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SEASONAL DISTRIBUTION OF RED AND SILVER HAKE

IN ICNAF DIVISIONS 5Z, 6A AND 6B

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ABSTRACT

The seasonal distribution of red and silver hake, in relation to ICNAF Red and Silver Hake Management Area (ICNAF Divisions 5Ze and 5Zw), and to the area of abstention covered by the U. S. -Soviet and U. S. -Polish Middle Atlantic Fishery Agreements (ICNAF Divisions 6A and 6B), has been preliminarily evaluated.

Evaluations have been based on average stratum catches made at randomly selected stratified survey stations during seasonal groundfish surveys conducted during the period 1963 through 1971.

Results indicate that large concentrations of red hake, and to a lesser extent silver hake, occupy the deep offshore water slopes along the continental shelf primarily within the closed areas of southern New England and the mid-Atlantic during the winter months, with a pronounced movement of both species into the shallow inshore waters during late spring where they remain until fall, when movement back to the deep offshore wintering areas along the slopes is initiated.

INTRODUCTION

This paper examines the seasonal distribution of red hake (Urophycis chuss) and silver hake (Merluccius bilinearis) with particular reference to the aforementioned closed areas on the basis of data gathered during groundfish surveys conducted by National Marine Fisheries Service, at Woods Hole, Massachusetts.

Both the United States and the Soviet Union conduct intensive fisheries for red and silver hake, although these fisheries are distinctly separated by time and space. The major portion of U. S. effort is concentrated during the summer and fall months along the coast at depths of usually less than 30 fathoms. On the other hand, the bulk of the Soviet effort is concentrated during the winter and early spring months along the slopes of the continental shelf where wintering concentrations of both species are found. In order to prevent the depletion and breakup of pre-spawning concentrations of these fish prior to their movement to inshore spawning grounds during the summer months, fishing has been prohibited from 1970 through 1972 in the "ICNAF Management Area" (Subarea 5) during January through March, and from 1969 through 1970 in the long belt from Rhode Island to Virginia (in waters of the 50 to 100 fathom zone) covered by "U. S. -USSR and U. S. -Poland Middle Atlantic Fishery Agreement" (Subarea 6) during the time period January 1 through April 15 (Figure 1).

METHODS

During the period 1963-71, seasonal groundfish surveys have been conducted (Table 1). Fall surveys have been routinely carried out on an annual basis. Other seasonal surveys have been conducted as follows: winter surveys, 1964-1966; spring surveys, 1968-71; and summer surveys, 1963-65, and 1969. While there have been slight variations from year to year of dates bridging individual surveys, the following definition, by dates, represents the maximum and minimum time period during which all surveys discussed hereafter were completed -- winter surveys, January 16 - March 2; spring surveys, March 4 - May 16; summer surveys, July 7 - September 3; and fall surveys, September 30 - December 10. The last 15 days of each survey however covers primarily areas outside of the coverage of the paper with generally only the few stations in 5Ze being considered here. The groundfish surveys have been described by Grosslein (1969).

Basic features of the groundfish survey are as follows:

1. Prior to each survey, stations are randomly selected within each sampling stratum (see Figure 1).
2. Thirty minute hauls with a #36 Yankee otter trawl are made at each random station. Trawling speed has been standardized at 3.5 knots except during the 1963 summer survey when trawling was conducted at 4 knots per hour.
3. Total weight, and a representative length frequency of each fish species are recorded for each survey haul.

By virtue of the random selection of stations, the catch per haul indices provides unbiased estimates of the availability of each species (to the survey trawl) in relation to its distribution.

The minimum and maximum depths of survey strata with which this paper is concerned are as follows:

<u>Strata No.</u>	<u>Depth (in fathoms)</u>	
	<u>Min.</u>	<u>Max.</u>
69 and 73	10	32
1	11	32
9	11	35
5	13	33
10	23	62
2, 6, 13, 70 and 74	28	62
3, 7, 11, 71 and 75	58	105
4, 8, 12, 15, 72 and 76	95	200

Seasonal distribution charts, as represented in figures 2-11, have been determined by dividing the total number of either red or silver hake caught within a specific stratum (by cruise and season) by the number of survey hauls in that stratum producing that species. The resulting number is termed the

"average stratum catch for effective effort". For the purpose of this paper, any resulting average stratum catch for effective effort exceeding 50 individuals during a particular cruise is considered as an area of concentration, and has been plotted, accordingly. Thus, resulting seasonal distribution charts do not represent any single year, but instead, represent a composite for those years indicated. Catch variation occurred between strata from year to year, such that certain strata may have shown concentrations only during a single year, and perhaps only minimal catches during succeeding years; however, during the time period indicated, areas of species concentration were plotted for a given stratum even though the resulting concentration may have only been represented by a single survey.

Due to the time span involved, as well as the differences in survey coverage, fall surveys are represented for each species by two distribution charts each with the periods covered being 1963-66 and 1967-71 corresponding to the change from winter to spring surveys.

Prior to 1967, groundfish surveys were exclusively conducted in ICNAF Divisions 5Ze, 5Zw and only as far south as to include sampling strata 1-4 (see figure 1) in Division 6A. Beginning in 1967, groundfish surveys were extended to include strata in Division 6B and 6C, as far south as Cape Hatteras, North Carolina. For the purpose of the paper however, only those strata located in Divisions 5Ze (9-15), 5Zw, 6A and 6B (69-76) will be considered. Further, material presented in this paper is based only on numbers of fish in relation to their depth of capture during specific seasonal groundfish surveys without regard to analysis of their length frequency or weight coefficients. The depth of capture was computed as the average depth of the stations sampled within a strata. Analysis of these data are anticipated and will be reported at a later date.

SEASONAL DISTRIBUTION OF RED HAKE

In general, seasonal distribution of red hake is characterized by concentration in the deep water along the slope of the continental shelf during the winter months; initiation of an inshore movement during the spring; and, the return during late fall to their offshore wintering grounds.

Winter Distribution, 1964-1966. -- The overall depth range occupied by red hake during winter surveys extended from an average stratum fishing depth of 18 fathoms down to 150 fathoms (Figure 2). Large concentrations were regularly located in two depth zones where average station depths ranged from 72 to 92 and 105 to 150 fathoms. Individual survey catches taken from the shallow inshore strata (1, 5 and 9) were represented by no more than just a few individuals per haul, and merely demonstrated that at least a few red hake spend the winter months in waters as shoal as 18 fathoms. With little exception, red hake were found to regularly occupy the deeper strata along the slope of the continental shelf which transverses both the ICNAF Management Area (5Ze and 5Zw) and a portion of the bilateral abstention area in Division 6A.

Spring Distribution, 1968-1971. -- With the exception of the 1971 spring survey, red hake did not appear to be concentrated to any great extent in the deep offshore strata such as was observed during the winter surveys. Instead, red hake were found in modest numbers occupying the middle and deep offshore strata (ranging from 42.3 to 173.5 fathoms) with only small stratum average catches taken from extreme shallow inshore areas. Unlike preceding years, the 1971 spring survey revealed excellent concentrations of red hake at average station depths of 43 fathoms (stratum 6), 158 fathoms (stratum 8), and to a lesser extent at 51 fathoms (stratum 13). Red hake were taken in survey hauls from most of the remaining strata under consideration, but stratum average catches were usually composed of merely a few individuals (Figure 3). Computer plots showing station locations, total number of red hake (top number) and the total weight of those fish (lower number) appear in figures 3A-3D.

Summer Distribution, 1963-65, 1969. -- During the 1963-65 surveys, red hake were distributed throughout most of the sampling strata in Divisions 5Ze, 5Zw and 6A, and in 1969 were found distributed throughout those strata in Division 6B at average strata depths ranging from 19 to 174 fathoms (Figure 4). Although this species occupied a broad range of depths during summer surveys, significant concentrations were primarily caught at average station depths ranging from 22 to 26 fathoms (strata 1, 5 and 9) and 40 to 47 fathoms (strata 2, 6, 10 and 13).

During the 1969 survey good concentrations of red hake were caught at an average station depth of 71 fathoms in stratum 14 (Division 5Ze). The 1969 survey was typified by small average stratum catches, with no significant concentrations found even in the previously productive (1963-65) shallow water strata.

Fall Distribution, 1963-1966. -- Concentrations of red hake during the 1963 survey were primarily confined to strata 11, 14 and 15 where average station depths ranged from 81 to 120 fathoms. Subsequent surveys (1964-66) were unable to locate concentrations in these deep offshore strata, but instead found the best concentrations to be located in the shallow inshore strata (1 and 9) where average station depths ranged from 22 to 24 fathoms. In addition, modest concentrations of red hake were observed in strata 10 and 2 during the 1963 and 1964 surveys, respectively (Figure 5). Throughout the overall survey period, red hake were found to occupy nearly all sampling strata in 5Ze, 5Zw and 6A, but with the exception of those strata previously mentioned average strata catches were typically small.

Fall Distribution, 1967-1971. -- Although the survey area during this period was expanded to include sampling strata in Division 6B, concentrations of red hake were clearly confined to strata 5, 6, 9 and 10 in 5Ze, 5Zw, and to a small portion of Division 6A (Figure 6). Concentrations were specifically limited to average station depth ranges of 24 to 26 fathoms (strata 5 and 9) and 37 to 48 fathoms (strata 6 and 10). Deep offshore strata along the continental shelf accounted for only small average catches and revealed no areas of concentration as was evident during the 1963 fall survey.

SEASONAL DISTRIBUTION OF SILVER HAKE

Silver hake appear to occupy a wide variety of depths during all four seasons, varying only in their numbers and strata of concentration. Generally, silver hake appear to show a definite spring movement to the shallow inshore strata where they remain until fall, at which time they begin moving into the deeper offshore strata. Wintering concentrations of silver hake do not appear to be quite as restricted to the deeper slope strata along the continental shelf as are red hake, as evidenced by the location of good concentrations of this species

in relatively shallow waters during winter surveys.

Winter Distribution, 1964-1966. -- Silver hake concentrations were located over a broad range of average fishing depths from 24 to 145 fathoms, with major concentrations specific to three depth ranges as follows: from 41 to 44 fathoms, from 63 to 84 fathoms, and 113 to 145 fathoms (Figure 7). Silver hake were found to be in residence in most of the extreme shallow inshore strata, but catches were small, and revealed no major concentrations. In general, silver hake were primarily concentrated along the slopes of the continental shelf, with concentrations to a lesser extent in those strata (6, 10 and 13) where average fishing depths ranged from 41 to 44 fathoms.

Spring Distribution, 1968-1971. -- Major areas of concentration were most evident in the deep strata along the slopes of the shelf, and were found consistently during all four years of survey data in stratum 6 (where average fishing depths range from 41 to 47 fathoms). Strata 2 and 10 have, on occasion, produced significant average stratum catches, but have not been consistent from year to year. In Division 6B, strata other than 72 and 76 produced only minimal average stratum catches (Figure 8). Inshore strata in Divisions 5Ze, 5Zw and 6A produced no major catches during the four years sampled. Computer plots showing station locations, total number of silver hake (top number) and the total weight of those fish (lower number) appear in figures 8A-8D.

Summer Distribution, 1963-65; 1969. -- Only small catches of silver hake were taken from the deep water strata along the slope of the continental shelf, with the exception of stratum 14 which showed some concentration (1965 survey only) in water where the average station depth was 72 fathoms. Strata showing concentrations for surveys during the period 1963-65 were confined mainly to the shallow inshore strata (1, 5 and 9) where average station depths ranged from 22 to 24 fathoms, and to strata 2, 6 and 10 where average station depths ranged from 37 to 44 fathoms. Although the 1969 summer survey included those strata in Division 6B, no areas of concentration were detected (Figure 9).

Fall Distribution, 1963-1966. -- Concentrations of silver hake were found to range from the shallow inshore strata (1, 5 and 9) out to, and including two of the deep offshore strata (12 and 15). While these strata showed silver hake occupying a wide range of depths in moderate numbers, large concentrations were most evident in the middle strata where average stratum depths ranged from 38 to 44 fathoms, and from 66 to 92 fathoms (Figure 10).

Fall Distribution, 1967-1971. -- Silver hake were found to be distributed throughout most strata in Divisions 5Ze, 5Zw, 6A and 6B during this 5 year survey period. Four specific average stratum depth zones where significant concentrations of silver hake were located are as follows:

	Strata	Depth Zones (fathoms)	
		Min.	Max.
(1)	5, 9 and 73	23	26
(2)	2, 6, 10 and 74	38	44
(3)	3, 7, 11, 71 and 75	65	77
(4)	12 and 72	108	170

In general, silver hake were found with more regularity, and in greater concentrations in the first three depth zones described. The overall fall distribution of concentrations is somewhat similar to that noted during summer surveys, with the exception that fall surveys show good concentrations of silver hake in the deep offshore strata along the slope of the continental shelf. The re-appearance of silver hake in these strata perhaps suggest movement from the inshore summer grounds into the deep offshore wintering strata is actively underway at the time fall groundfish surveys are conducted (Figure 11).

SUMMARY

In Table I are summarized the seasonal distribution patterns of red and silver hake. The following conclusions can be drawn from this study.

1. It is apparent that large numbers of red hake descend to the deep water strata along the slopes of the continental shelf during late fall, remaining there throughout the winter months (mid January through February). While the movement into deep water is also true for silver hake, they do not appear to be as strictly confined to the deeper strata as evidenced by good winter catches from strata where average station depths ranged from 43.1 to 44.0 fathoms.

2. Spring groundfish surveys (March - mid May) revealed that while large numbers of both red and silver hake are still to be found in the deeper strata, definite inshore movement had been initiated. Inshore movement was more pronounced in the case of red hake, with concentrations being noted particularly in strata 6 and 13 in Divisions 5Zw and 5Ze. Silver hake occupied nearly the same strata as during the winter months with some movement of concentration into stratum 2 in Division 6A.

3. Summer (July to September) distribution of both red and silver hake were nearly identical being abundant throughout the inshore area with the exception of the survey conducted in 1965 when red hake were found to occupy stratum 13 (Division 5Ze) in significant numbers. Noticeably, the 1969 summer survey revealed no concentrations of either species south of strata 1-4 in Division 6B.

4. Fall surveys (October through early December) show that a large number of silver hake were resident in the deep offshore strata along the continental slopes during this time than were red hake. By fall, significant numbers of silver hake had already reached the outer strata, while red hake were still mainly concentrated in the shallow inshore areas. Although silver hake occupied portions of the deep offshore strata during the fall, significant

concentrations were also located over the same range of strata occupied by red hake. Surveys during the period 1967-71 showed concentrations of red hake to be limited to those strata in Divisions 5Ze, 5Zw and a small portion of 6A. Silver hake on the other hand, in addition to occupying the same strata as red hake, occupied a large number of strata in Division 6A as well as a significant portion of Division 6B.

5. In general, small numbers of red and silver hake remain year-round resident throughout most of the inshore and offshore sampling strata without regard to major seasonal species changes in hydrographic distribution.

6. The closed areas do encompass the winter concentrations of red and silver hake. However to provide additional protection to wintering stocks of red and silver hake during their periods of winter and early spring concentration, consideration may want to be given to extending the abstention period in "ICNAF Management Area" (Division 5Ze and 5Zw) from January to March to January through April 15. With the same interest in mind, the possibility of extending the "ICNAF Management Area" further east (Division 5Ze), and corresponding as closely as possible to include survey strata 14 and 15, for the same period of abstention, may prove to be of considerable value particularly to those populations moving onto the shallow waters of Georges Bank in the summer.

LITERATURE CITED

Grosslein, M. D., 1969. Groundfish Survey Program of BCF, Woods Hole.

Commercial Fisheries Review, Vol. 31, Nos. 8-9, pp. 22-30.

Table 1. -- Groundfish Survey Cruises 1963 - 1971

<u>DATE</u>	<u>YEAR</u>	<u>SEASON</u>
18 July - 19 August	1963	Summer
13 November - 16 December	1963	Fall
16 January - 15 February	1964	Winter
27 July - 22 August	1964	Summer
22 October - 25 November	1964	Fall
1 February - 8 April	1965	Winter
7 July - 10 August	1965	Summer
6 October - 9 November	1965	Fall
18 January - 23 February	1966	Winter
12 October - 13 November	1966	Fall
17 October - 9 December	1967	Fall
4 March - 16 May	1968	Spring
10 October - 26 November	1968	Fall
5 March - 10 April	1969	Spring
14 July - 28 August	1969	Summer
8 October - 23 November	1969	Fall
12 March - 29 April	1970	Spring
15 October - 20 November	1970	Fall
9 March - 1 May	1971	Spring
30 September - 19 November	1971	Fall

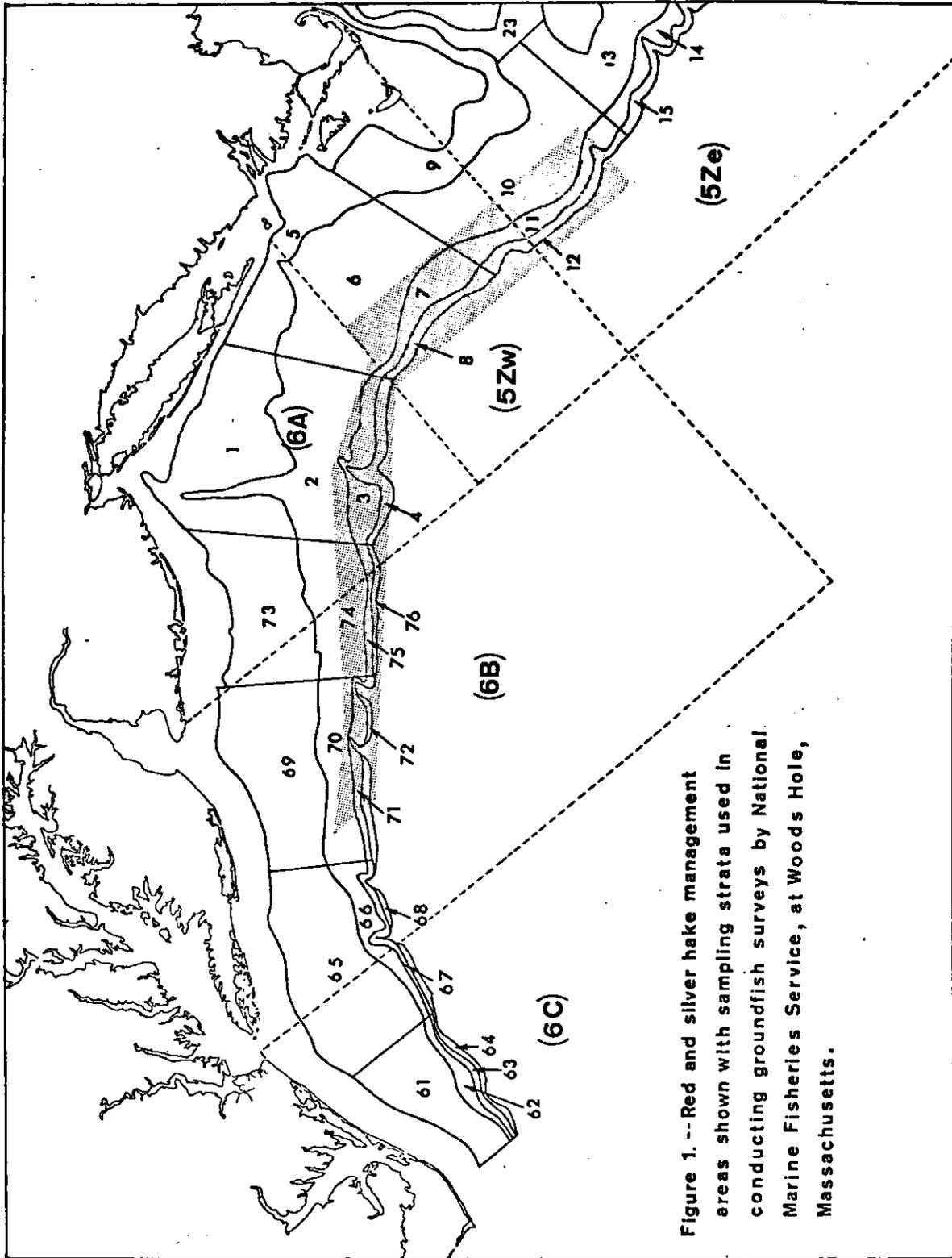


Figure 1. -- Red and silver hake management areas shown with sampling strata used in conducting groundfish surveys by National Marine Fisheries Service, at Woods Hole, Massachusetts.

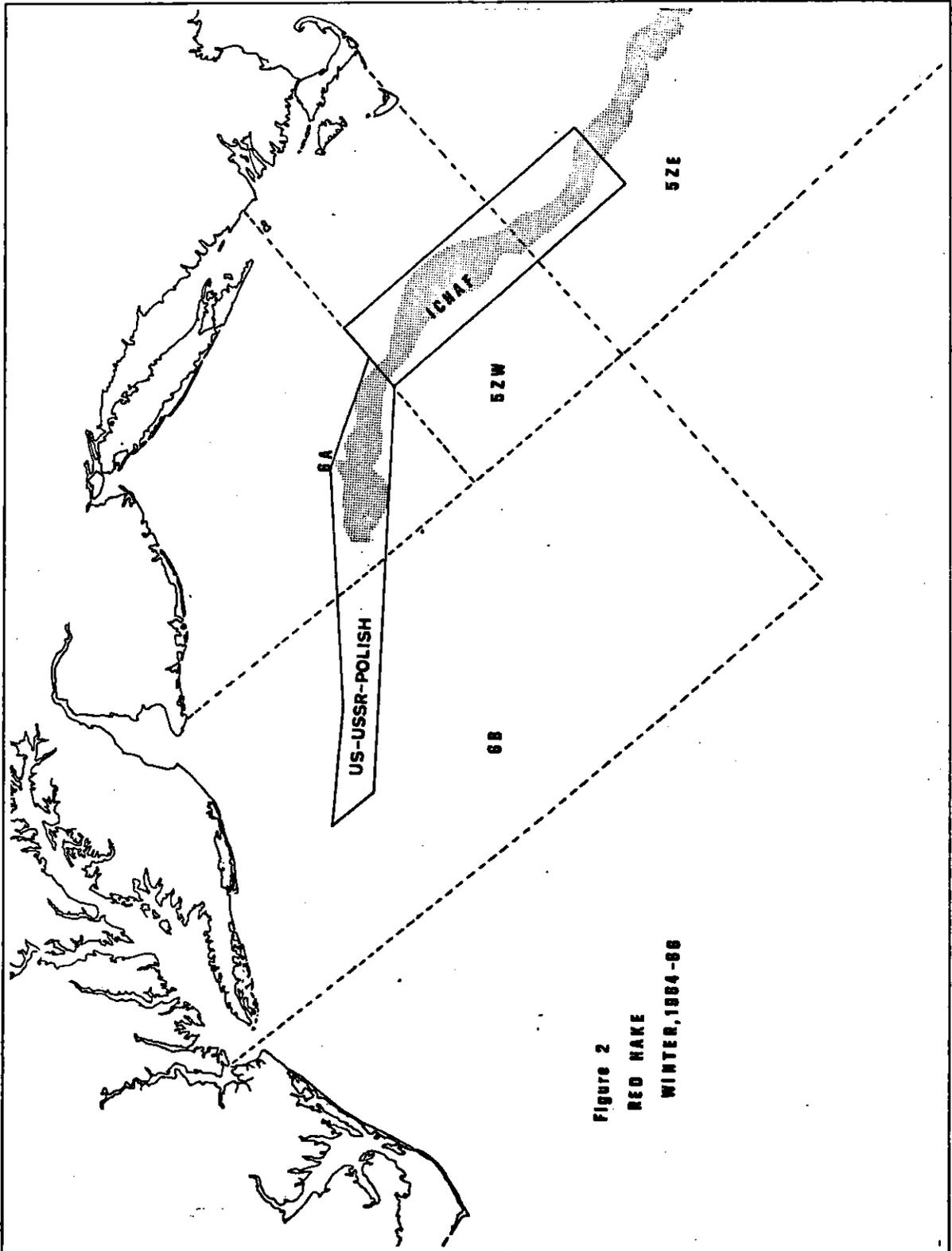


FIGURE 2
RED HAKE
WINTER, 1984-86

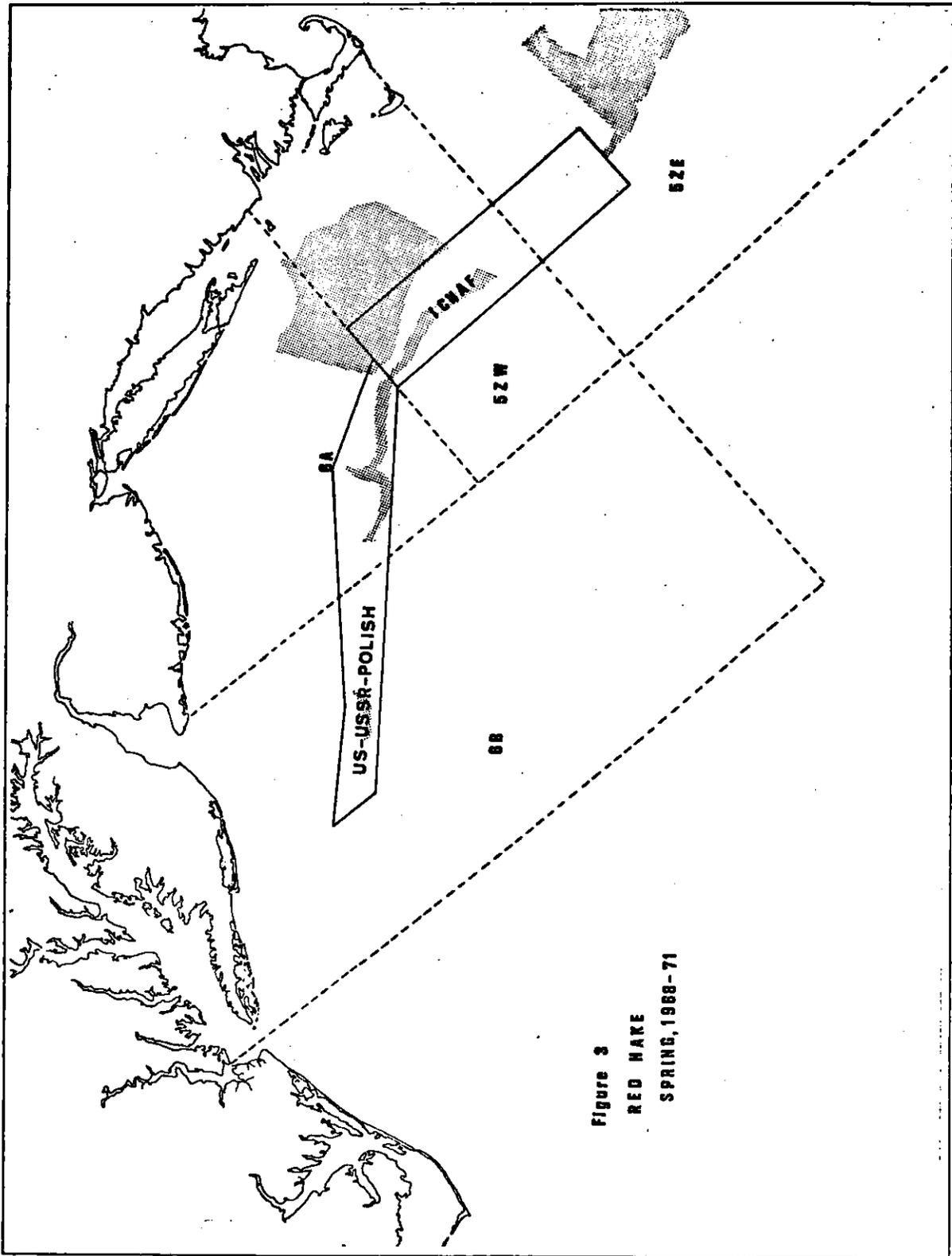


Figure 3
RED HARE
SPRING, 1988-71

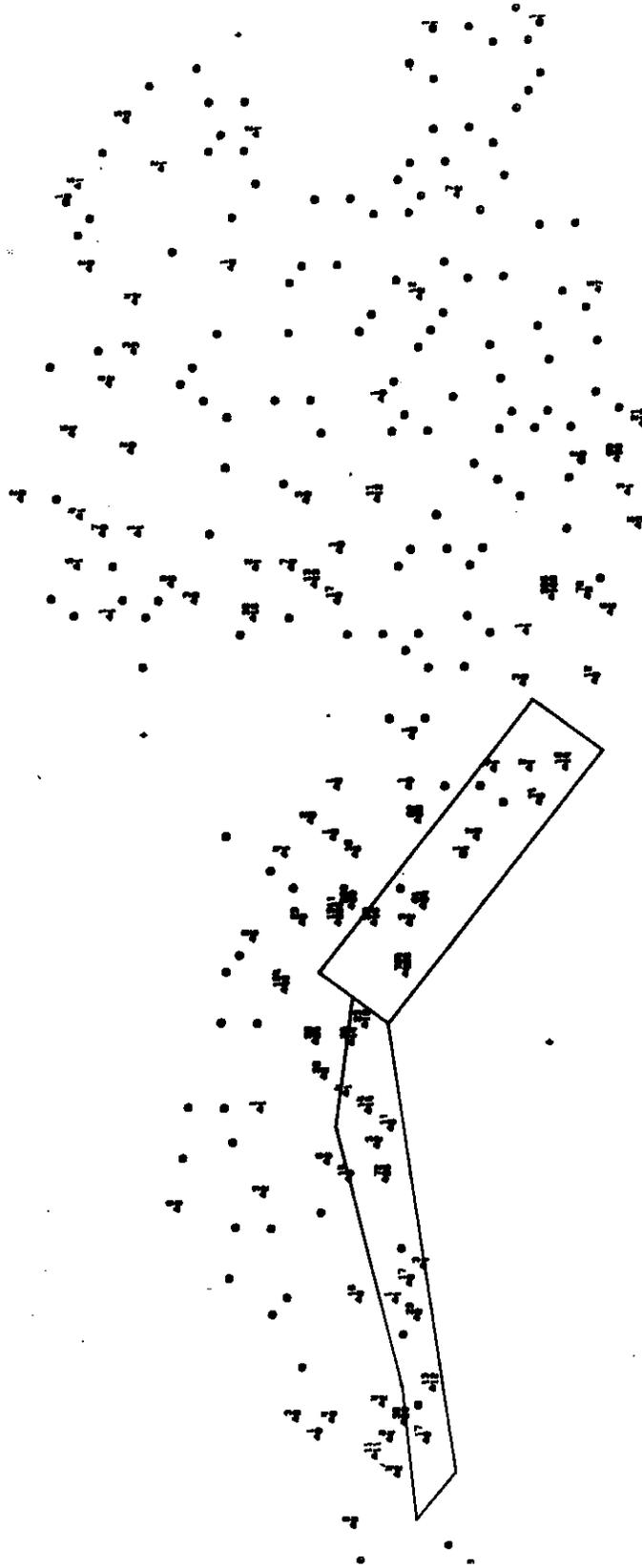


FIGURE 3A
RED HAKE
SPRING
MARCH 9 - MAY 1, 1971

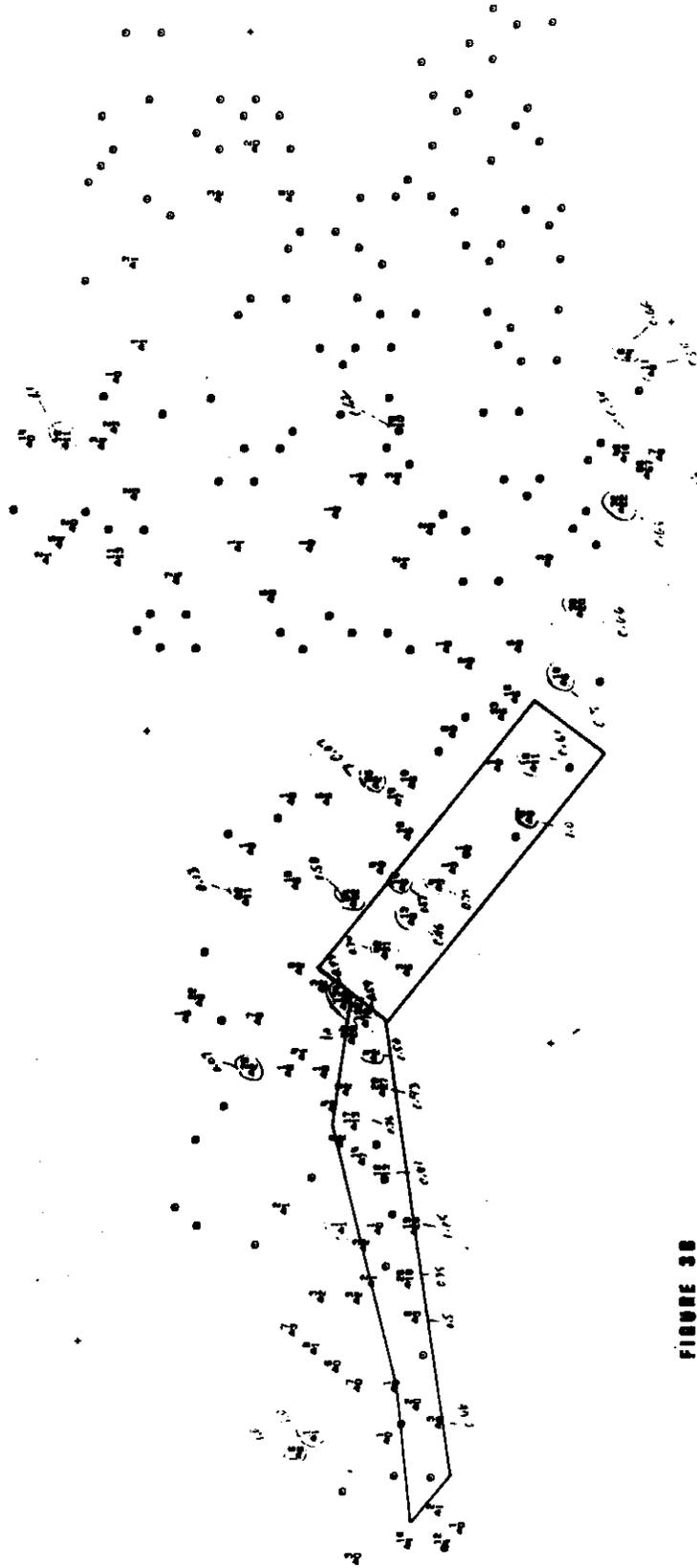


FIGURE 38
RED HAKE
SPRING
MARCH 12 - APRIL 29, 1970

70 703

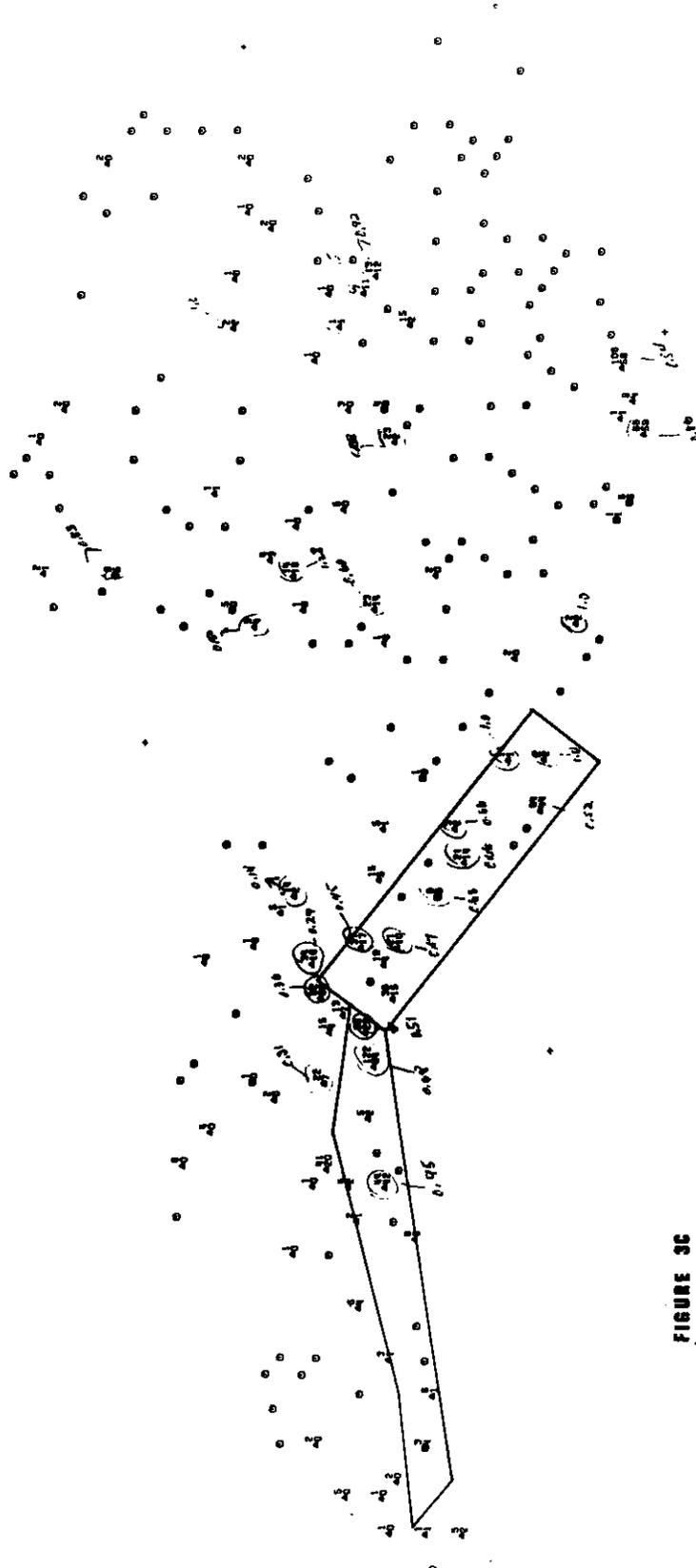


FIGURE 3C
RED HAKE
SPRING
MARCH 5 - APRIL 10, 1969

39 902

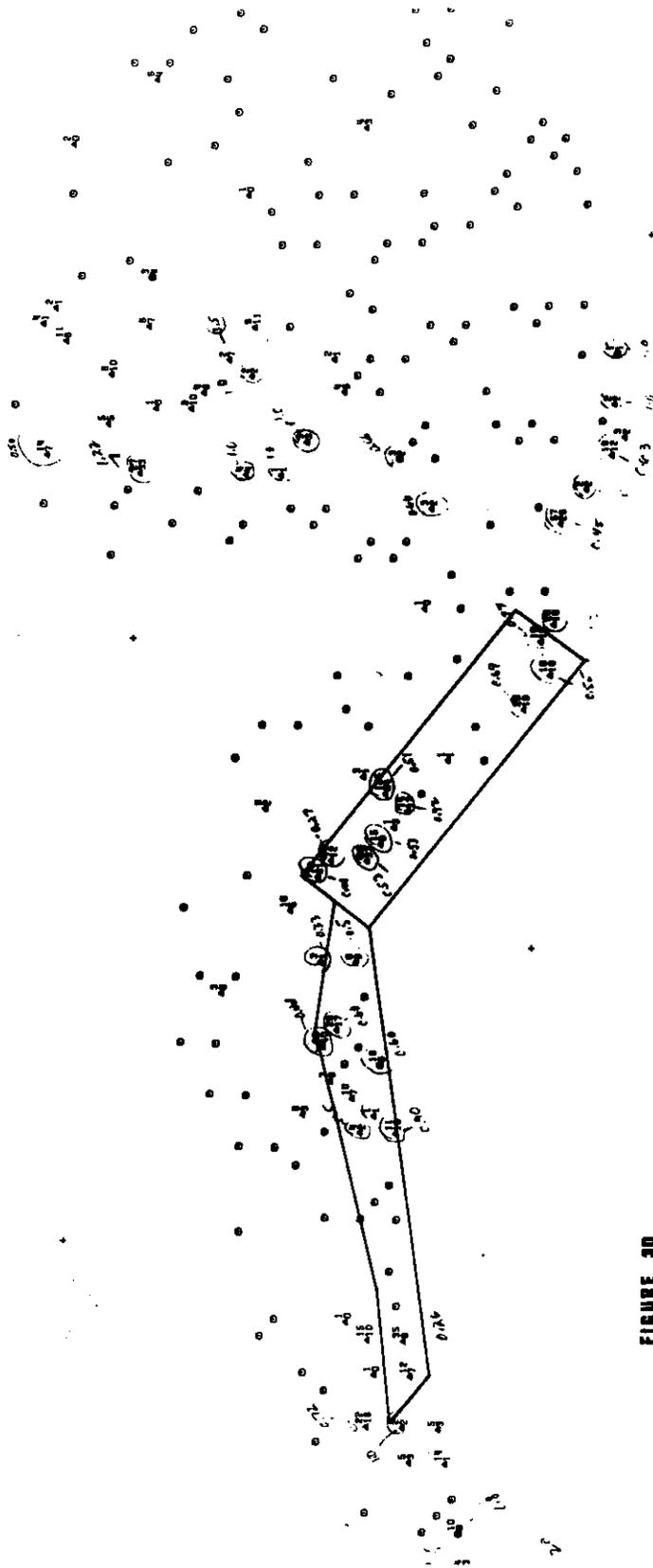


FIGURE 30

RED HAKE
SPRING
MARCH 4 - MAY 16, 1968

077 68 803

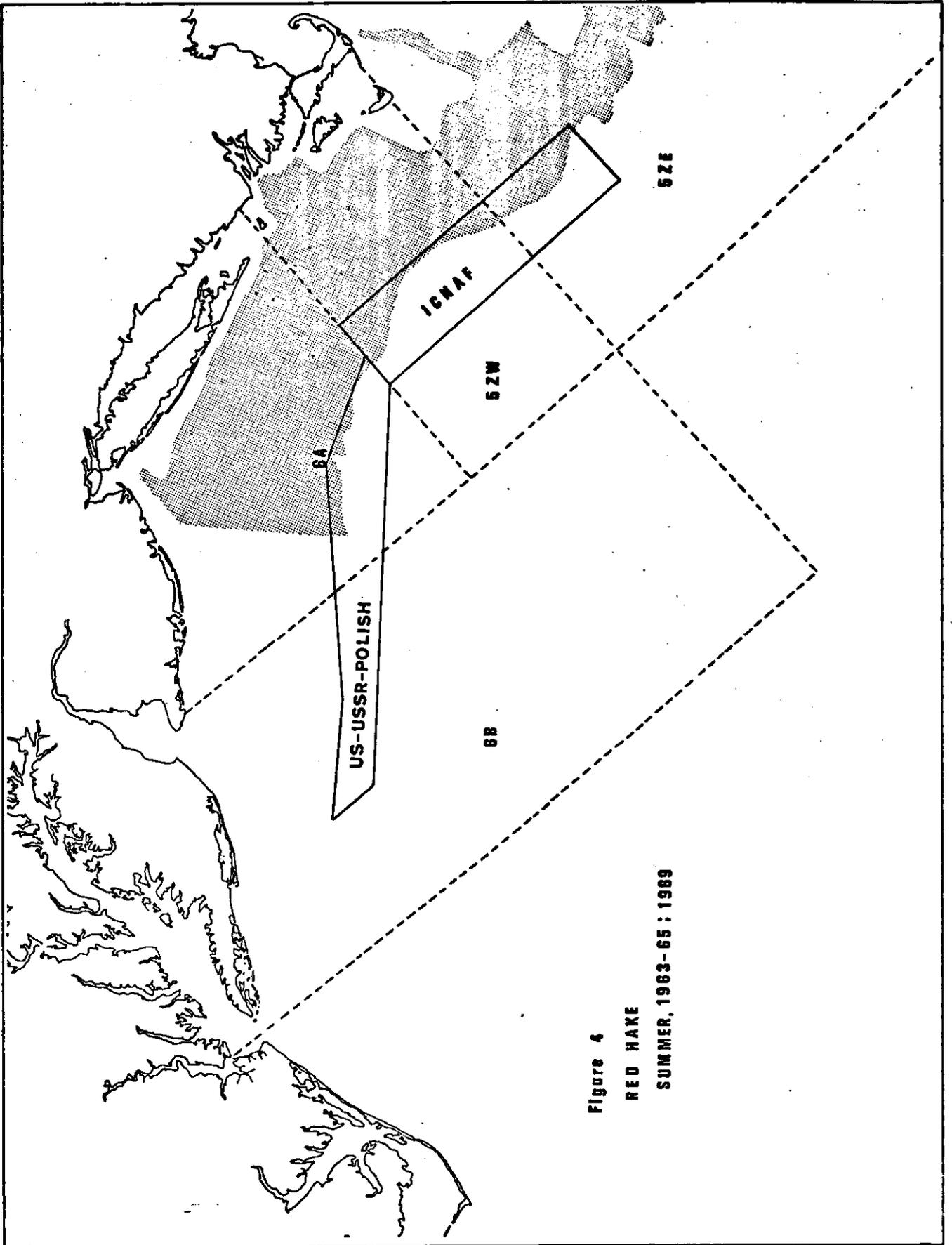


Figure 4
RED HAKE
SUMMER, 1963-65 : 1969

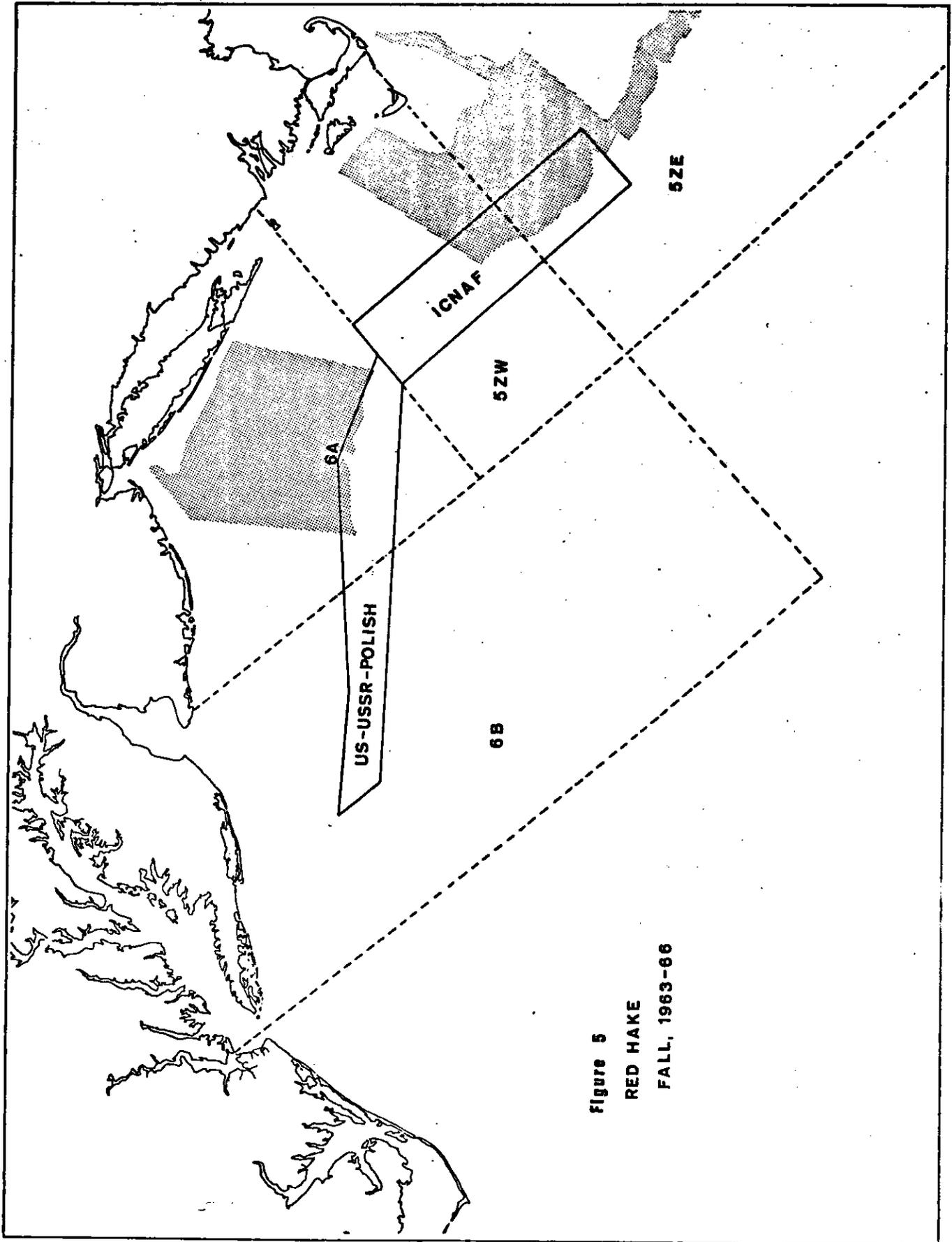


Figure 5
RED HAKE
FALL, 1963-66

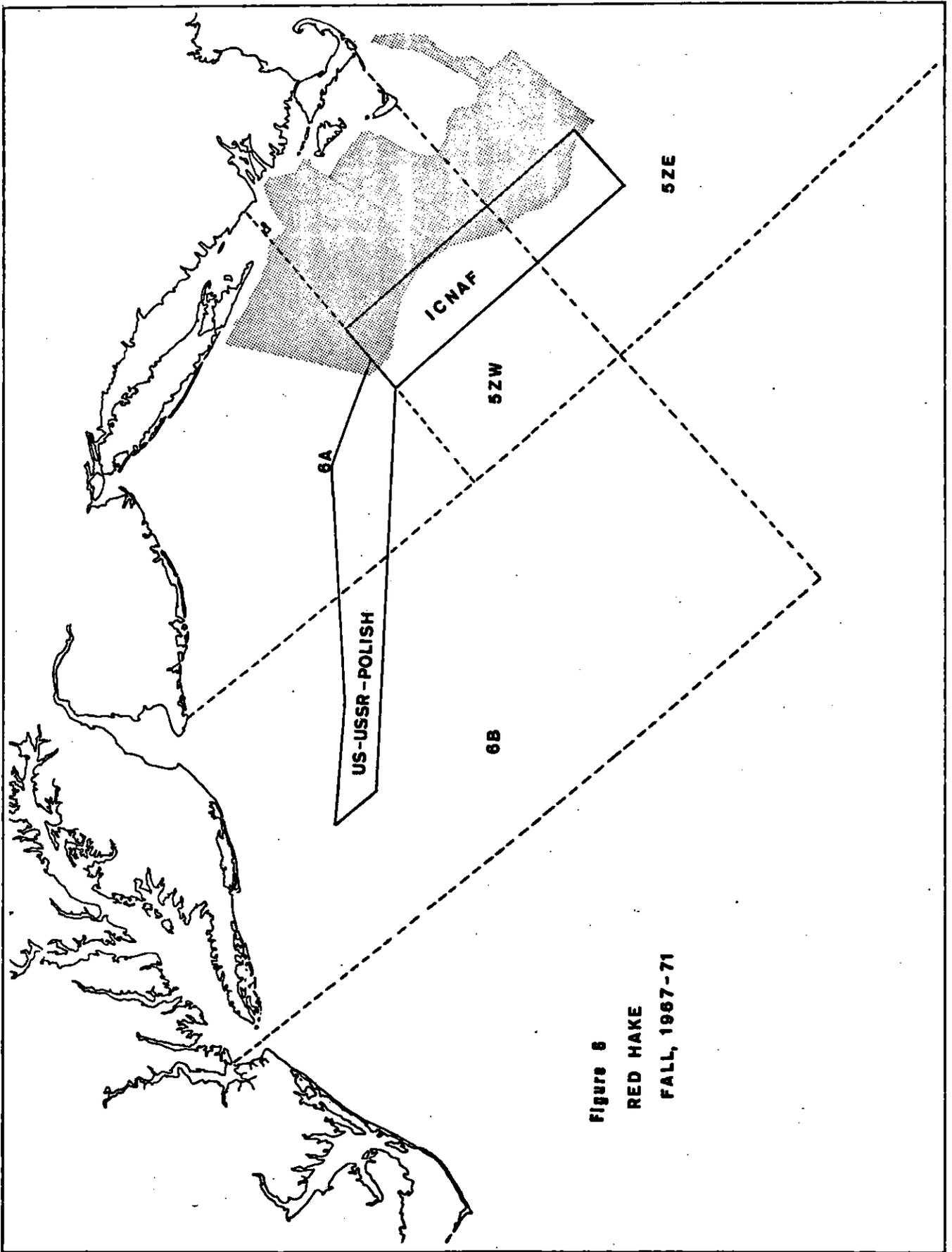


Figure 6
RED HAKE
FALL, 1967-71

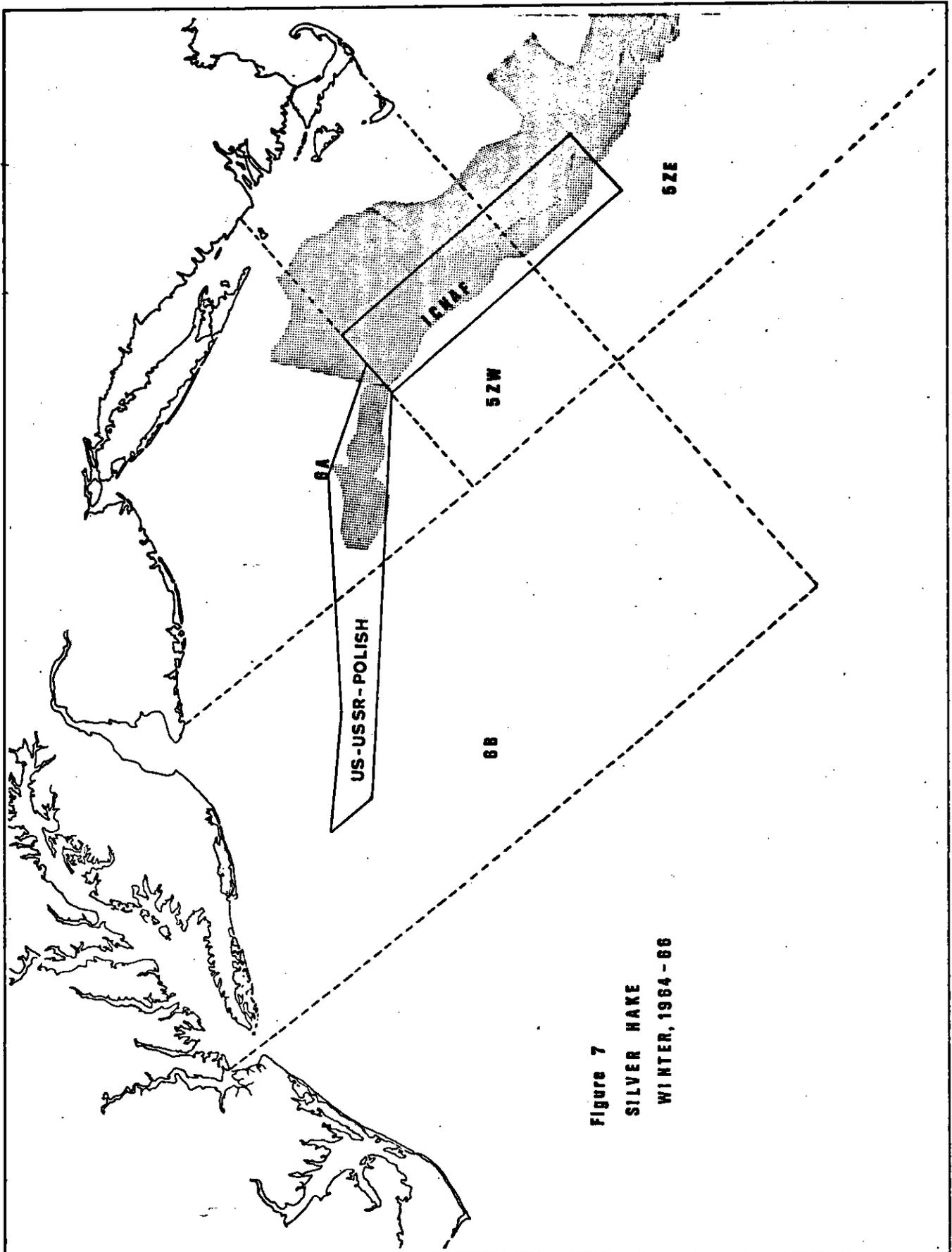


Figure 7
SILVER HAKE
WINTER, 1964 - 66

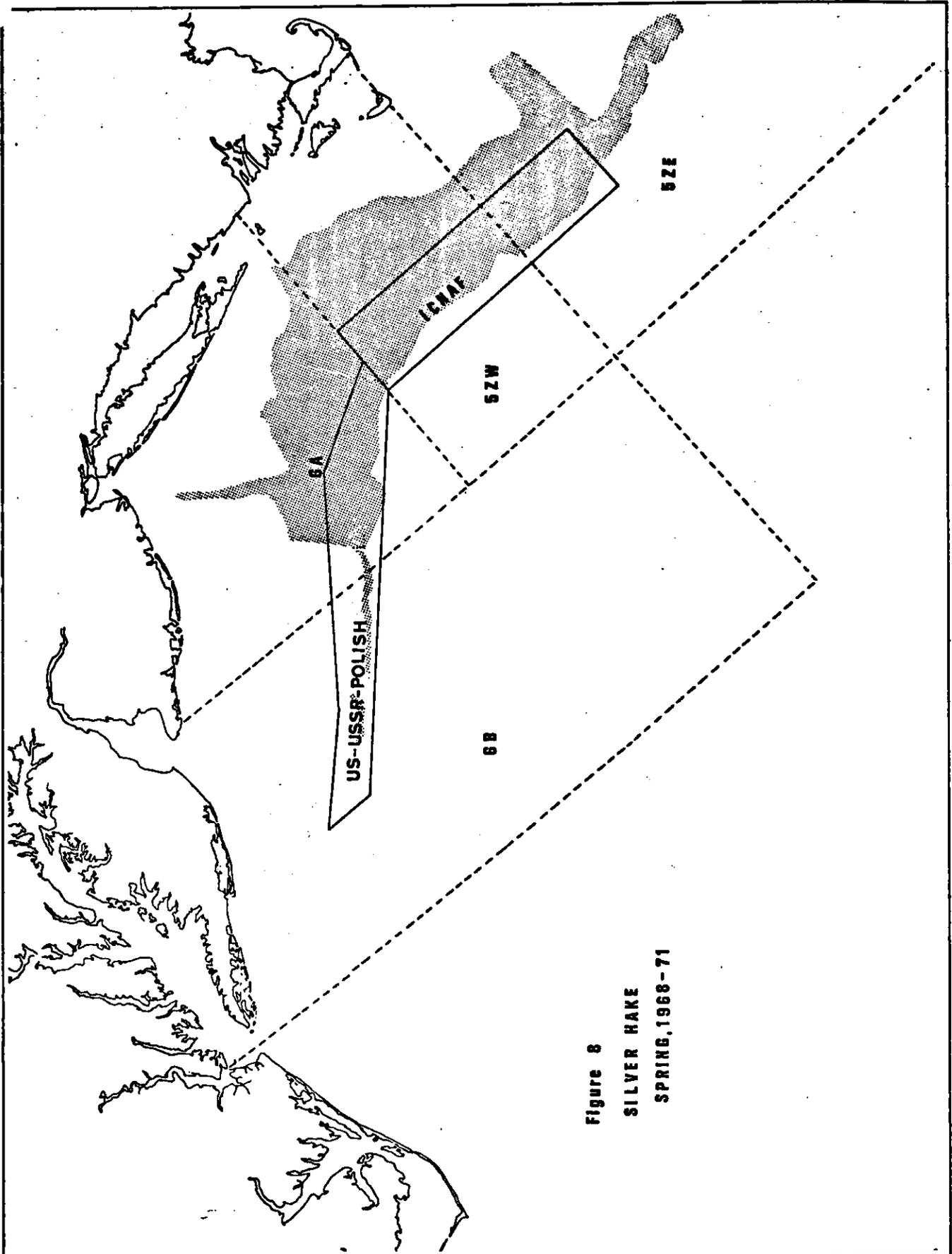


Figure 8
SILVER HAKE
SPRING, 1968-71

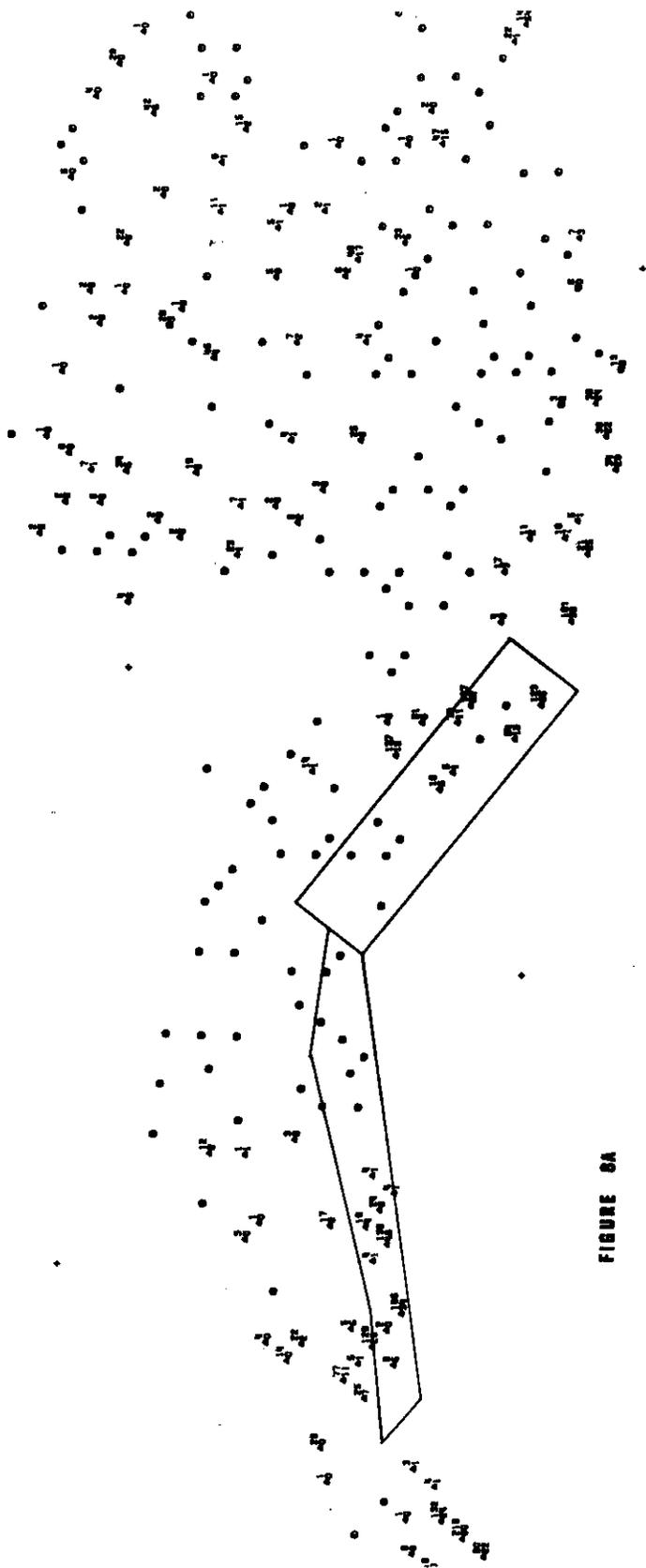


FIGURE 9A

SILVER HAKE
SPRING
MARCH 9 - MAY 1, 1971

072 71 711

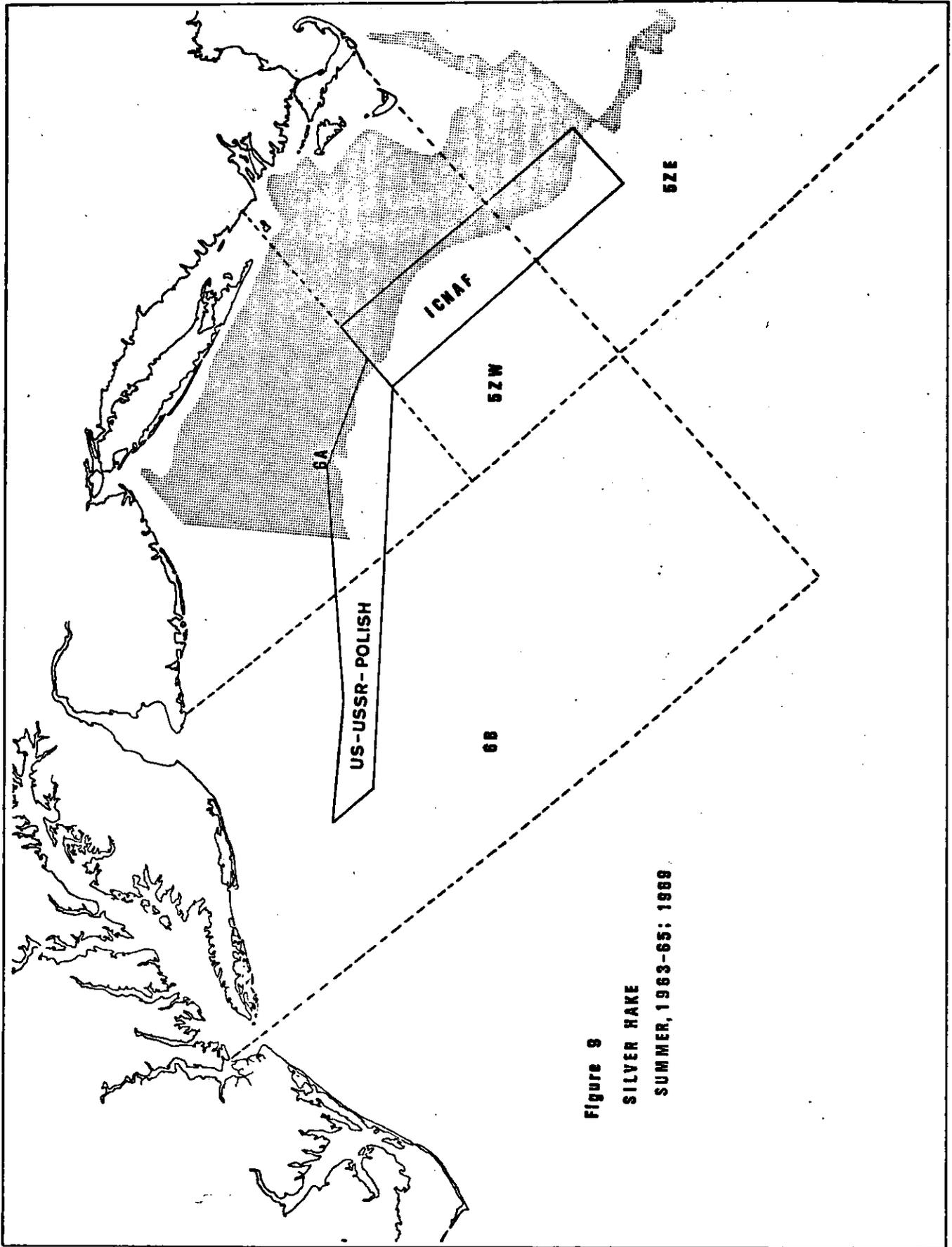


Figure 9
SILVER HAKE
SUMMER, 1963-65: 1969

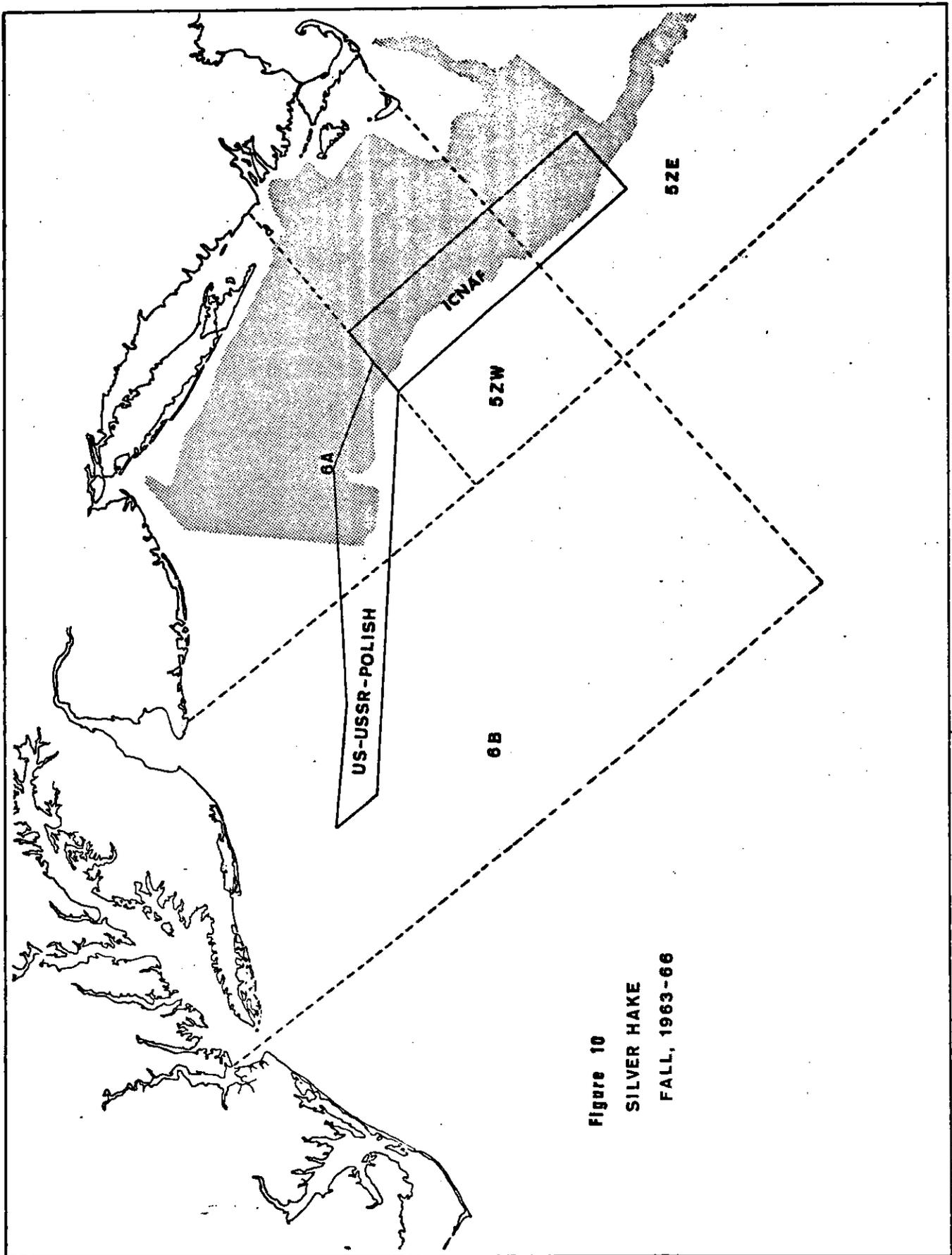


Figure 10
SILVER HAKE
FALL, 1963-66

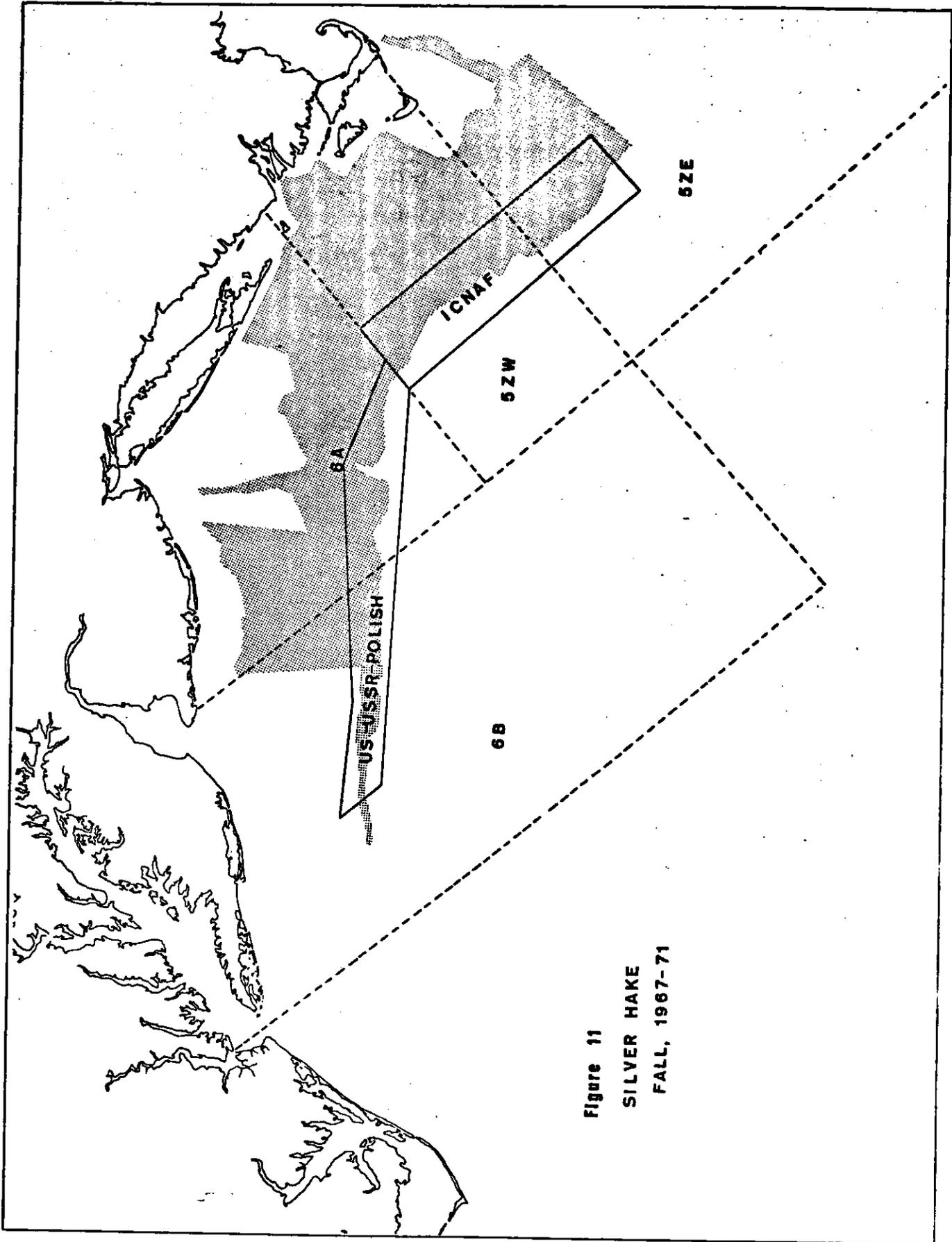


Figure 11
SILVER HAKE
FALL, 1967-71