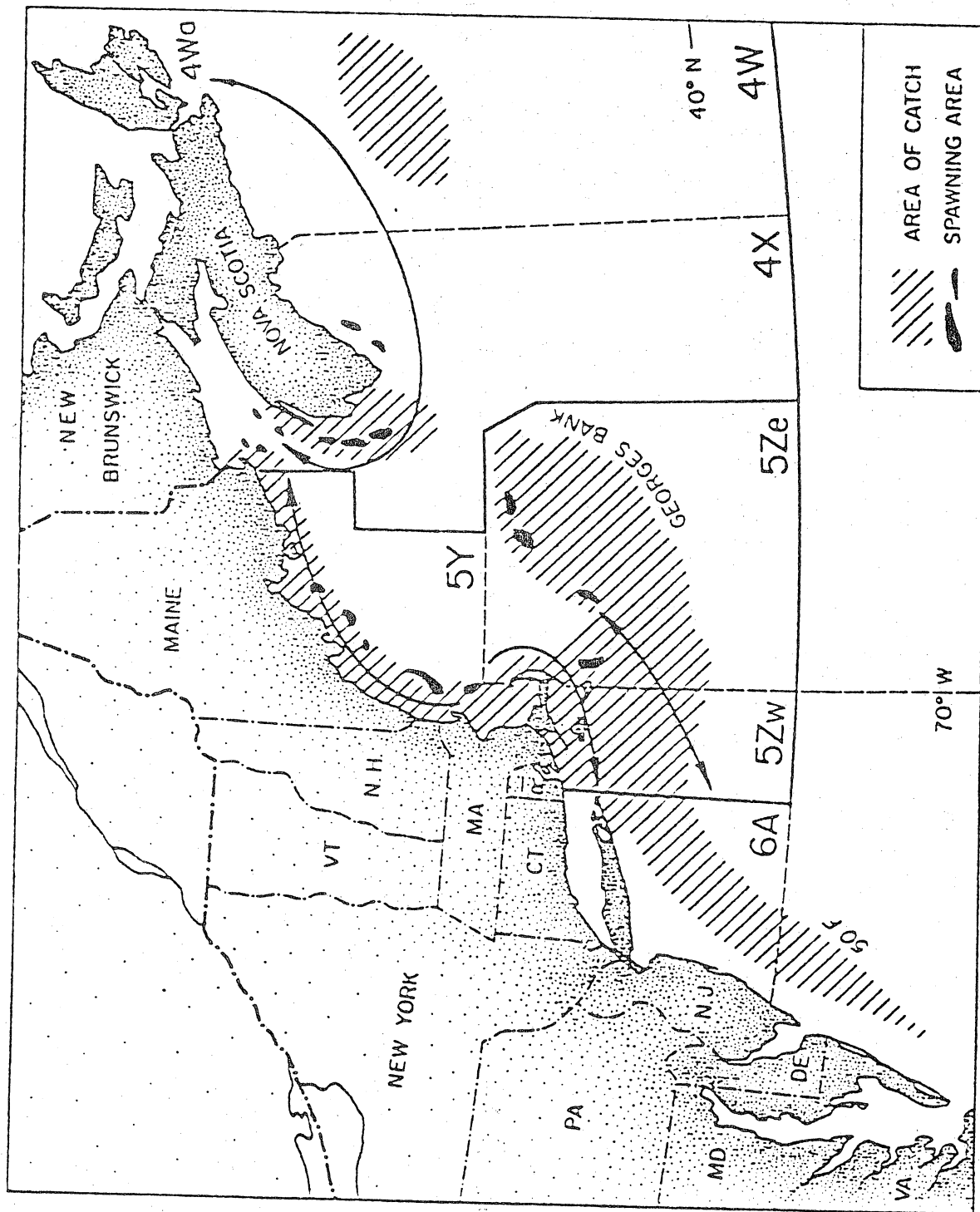


Figure 1. Herring fishing grounds (dashed lines) and spawning sites (dark circles) in ICNAF Subareas 4 and 5 and Statistical Area 6. (Modified from Redbook, 1972, Part I, pp. 62).

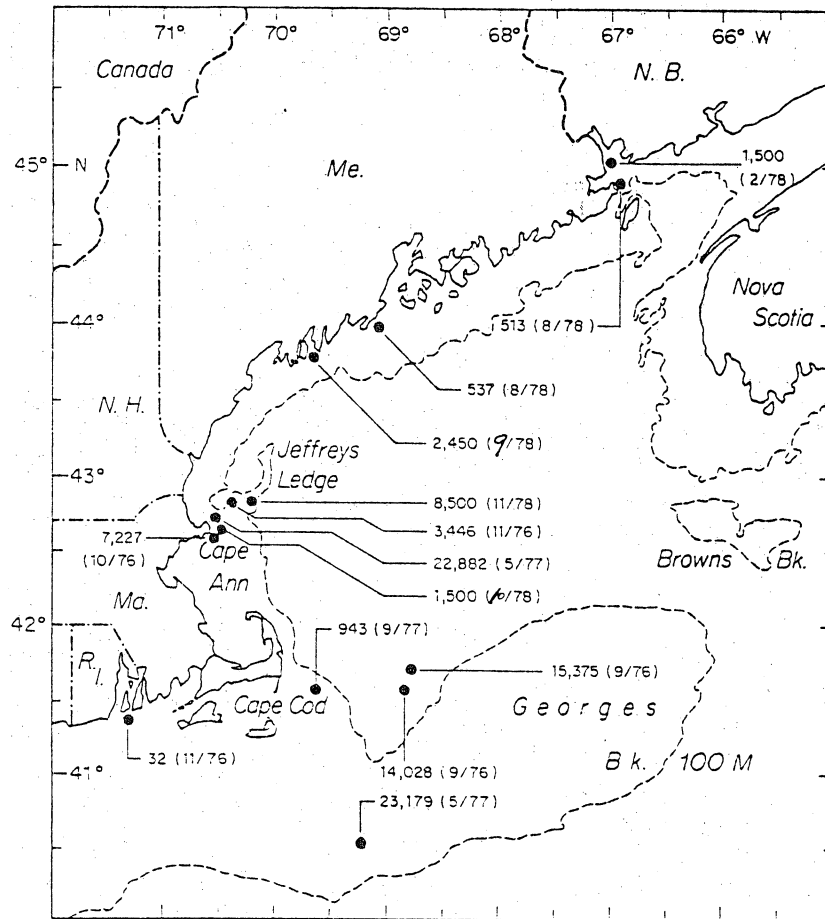


Figure 2. Tagging sites and numbers of fish released by month and year in the International Herring Tagging Program by US 1976-1978.

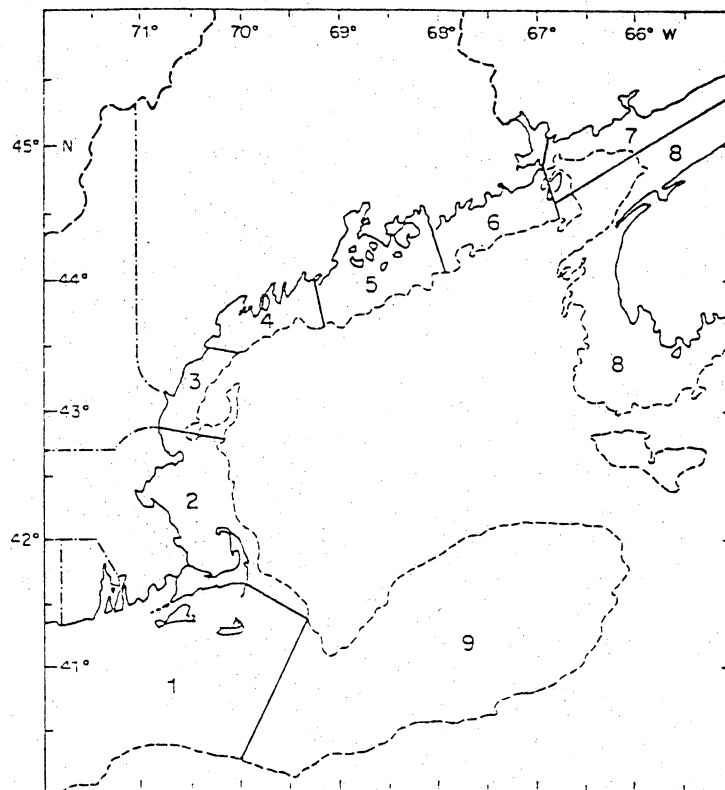
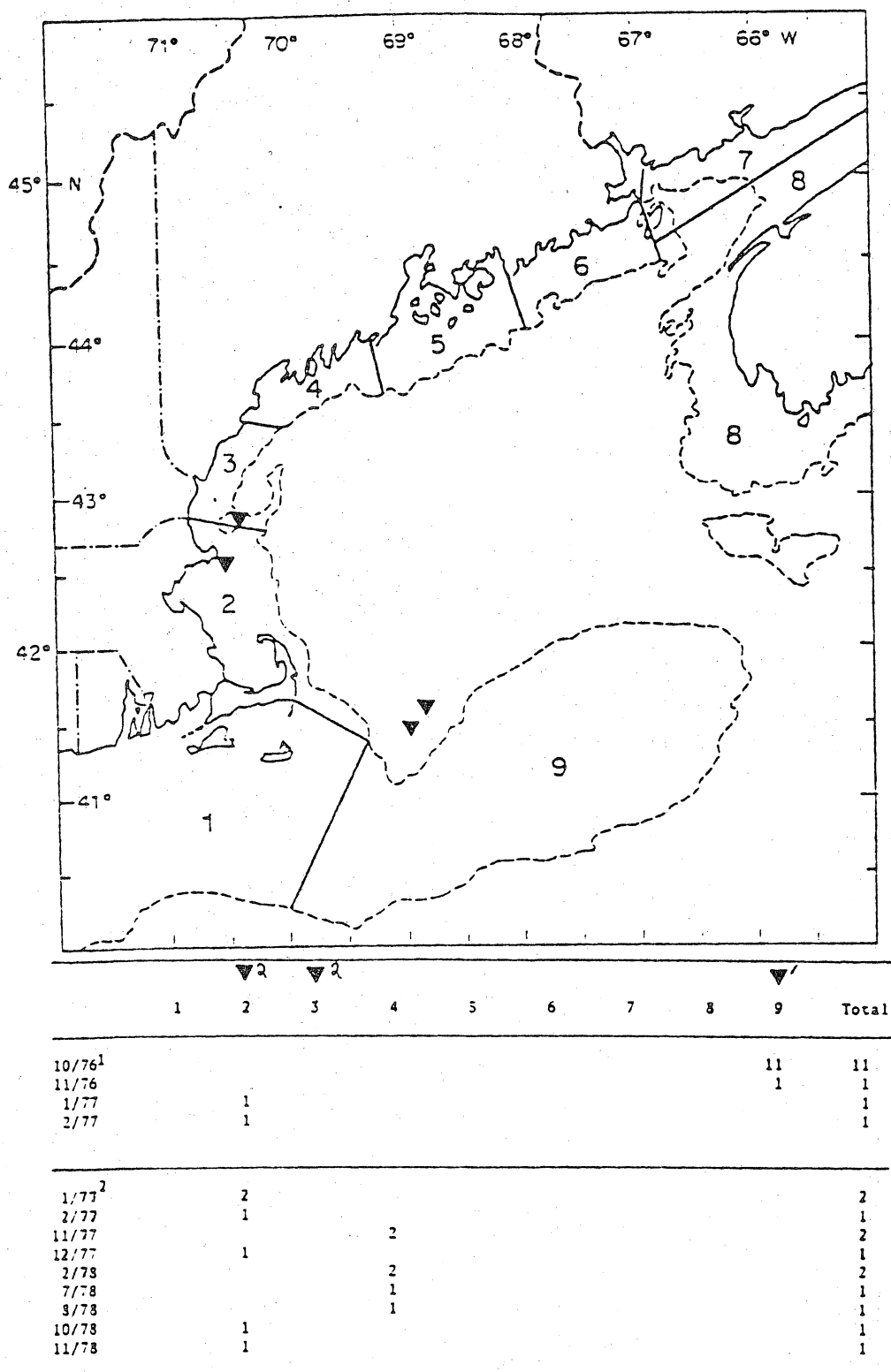


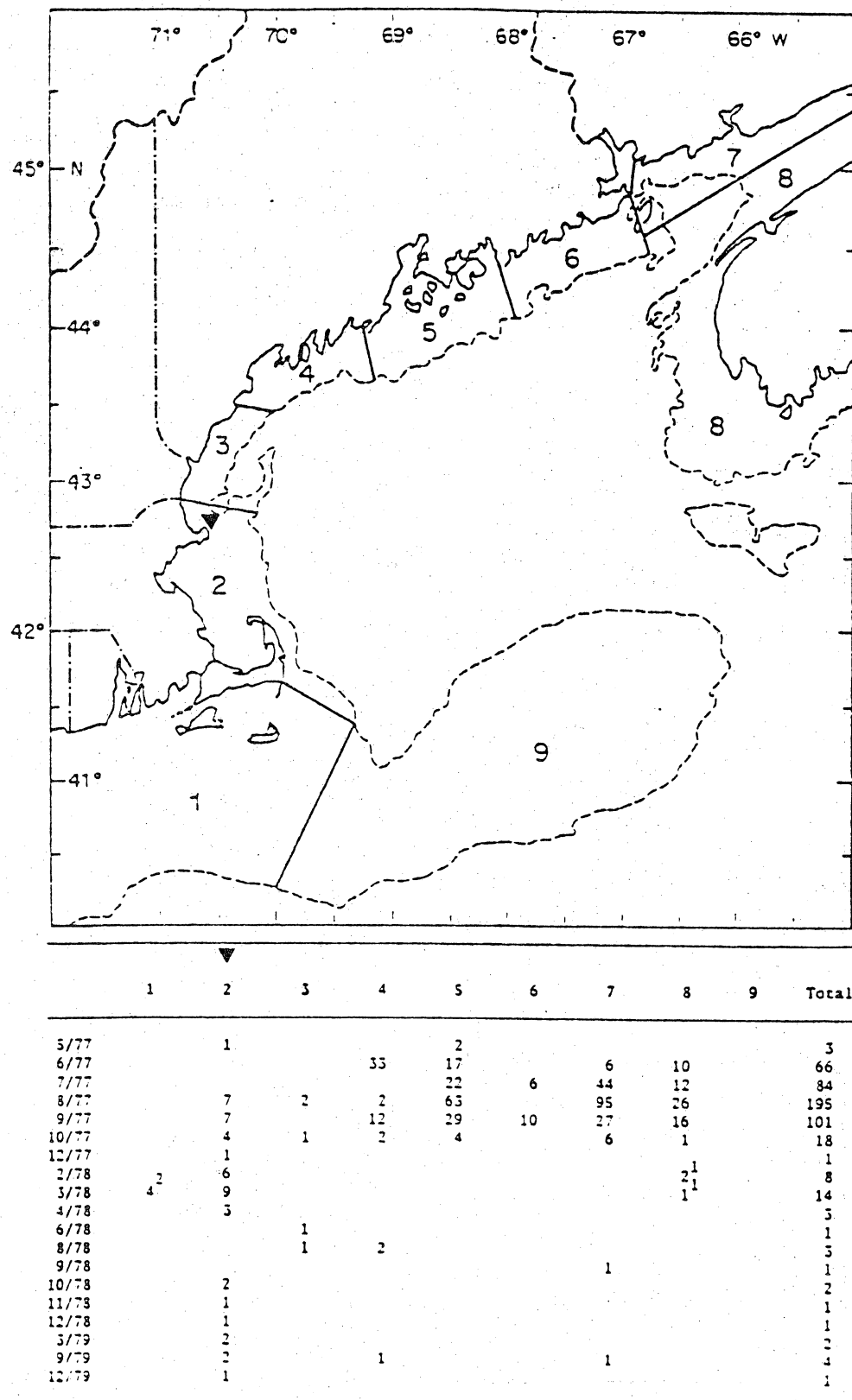
Figure 3. Regions utilized for summarizing INT. HER. tag recoveries.



¹ Cultivator Shoals

² Jeffreys Ledge-Cape Ann

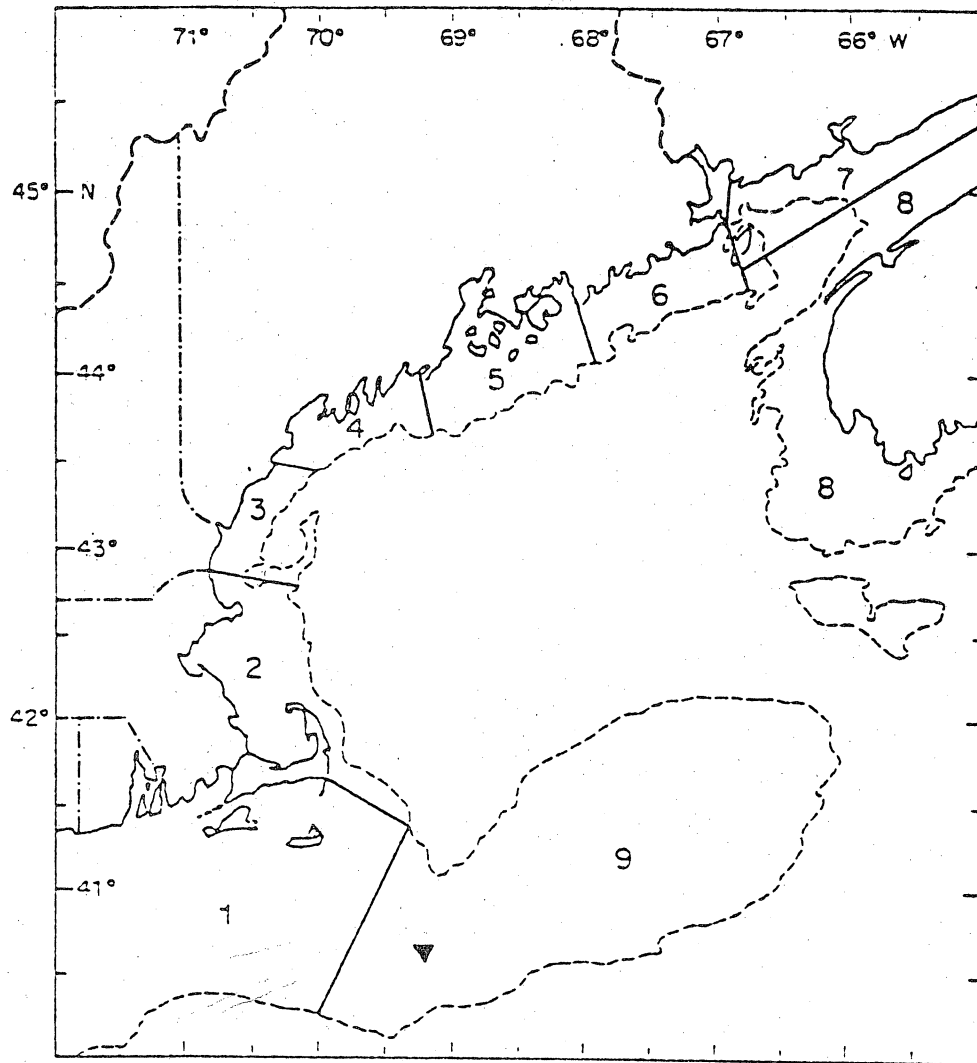
Figure 1. Number of recoveries by region from INT. HER. tagging conducted during September 1976 on Cultivator Shoals and October 1976 in the Jeffreys Ledge - Cape Ann areas.



¹Chedabucto Bay

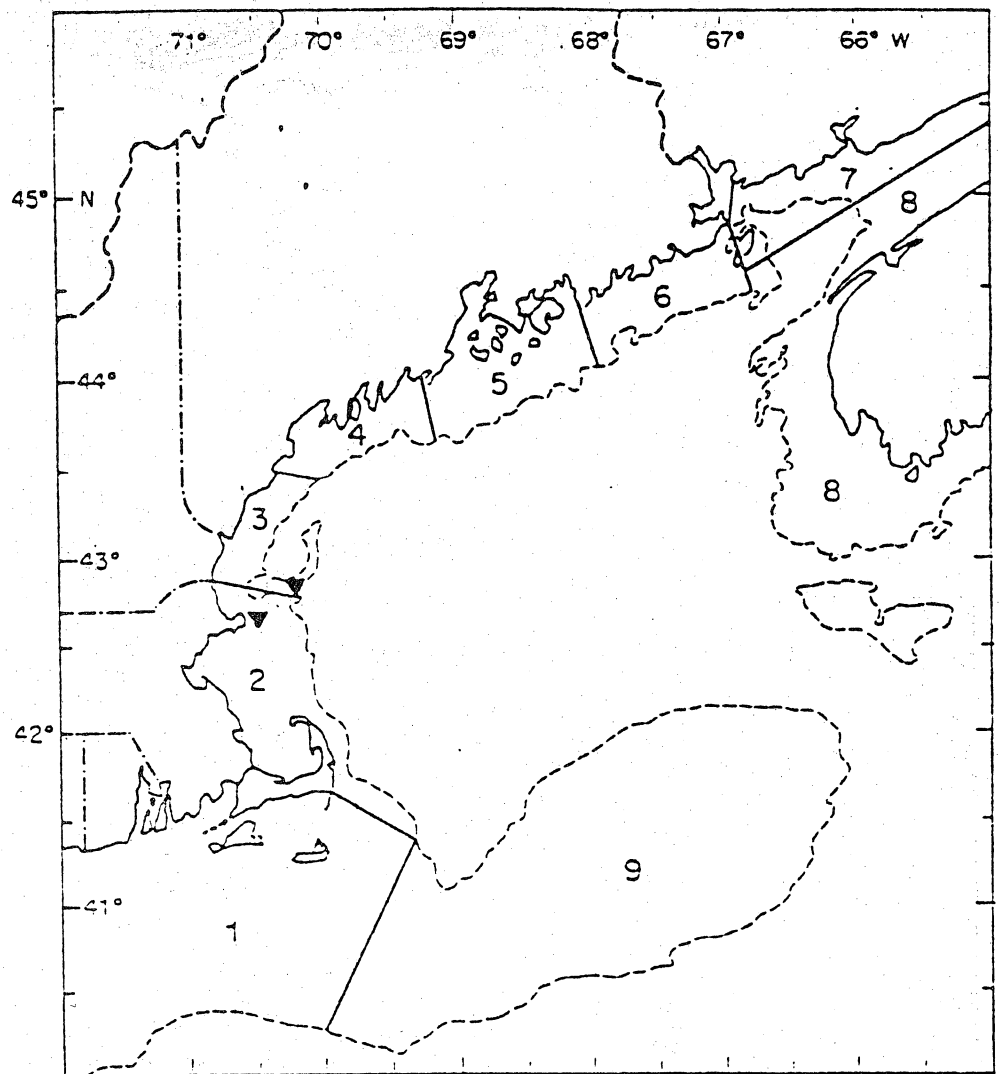
²One tag taken off Hudson River

Figure 5. Number of recoveries by region from INT. HER. tagging conducted during May 1977 in the vicinity of Jeffreys Ledge.



	1	2	3	4	5	6	7	8	9	Total
6/77				37	11			2		50
7/77				2	12	2	4	2		22
8/77		14	3	7	40		10			74
9/77		9		6	24	1	2			42
10/77		1	1	1	2			2		7
11/77		3	2							7
12/77		2					2			4
1/78		1					2			3
2/78	9	6			2					17
3/78	5	10	1				1			16
6/78			1	3	1					5
7/78				5						5
8/78			6	1			1			8
9/78		2	2		1					5
10/78		2								2
11/78			2							2

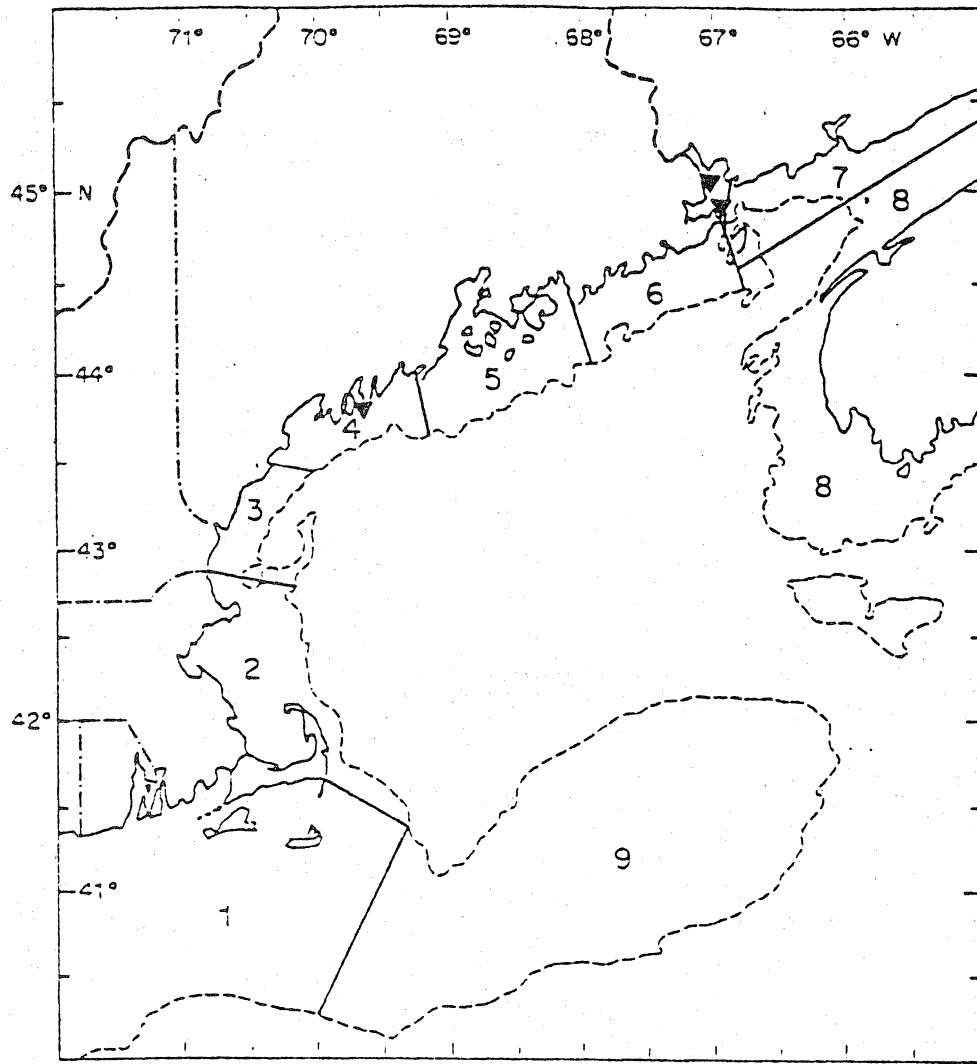
Figure 6. Number of recoveries by region from INT. HER. tagging conducted during May 1977 in the Great South Channel.



	1	2	3	4	5	6	7	8	9	Total
11/78		(4)		(4)						(14) --
12/78		(1) 33	(6)							(1) 33
1/79		63								63
2/79	1	19		2						22
3/79	(1) 1	61	1	2						(1) 65
7/79		5	9							14
8/79		(1) 22	4	1			1			(1) 28
9/79		(2) 29	3							(2) 32
10/79		(1) 3					4			(1) 7
11/79		3								3
2/80		1								1
3/80		1								1
9/80		1								1

() Oct 78 tagging

Figure 7. Number of recoveries by region from INT. HER. tagging conducted during October 1978 () and November 1978 in the Jeffreys Ledge - Cape Ann areas.



	1	2	3	▼3	4	5	▼1,2	6	7	8	9	Total
8/78 ¹					5			2	1			6
9/78 ²								1				2
10/78												1
7/79									1			1
1/79 ³		2			1							3
2/79					1							1
7/79									1			1
8/79								1				1
10/79					1							1

¹21 Feb. tagging

²31 Aug. tagging

³7 Sept. tagging

Figure 8. Number of recoveries by region from INT. HER. tagging conducted during February 1978, August 1978, and September 1978 in Maine coastal waters.

Appendix 1. Length frequency samples for herring tagged in Subdivision 5Ze, 5Zw, and Division 5Y by tagging site and station from 16 September to 10 November 1976.

Division	Cultivator Shoals (5Ze) (16-9-76 - 28-9-76)					Jefferys Ledge (5Y) (8-10-76 - 11-10-76)					Tiverton, RI (5Zw) (10-11-76)				
Station	1	2	3	4	5	6	7	8	9	10	11				
Length (cm)															
21												1			
22												--			1
23												--			--
24												--			--
25		1						1				--			--
26	8	--	2	1	3			12	4	19	16			6	
27	14	4	6	4	4	2	2	22	39	37	37			24	
28	5	3	4	3	1	2	--	15	22	21	21			22	
29	13	4	9	7	8	10	10	26	27	14	14			10	
30	34	44	40	29	46	34	38	55	43	38	38			8	
31	81	78	83	82	75	87	81	42	28	47	47			6	
32	36	51	47	54	43	50	43	16	10	19	19			7	
33	7	9	6	11	10	7	8	5	7	5	5			1	
34	2	5	3	6	7	7	1	2		1	1			5	
35		1		3	1	1	1			1				3	
36														3	
37														3	
38														1	
Total	200	200	200	200	200	200	184	200	200	200	200			100	
Mean	30.4	31.0	30.8	31.2	31.0	31.1	31.0	29.5	29.0	29.3	29.3			29.5	
Range	26-34	25-35	26-34	26-35	25-36	27-35	27-35	24-34	25-36	25-35	25-35			22-38	

Appendix 2. Length frequency samples for herring tagged in Subdivision 5Ze, and Division 5Y by tagging site and station in 1977.

Length (cm)	Jefferys Ledge (5y) (1-5-77)		Great South Channel (5Ze) (7-5-77 - 15-5-77)		Chatham, MA (5Ze) (23-9-77 - 25-9-77)	
	1	2	3	4	5	6
15				1		
16				--		
17				--		
18				--		
19				--		
20				--		
21				--		
22				3		
23		1		5		
24	1	2	6	31		
25	--	7	7	44		
26	3	17	23	44	29	1
27	15	56	30	37	67	2
28	29	58	24	20	54	16
29	21	29	8	10	19	35
30	27	9	2	2	10	39
31	59	13		3	8	32
32	38	8			3	19
33	6				3	31
34	1				3	21
35						7
36						4
Total	200	200	100	200	200	207
Mean	30.1	28.0	26.9	25.9	27.7	30.1
Range	25-34	24-32	24-30	16-31	22-33	26-35
						26-34
						100
						29.8
						26-34

Appendix 3. Length frequency samples for herring tagged in Division 5Y by tagging site and station in 1978.

Length (cm)	White		Boston		Jeffreys Ledge				
	Passamaquoddy Bay (5y)	Island (5y)	Boot Cove (5y)	Island (5y)	(10-16-78 - 9-11-78)	(10-16-78 - 9-11-78)	(10-16-78 - 9-11-78)	(10-16-78 - 9-11-78)	(10-16-78 - 9-11-78)
10	2								
11	4								
12	9								
13	6								
14	11								
15	9								
16	7								
17	1								
18	--								
19	--								
20	1								
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
Total	50	73	50	50	114	186	114	101	103
Mean	13.8	30.6	18.5	19.7	30.2	30.6	31.5	30.6	29.2
Range	10-20	25-35	15-21	17-24	25-35	25-35	25-36	25-36	22-34