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A preliminary analysis of the status of butterfish in ICNAF Subarea 5 and Statistical Area 6

by

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Introduction

Agreements by ICNAF member nations to reduce overall fishing effort in ICNAF Areas 5 and SA6 has resulted in the enactment of total allowable catch (TAC's) quotas for species grouped under ICNAF's "other fish" category.

The butterfish, *Peprilus tricanthus* (Peck), one of the species included in the "other fish" category is the subject of the present paper. This paper provides a summary of landing statistics, commercial and survey length frequencies, age and growth analysis, and relative abundance indices for ICNAF Subarea 5 and Statistical Area 6.

Biology of the species

The butterfish, *Peprilus tricanthus* (Peck), occurs along the east coast of North America from Newfoundland to Florida (Hildebrand and Schroder, 1928), and is commercially important between Cape Hatteras and Southern New England.

Catches in *Albatross IV* 1968-73 autumn bottom trawl surveys (Strata 1-12, 61-76 combined) (Figure 1) indicate a northerly and shoalward distribution of butterfish in the summer and autumn (Figures 2-8). Spring catches in *Albatross IV* 1968-74 bottom trawl surveys indicate that butterfish tend to concentrate on the outer shelf. This species feeds primarily on copepods, small fish, annelids, and squid. Seasonal distribution patterns of squid, *Loligo pealei*, are very similar to butterfish (Tibbets, 1975), and thus squid would be a continuous food source throughout its range.

Spawning takes place chiefly during the summer months, with the height of the reproductive season being July (Hildebrand and Schroder, 1928). Preliminary data from standard bongo net and neuston tows aboard *Albatross IV* research cruises indicate butterfish larvae are confined to waters south of Southern New England, *i.e.* south of Strata 9 (Figure 1). These cruises were during August-September 1968-72.

Age and growth

Four age groups were observed (Table 2) from readings of butterfish otoliths taken from 1974 autumn *Albatross IV* surveys utilizing a new aging technique of reading thin sections (Anderson and Nichy, 1975).

The von Bertalanffy growth equation fit using the Tomlinson-Abramson technique (Calif. Dept. Fish and Game Bull. No. 116, 1961) is given in Figure 9.

The estimated parameters are L_∞ = 21.2 cm, K = 0.446, and t_0 = -1.2.

A length-weight equation was estimated by least squares linear regression (Figure 10) to be

Log W = log .01074 + 3.2276 log L

The coefficient of determination was 96.1%.

Commercial fishery

The butterfish landings were entirely from US fishermen during the period 1920-63 for ICNAF Subarea 5 and SA6. The landings during this period averaged 3,500 MT per year and revealed no significant trends for the fishery (Figure 11). Since 1963, when distant water fleets first began catching butterfish, US landings steadily declined, reaching a 40-year low of 819 MT in 1972. US 1973 landings increased twofold to 1,561 MT, but well below the historical average of 3,500 MT (Figure 12).

Catch statistics from countries other than the US were first reported in 1963 (USSR). Nations other than USSR began reporting catches in 1967 (Table 1, Figure 13). From 1963-1968, total landings averaged 5,350 MT. In 1969, total landings reached 13,530 MT (chiefly as a result of USSR butterfish catches of 12,180 MT). The average yearly landings in the period 1969-1973 was 12,143 MT. Japan took the major portion of the catch after 1969.

Reported landings for all nations declined to 6,476 MT in 1972, but increased threefold to 19,459 MT in 1973.

Butterfish nominal catch statistics as reported to ICNAF have not been received from Spain or Italy, but it is likely that they take significant by-catch of butterfish in the squid fishery.

US butterfish landings from ICNAF Subarea 5 are predominantly in 5Zw; Pt. Judith, Rhode Island, fishermen land the majority of the catch. Butterfish are part of a mixed fishery, being taken in the food and industrial fisheries with a variety of species such as squid, scup, flounders, skates, and red hake. SA6 landings are primarily from the food fishery, but Pt. Judith trawlers from the industrial fishery take butterfish in area labeled 613 in Figure 14.

US landings are primarily from a coastal fishery, with landings peaking in the fall of the year when butterfish move into shoal waters (Figure 13). The landings from ICNAF Division 6A at Pt. Judith were combined with 5Zw landings, since the Pt. Judith vessels do fish on occasion both areas during the same trip, and as stated earlier, fish in the area in SA6 immediately adjacent to 5Zw.

Japanese butterfish catches were first reported in 1967 for ICNAF Division 5Z and SA6. The major portion of the catch during the period 1967-73 is from SA6. The 1973 SA6 catches of 9,882 MT are the highest reported since 1967, and 2.37 times greater than the average (4,170 MT) for the stated period. Japanese catches are primarily taken in the period January-May.

USSR catches in Subarea 5 for the period 1963-73 have averaged 1,965 MT, primarily as a result of their 1969 catches of 9,479 MT (Table 1).

USSR SA6 catches show large yearly fluctuations, and 1973 catches of 982 MT are 1.82 times greater than the 11-year average of 511 MT.

Length composition of landings

US length frequency samples are available from the Pt. Judith food and industrial fisheries for the years 1974 and 1975 (Figures 15-16).

Length frequency samples from the food fishery indicate landings are primarily of fish between 16 and 18 cm, composing the 2- and 3-year age groups. Industrial samples indicate 1-year olds along with 2's and 3's are taken in the catch.

The small proportion (<1%) of fish below 12 cm in the food fishery length frequency samples compared to 18% in the industrial samples may be explained by two interacting factors. First, marketability size in the food fishery may result in the discard of undersize fish; and second, mesh size in the industrial fishery is 66 mm compared to 74-114 mm for trawlers in the food fishery.

Japanese length frequency samples as submitted to ICNAF 1971-74 are summarized in Figures 17-20. The most significant trend in the Japanese samples is the steady decline in numbers of fish greater than 20 cm, and a corresponding increase in numbers of fish less than 12 cm. In the 1971 samples, 10.2% were 20 cm or greater, versus less than 0.1% in 1974, while fish 12 cm or less composed 8.9% and 19.4% of the 1971 and 1974 samples, respectively. This trend indicates that butterfish are now being recruited into the fishery at age 1, and the fishery is supported by age group 1-3.

Commercial fisheries abundance indices

Catch/effort indices were calculated using US vessels from Pt. Judith, Rhode Island, landing at least 10% of their catch as butterfish. Catch and effort data (1968-71) was available for Japan from the 1973 Japanese research report (ICNAF Redbook 1973, Part II) for the years 1968-71, and obtained from ICNAF Statistical Bulletin, Vols. 22-23, Table 6, for 1972-73. In the latter case the category "other pelagics" was assumed to be butterfish. The results are given in Table 6.

US indices for Subarea 5 and SA6 individually and combined have steadily declined during the period 1968-73, but showed a marked improvement in 1974, up 50% from the previous year. Japanese indices in Subarea 5 and SA6, and in 5 + 6 combined, have been fluctuating since 1968, showing no clear trend for the fishery (Table 6).

Research vessel survey abundance indices

Stratified mean Ln (n + 1) lbs per tow of butterfish for *Albatross IV* and USSR autumn, and *Albatross IV* spring bottom trawl surveys do not indicate any significant trends since 1967 (Figure 23). Gear comparison studies aboard *Albatross IV* and USSR research vessels (1973-74) give a mean catch ratio of 2.23, in terms of weight over three cruises, for the modified Yankee #41 trawl to the standard #36 trawl. This factor was applied to *Albatross IV* spring 1973-74 catch/tow (lbs) to adjust the indices (Figure 23), making them comparable to previous years when the #36 trawl was used in spring bottom trawl surveys (Bowman, 1975). Diel differences in catches were also observed for butterfish in these studies (Table 3).

Survey cruise length frequencies

Length frequency data from *Albatross IV* and USSR autumn, and *Albatross IV* spring bottom trawl surveys (1968-74) are shown in Figures 21 and 22. Prior to the autumn 1971 surveys, comparatively few fish <11 cm (age 0-1) were taken in the tows. The size composition of the autumn 1971 surveys indicates that a strong incoming year class in 1971 is entering the fishery, assuming $\leq$ 9.4 cm to be young-of-the year (Table 4). The relative strength of the 1971 year class is indicated by appearance and progression of length group in length frequency data for 1972-74.

Young-of-the-year index

An estimate of relative year class strength of young-of-the-year (YOY) was determined from *Albatross IV* and USSR autumn surveys for 1968-74 (Table 4) by summing the mean stratified numbers per tow for lengths $\leq$ 9.4 cm (Strata 1-12, 61-76, combined) for each cruise.

The 1971 YOY index was the highest for a seven-year period starting with 1968, and 1972 YOY was correspondingly the smallest.

Stock size

Survey cruise data can be used to provide a minimum estimate of stock size, according to the following equation:

$$\hat{B} = \frac{(A)\ (\bar{W})}{\alpha} \qquad (1)$$

where $\hat{B}$ = biomass estimate

$\bar{W}$ = stratified mean wt/tow

A = area covered by the groundfish survey (sq miles)

α = area swept by each ton (0.011 sq. miles)

The estimate of minimum stock size was modified using the following equation, and data contained in Table 4.

$$\hat{B}' = \left(\frac{\Sigma\ D_c}{\Sigma\ D_{tow}} \Big/ \frac{\Sigma\ D_c + N_c}{\Sigma\ D_{tow} + N_{tow}} \right) (\hat{B})\ (C) \qquad (2)$$

where D_c = day catch

N_c = night catch

D_{tow} = total number of day tow

N_{tow} = total number of night tow

C = catch ratio of 41 to 36 trawl for butterfish

The estimates from (1) and (2) of minimum stock size are shown in Table 5. The average of the estimates from (2) was 93000 MT with a range of 37000 to 252000 MT. If the highest value is eliminated the average is 60000 MT.

Length and age at recruitment

Available data suggest butterfish are partially recruited at age 1 (9.6 to 14.0 cm) and fully recruited into the US and Japanese fisheries at age 2 (13.5 to 18.7 cm).

Catch of small fish (less than 12 cm) has increased with increasing catches as witnessed by Japanese length frequency data for 1974.

Discussion

Age and growth studies supported by length frequency samples indicate the butterfish fishery is primarily supported by age groups 1-3.

While US landings have steadily declined since 1963, foreign catches since 1967 have continued to increase primarily as a result of Japanese butterfish catches in SA6. Catches of butterfish by nations only recently in the fishery contributed to record high catches of 19,454 MT in 1973.

The seasonality of the US fishery is indicated by the mean monthly landings 1963-74. The effect of distant water offshore fleets (fishing primarily for squid) on the availability of butterfish stocks in the shoal waters where the US fleet is concentrated is yet to be determined.

Survey cruise abundance indices and commercial abundance indices do not reveal any significant trends for the population. Expansion of survey cruise catches indicated a minimum stock size between 60000 and 90000 MT.

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Table 1. Butterfish landings (MT) for ICNAF Division 5 and Statistical Area 6 1963-74

Year	BUL	GDR	JAP	POL	ROM	USSR	USA	TOTAL
					5Y			
1963						110	74	184
1964							27	27
1965							37	37
1966							52	52
1967							44	44
1968							37	37
1969							33	33
1970							20	20
1971							20	20
1972						83	24	107
1973				81			3	84
1974							2	2
					5Ze			
1963						712	99	811
1964						68	38	106
1965						293	41	334
1966						1546	21	1567
1967						562	30	592
1968			164			648	27	839
1969			960			702	74	1736
1970			846			70	17	933
1971		1	550			61	8	620
1972	43	10	1107			138	2	1300
1973	82		610	2354	30	500	8	3584
1974							19	19
					5Zw			
1963						1067	2365	3432
1964						101	908	1009
1965						439	984	1423
1966						2319	512	2831
1967			1			844	721	1566
1968			164			948	611	1723
1969	36		961			8777	637	10411
1970			877			326	354	1557
1971			423			232	387	1042
1972	53		289			214	97	653
1973	124	190	1680	155	26	852	508	3535
1974							1078	
					Statistical Area 6			
1963						111	1830	1941
1964						316	1630	1946
1965						17	2366	2383
1966						-	2010	2010
1967			144			764	1657	2565
1968			3198			315	1129	4642
1969			2010			1613	1694	5317
1970			6898			8	1478	8384
1971	25		4795			86	1151	6057
1972	18	24	2265			1413	696	4416
1973	33	6	9882	214	96	982	1043	12256
1974								

Table 2. Observed fork-lengths at age of butterfish; *Albatross IV* autumn 1974 -- Southern New England.

Age	Length-extremes observed	Number	Observed mean
I	96-140mm	44	123
II	135-187mm	49	169
III	173-195mm	12	188
IV	178-190mm	2	186

Table 3. Comparison of butterfish catches during joint US, USSR gear studies.

	Daylight			Darkness			Total lbs. caught daylight/ darkness	Catch ratio #41 to #36 trawl
	No. of 30-min. tows	Mean ave. catch/tow	Total lbs. caught	No. of 30-min. tows	Mean ave. catch/tow	Total lbs. caught		
Belogorsk 1973								
No. 36	20	8.5	170	20	0.2	5	175	2.9:1
No. 41	20	24.4	488	20	1.0	21	509	
Belogorsk 1974								
No. 36	18	9.9	189	18	0.1	3	192	1.3:1
No. 41	18	16.5	252	18	0.1	3	255	
Albatross 1974								
No. 36	18	11.7	211	18	0.4	8	219	2.5:1
No. 41	18	30.2	544	18	0.6	11	555	

Table 4. Young-of-Year-Index *Albatross IV* and USSR 1968-1974 fall groundfish surveys

Year	Stratified mean No's/tow ≤ 9.4 cm	
	Albatross IV	USSR vessel[1]
1968	3.30	13.61
1969	20.89	5.89
1970	1.11	0.23
1971	106.58	985.25
1972	0.78	25.68
1973	27.85	190.24
1974	10.06	14.10

[1] Gear was not standard throughout the surveys.

Table 5. Index of stock size for butterfish in combined Mid-Atlantic and Southern New England strata, *Albatross IV* fall surveys 1968-1974.

Year	First estimate of $\hat{B}$ 10^3 MT	Total correction factor	Final estimate $\hat{B}$ $X10^3$ MT
1968	58.14	4.33	251.75
1969	14.82	4.33	64.17
1970	8.54	4.33	36.98
1971	15.19	4.33	65.77
1972	8.94	4.33	38.71
1973	23.36	4.33	101.15

Table 6. 1968-73 catch and effort for butterfish in ICNAF Areas 5 and 6.

Area	Gear	Country	Year 1968	1969	1970	1971	1972	1973	1974
Subarea 5	Otter trawl	USA							
		Landings (MT)	312.3	146.5	181.6	112.4	43.2	342.6	588.3
		Effort (DF)	293.2	108.5	136.5	86.9	37.2	400.2	450.6
		C/E	1.07	1.35	1.33	1.29	1.16	0.86	1.31
		Japan							
		Catch (MT)	328.0	1291.0	1224.0	973.0	1396.0	2290.0	
		Effort (DF)	22.5	342.3	387.9	384.2	440.2	371.6	
		C/E	14.6	3.8	3.2	2.5	3.2	6.2	
SA 6	Otter trawl	USA							
		Landings (MT)	7.3	10.9	1.7	6.3	9.8	102.9	117.3
		Effort (DF)	9.5	9.8	8.1	8.4	8.3	42.6	37.6
		C/E	0.77	1.11	0.21	0.75	1.18	2.42	3.12
		Japan							
		Catch (MT)	3198.0	2010.0	6898.0	4795.0	2265.0	9882.0	
		Effort (DF)	169.0	359.3	671.3	538.2	598.8	860.3	
		C/E	18.9	5.6	10.2	8.9	3.8	11.5	
Total 5 + 6		USA							
		Catch (MT)	321.8	157.4	183.3	118.7	53.0	445.5	705.6
		Effort (DF)	302.7	118.3	144.6	95.3	45.5	442.8	488.2
		C/E	1.06	1.33	1.27	1.25	1.16	1.00	1.45
		Japan							
		Catch (MT)	647.8	3301.0	8122.0	5768.0	3661.0	12172.0	
		Effort (DF)	191.5	701.6	1059.2	922.4	1039.0	1231.9	
		C/E	3.38	4.70	7.67	6.25	3.52	9.88	

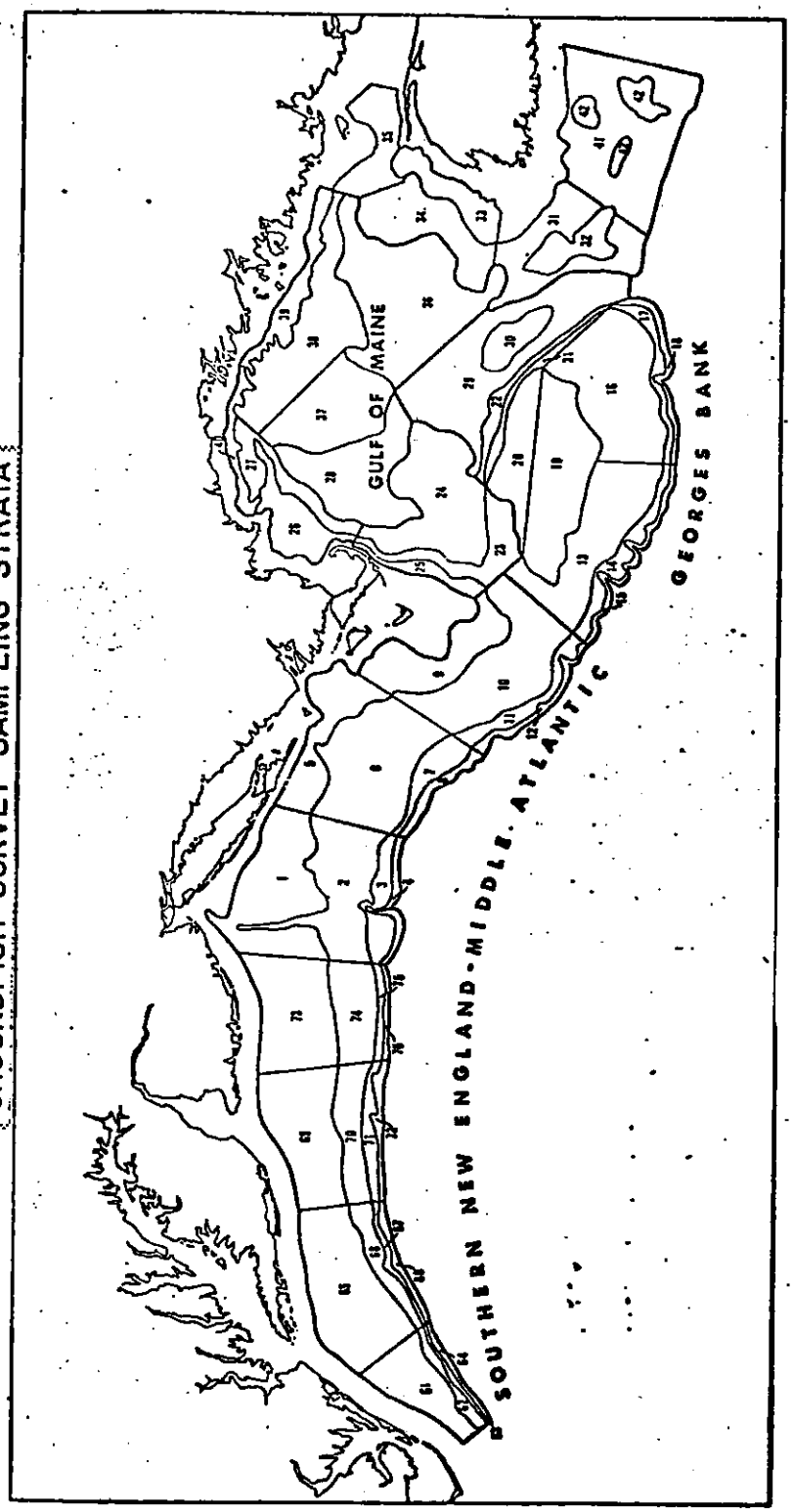

GROUNDFISH SURVEY SAMPLING STRATA
GULF OF MAINE
GEORGES BANK
SOUTHERN NEW ENGLAND-MIDDLE ATLANTIC

Figure 1

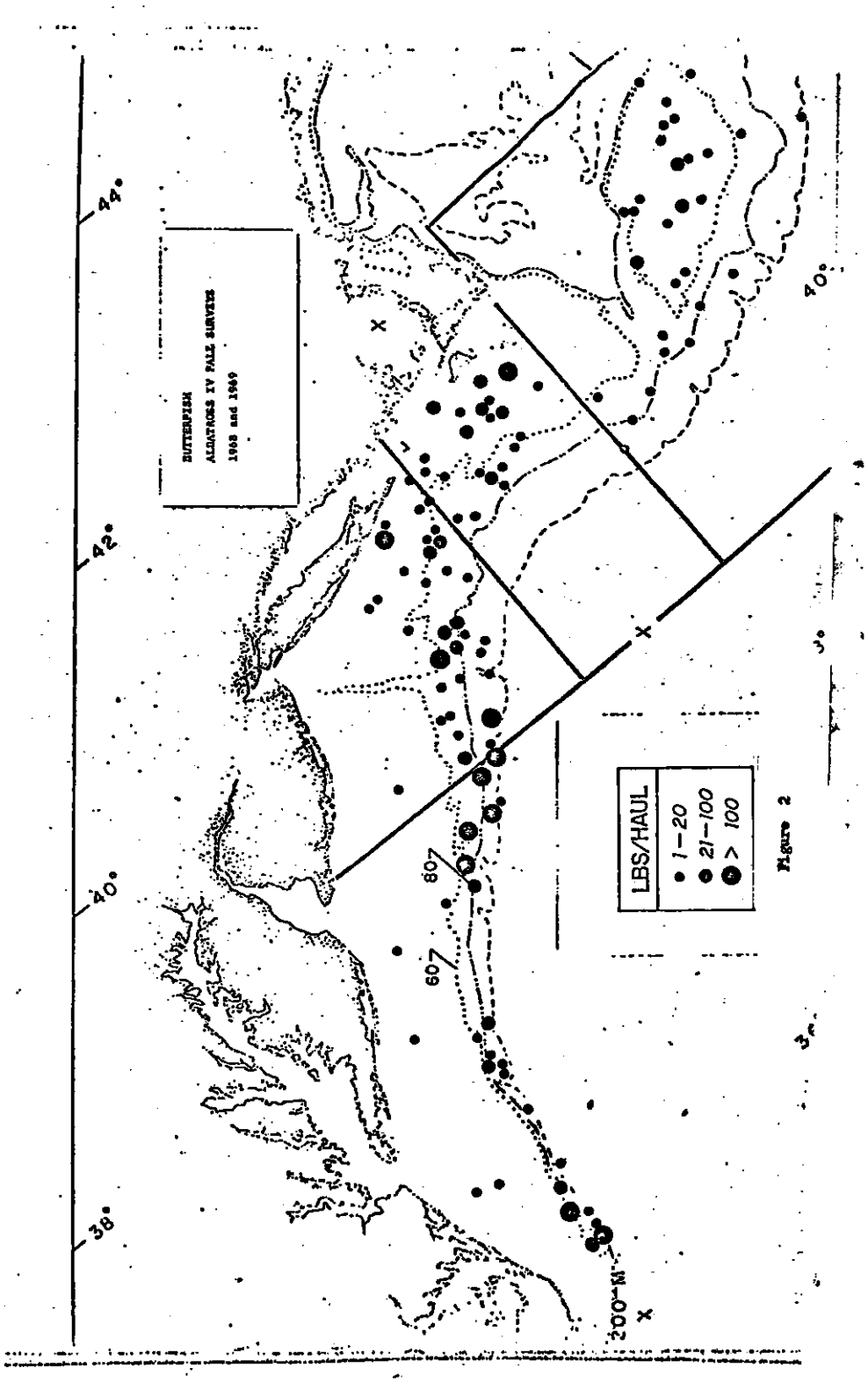

BUTTERFISH
ALBATROSS IV FALL SURVEYS
1968 and 1969
LBS/HAUL
• 1–20
● 21–100
● > 100
44°
42°
40°
38°
70°
60°
200 M

Figure 2

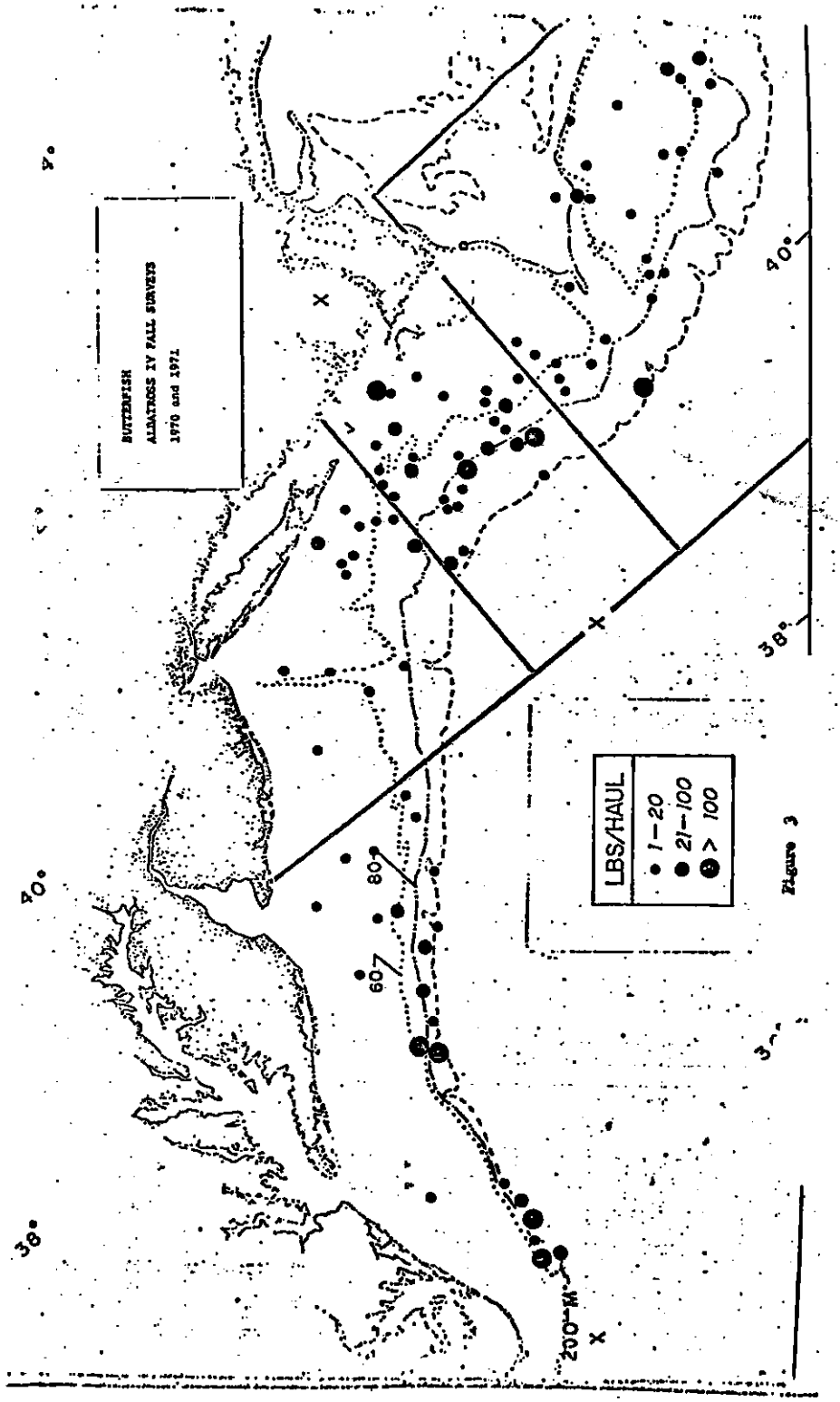

BUTTERFISH
ALBATROSS IV FALL SURVEYS
1970 and 1971
LBS/HAUL
1-20
21-100
> 100
40°
38°
80
60
200-M

Figure 3

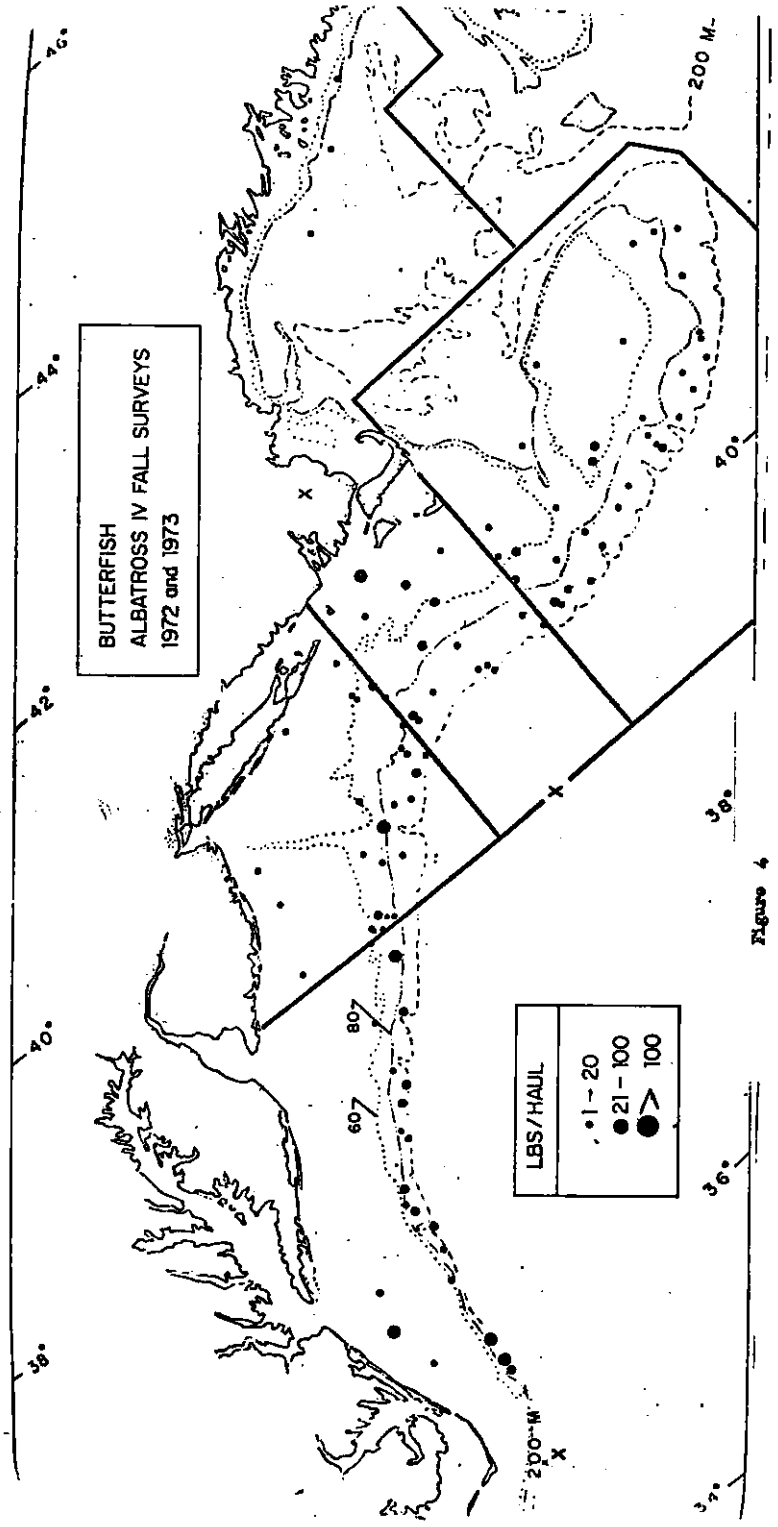
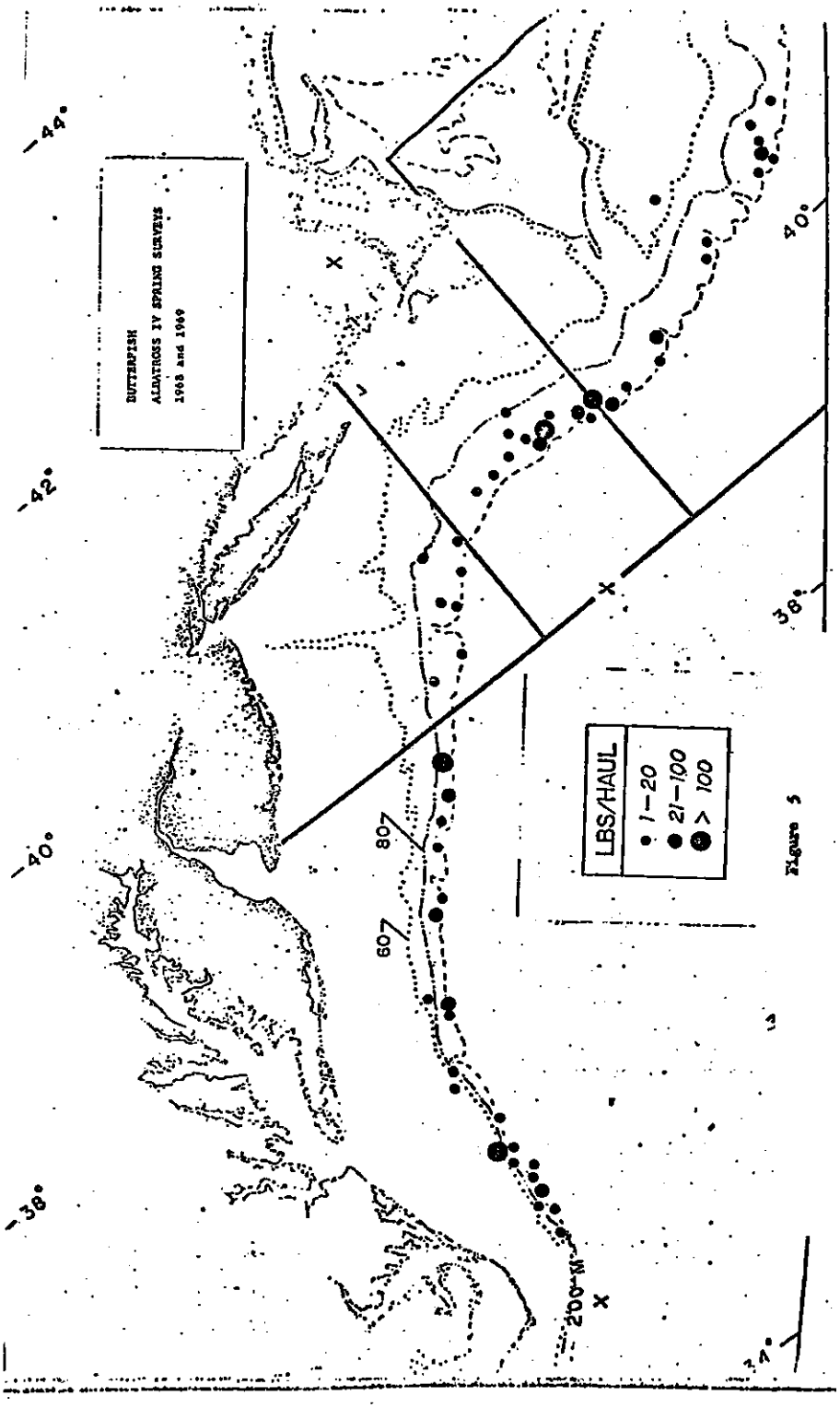

BUTTERFISH
ALBATROSS IV FALL SURVEYS
1972 and 1973
LBS/HAUL
1 - 20
21 - 100
> 100
200 M.
200 M.
80'
60'
44°
42°
40°
38°
36°
34°

Figure 4


BUTTERFISH
ALBATROSS IV SPRING SURVEYS
1968 and 1969
LBS/HAUL
1-20
21-100
> 100
-44°
-42°
-40°
-38°
40°
38°
80
60
200 M
Figure 5

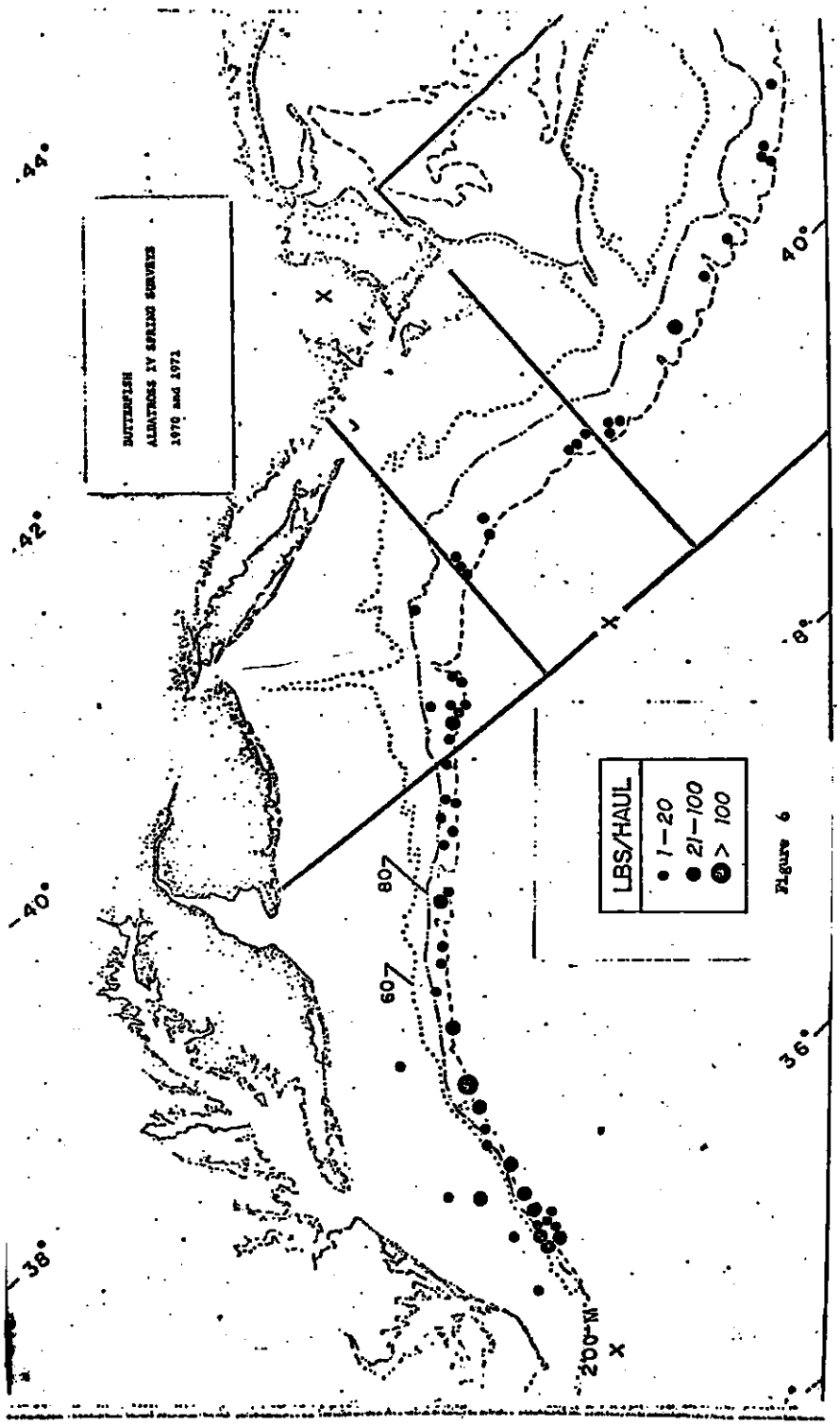

BUTTERFISH
ALBATROSS IV SPRING SURVEYS
1970 and 1971
LBS/HAUL
• 1–20
● 21–100
● > 100
44°
42°
40°
38°
36°
70°
68°
80
60
200 M

Figure 6

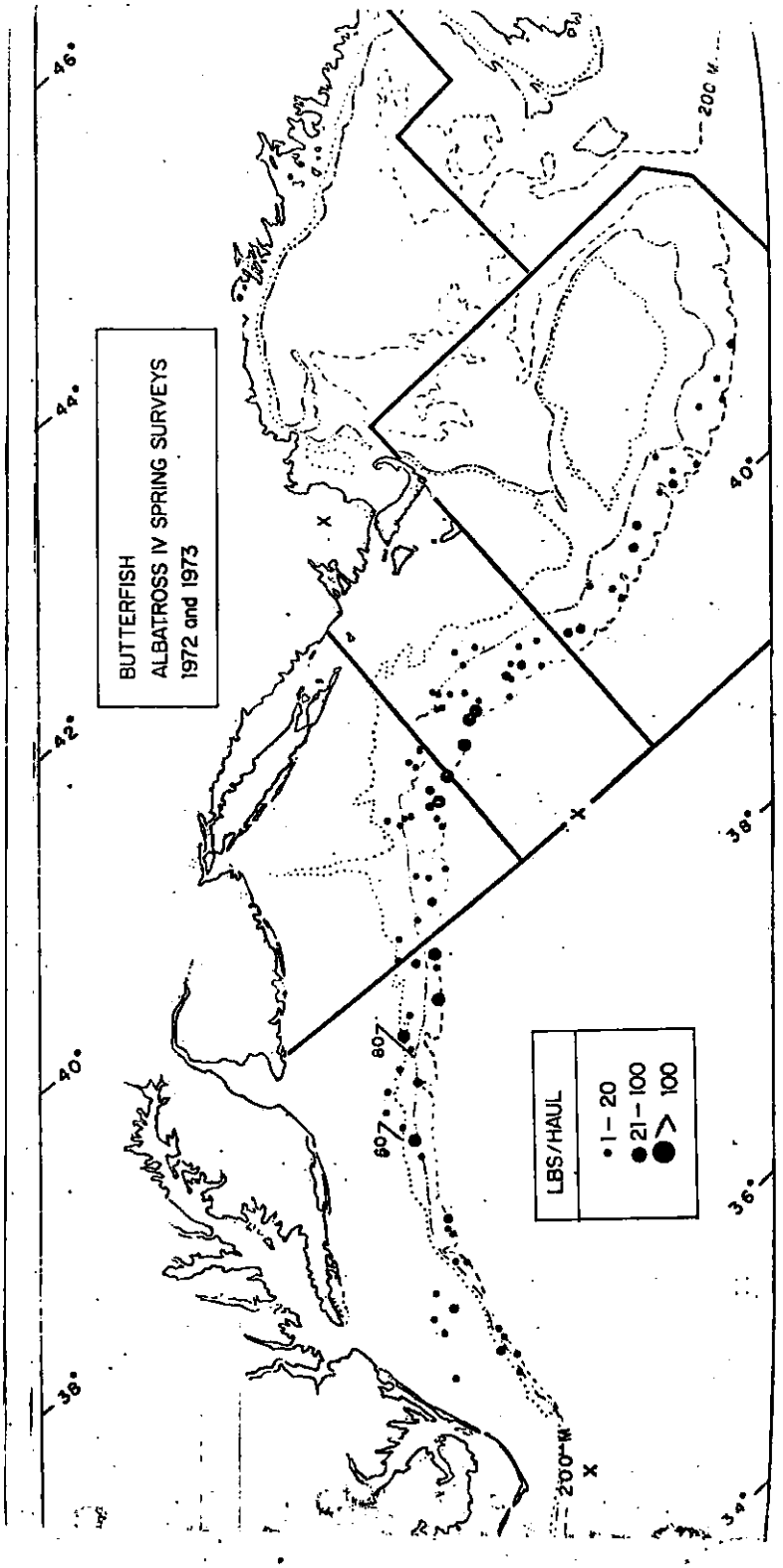

BUTTERFISH
ALBATROSS IV SPRING SURVEYS
1972 and 1973
LBS/HAUL
• 1 – 20
● 21 – 100
● > 100
46°
44°
42°
40°
38°
36°
34°
76°
74°
72°
70°
68°
66°
64°
200 M.
200 M.

Figure 7

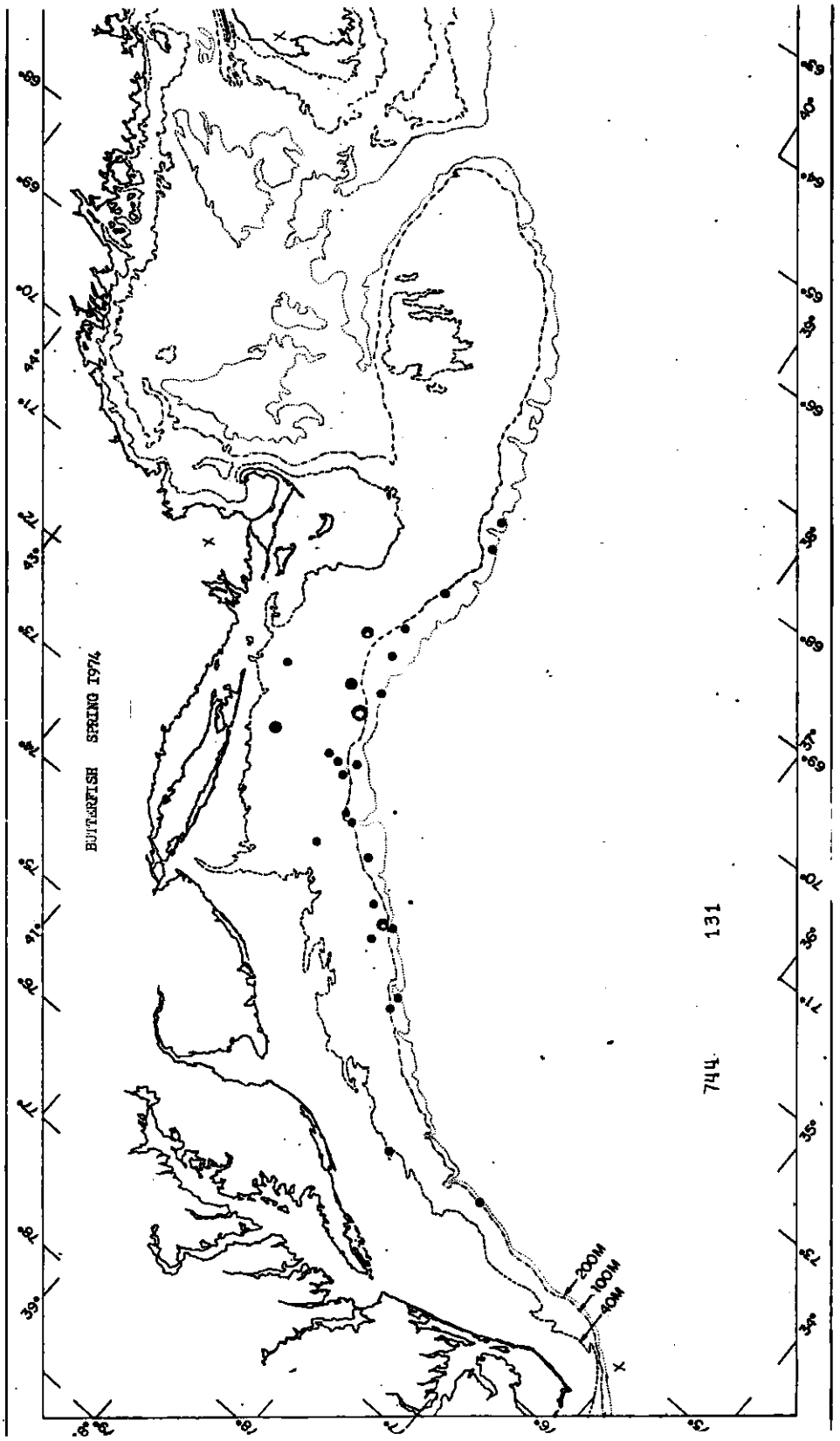


Figure 8

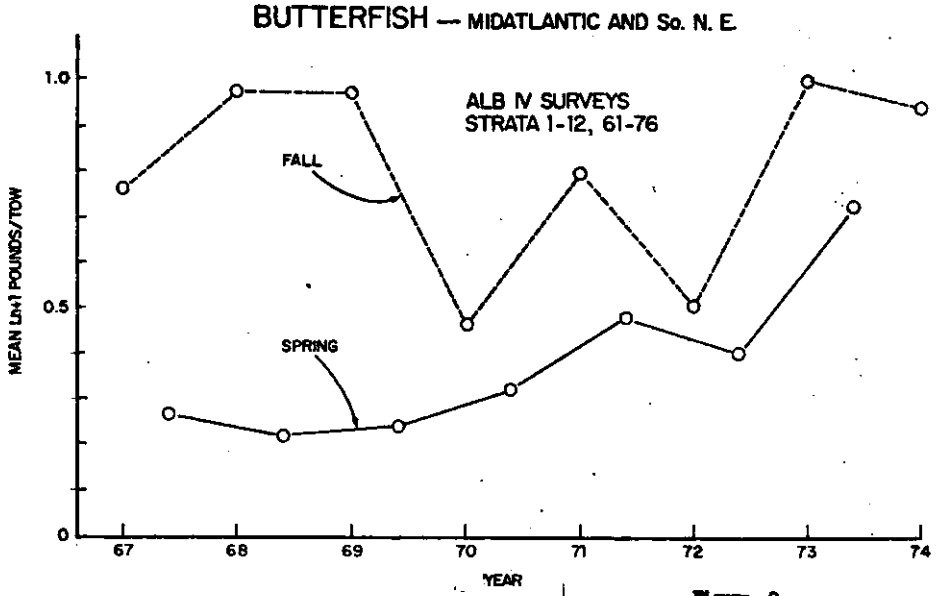


Figure 9

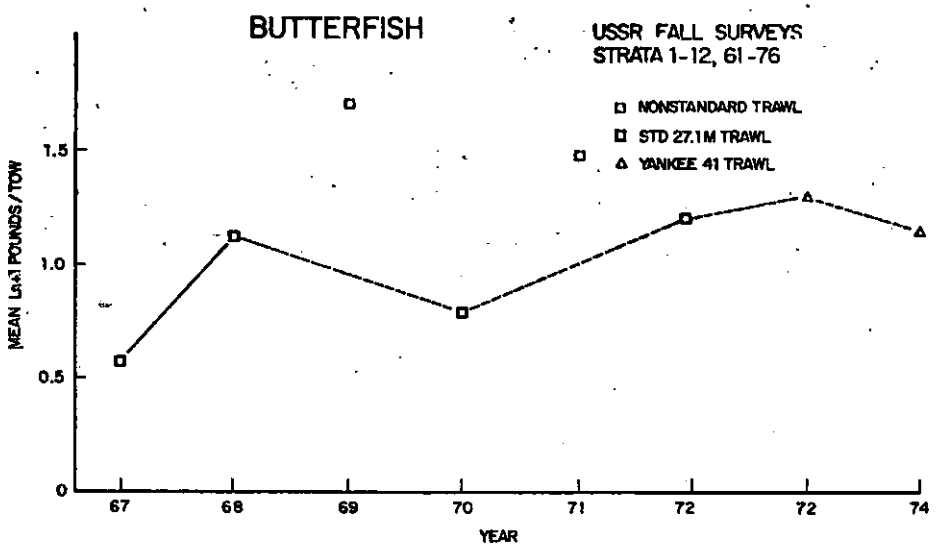


Figure 10

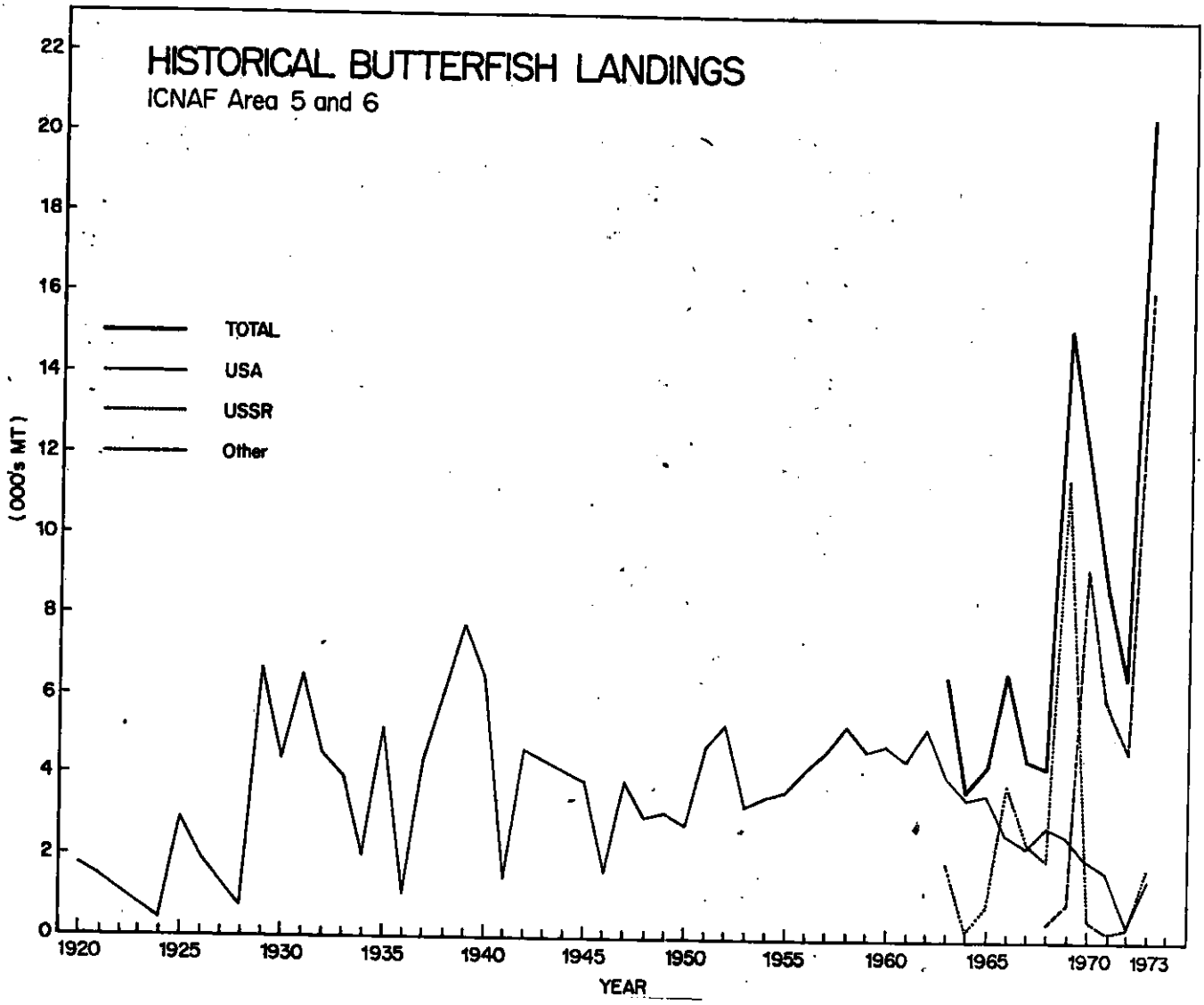
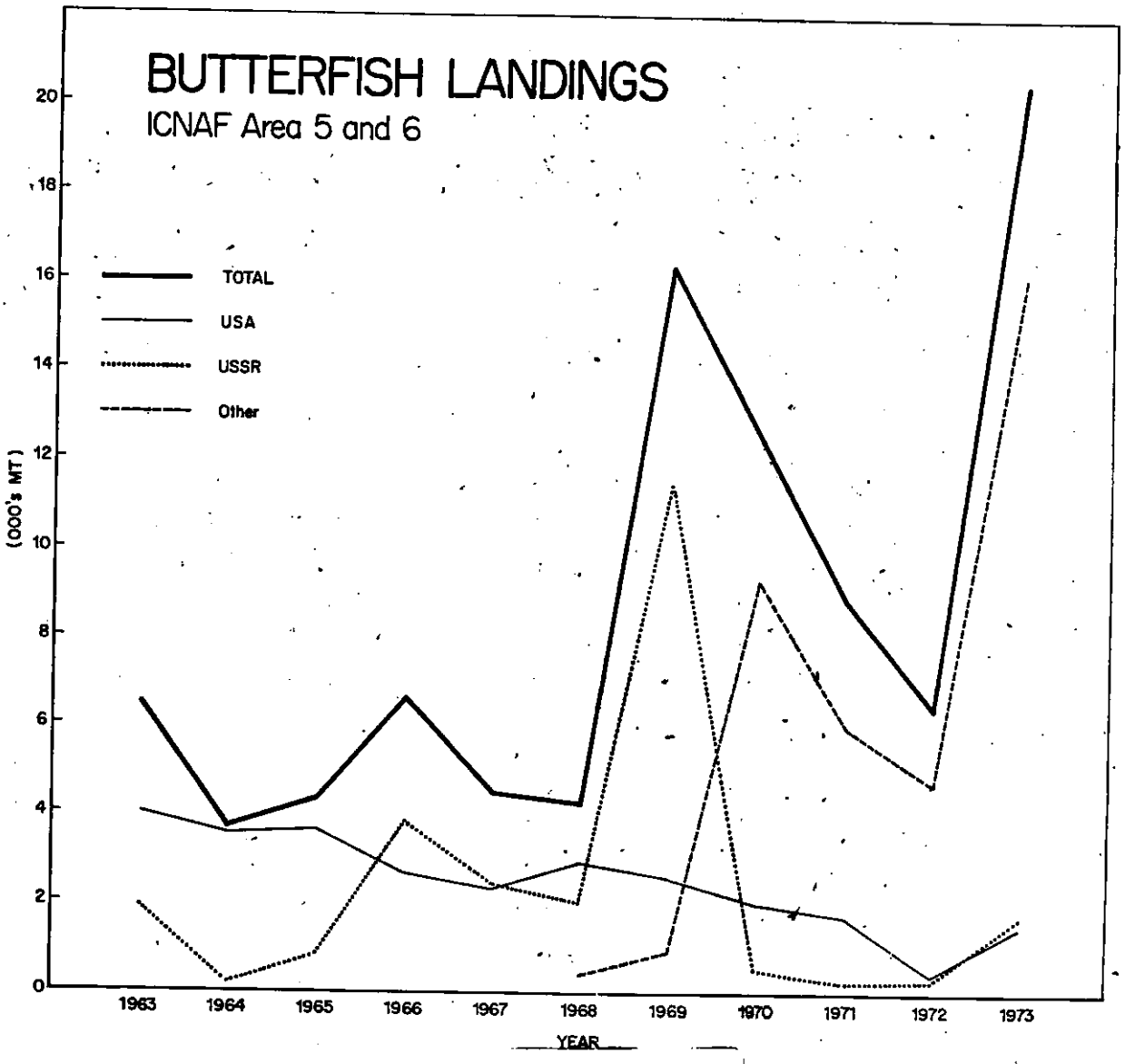

HISTORICAL BUTTERFISH LANDINGS
ICNAF Area 5 and 6
TOTAL
USA
USSR
Other
(000's MT)
YEAR
0
2
4
6
8
10
12
14
16
18
20
22
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1973

Figure 11


BUTTERFISH LANDINGS
ICNAF Area 5 and 6
TOTAL
USA
USSR
Other
(000's MT)
0
2
4
6
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1963
1964
1965
1966
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1968
1969
1970
1971
1972
1973
YEAR

Figure 12

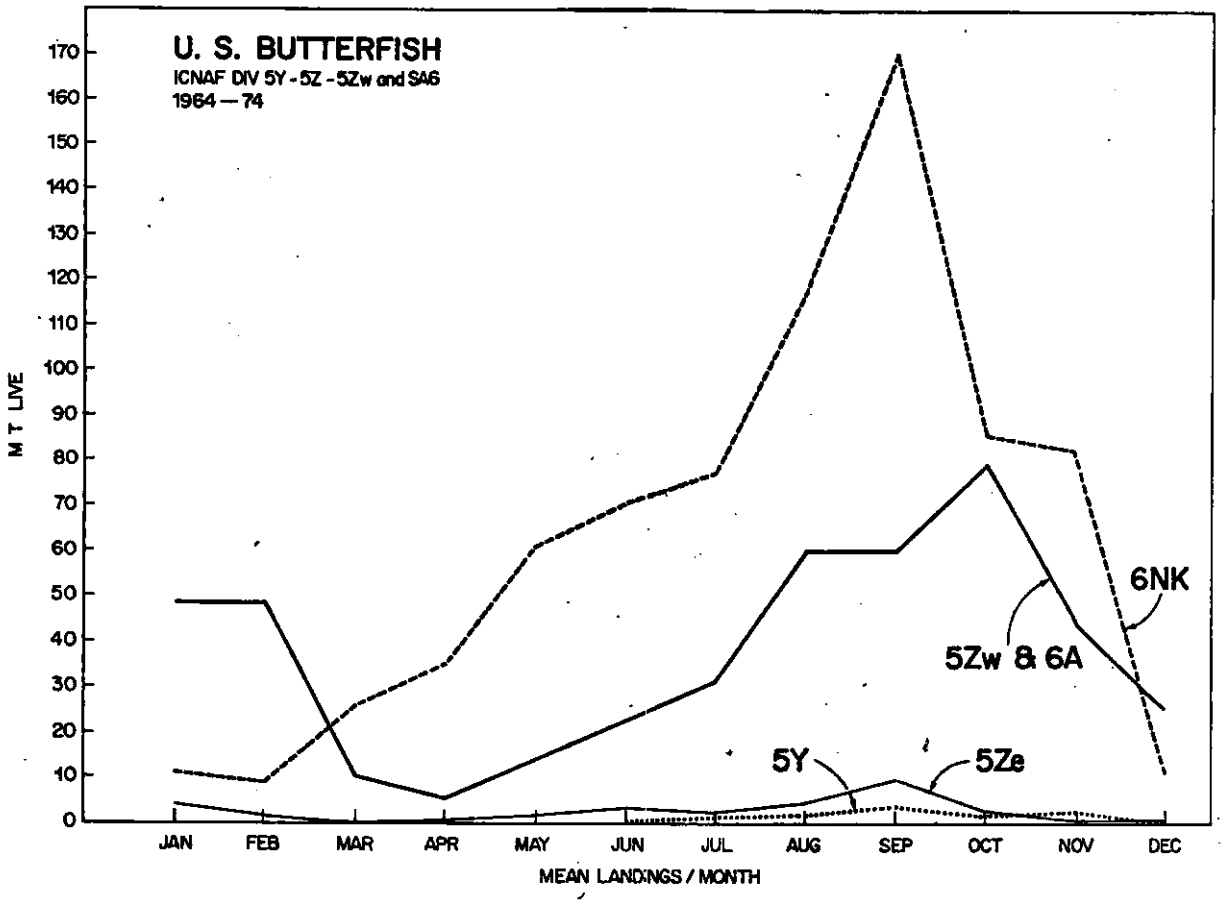

U. S. BUTTERFISH
ICNAF DIV 5Y - 5Z - 5Zw and SA6
1964 — 74
M T LIVE
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MEAN LANDINGS / MONTH
6NK
5Zw & 6A
5Y
5Ze

Figure 13

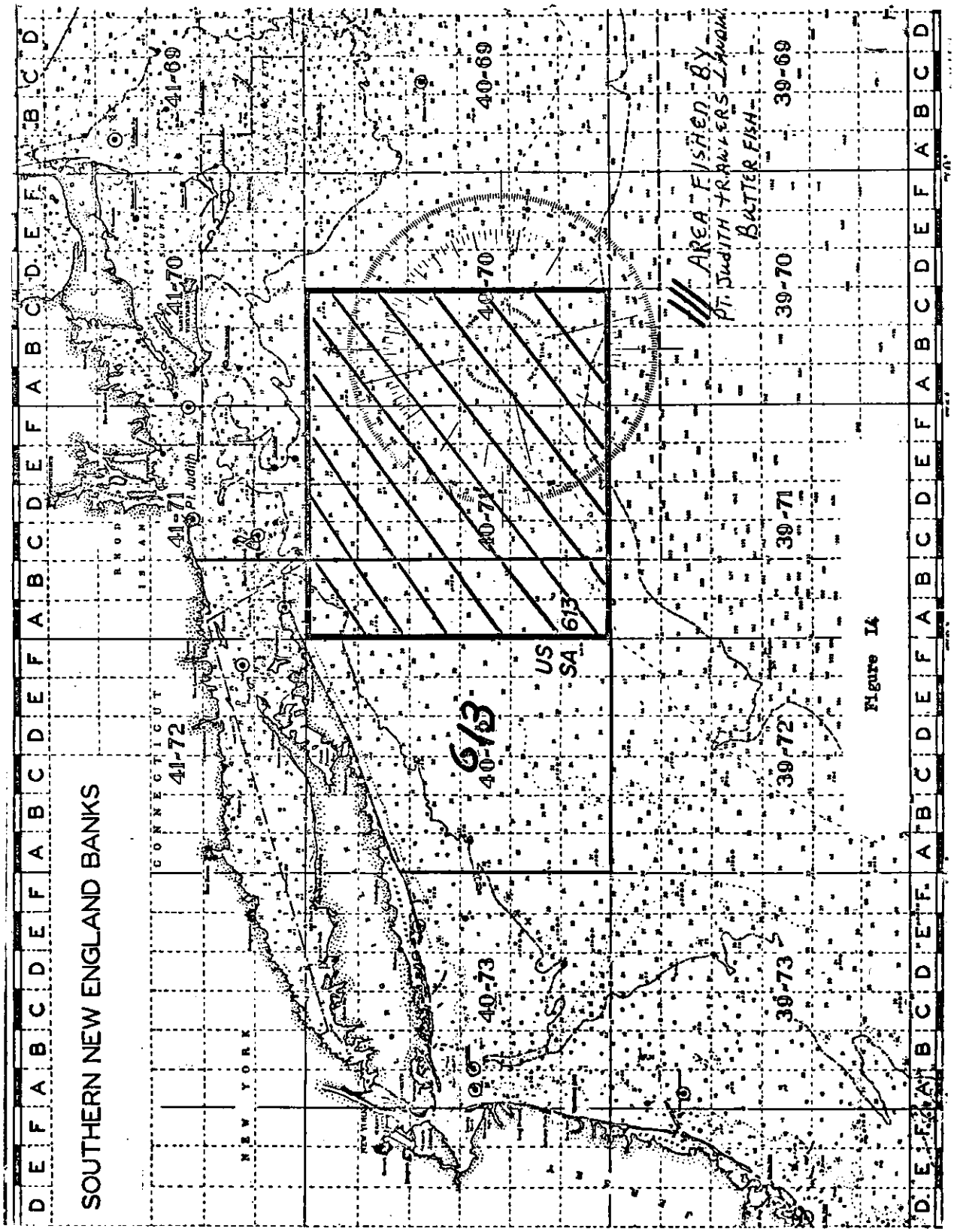

SOUTHERN NEW ENGLAND BANKS
AREA FISHED BY PT. JUDITH TRAWLERS
BUTTER FISH
613
US SA 613
CONNECTICUT
NEW YORK
Pt. Judith
41-69
41-70
41-71
41-72
40-69
40-70
40-71
40-73
39-69
39-70
39-71
39-72
39-73

Figure 14

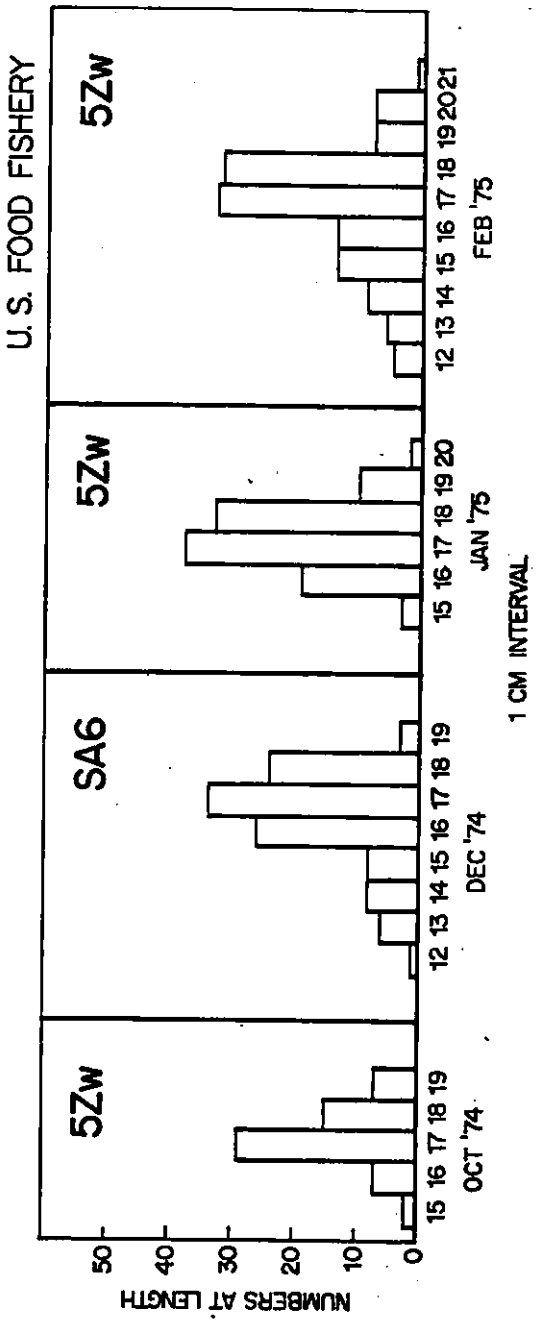


Figure 15

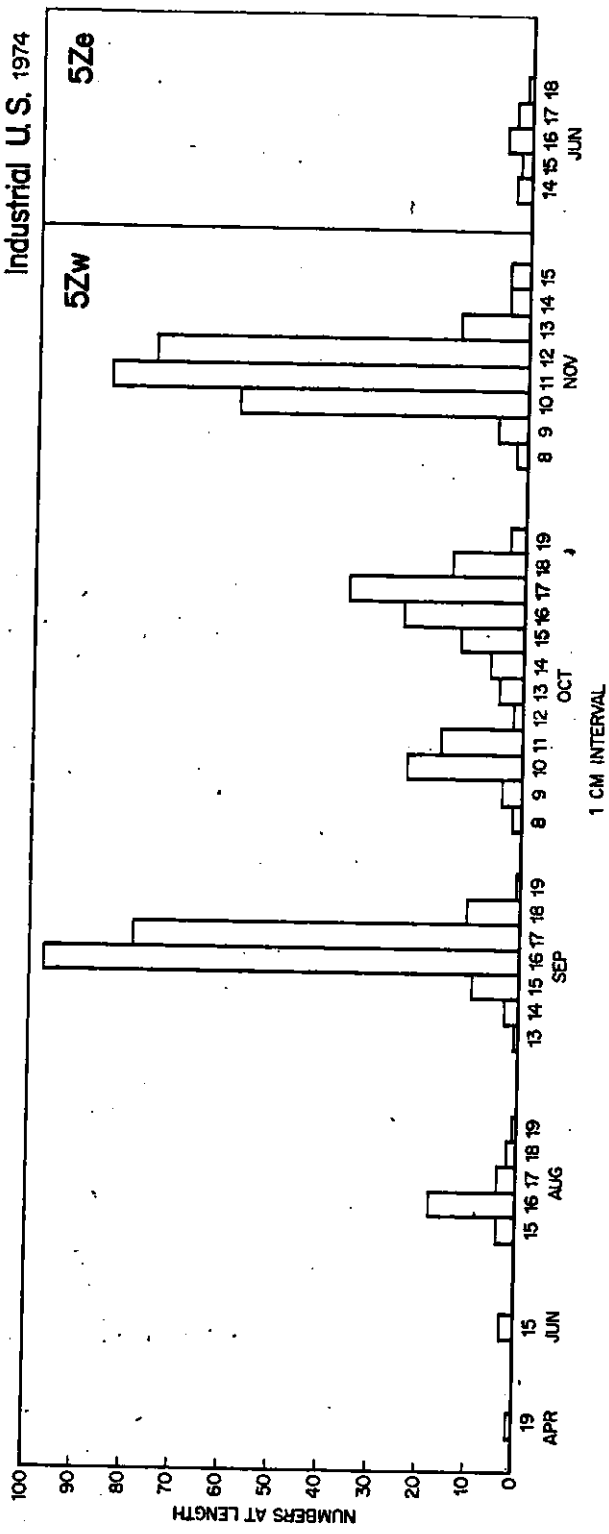


Figure 16

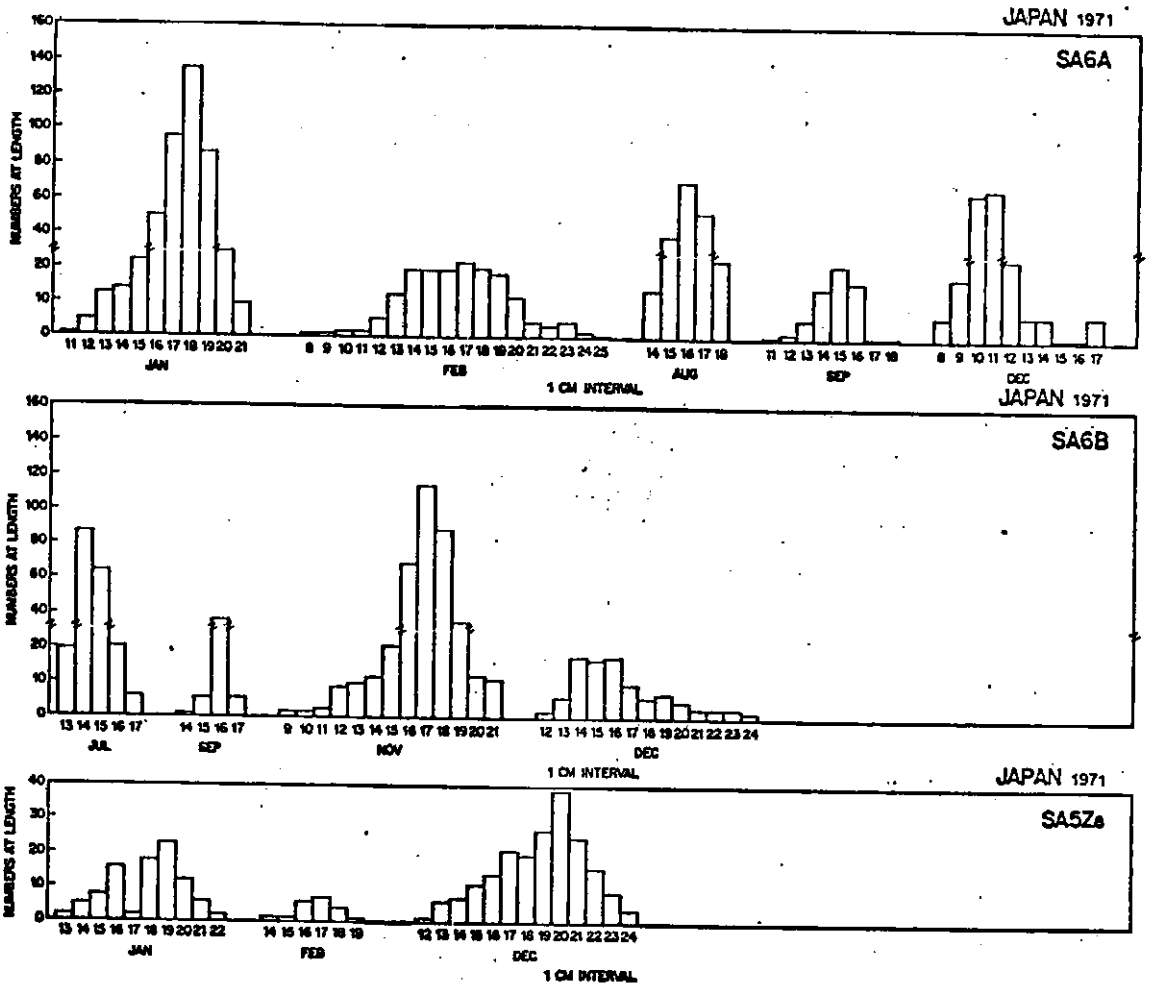

JAPAN 1971
SA6A
NUMBERS AT LENGTH
JAN
FEB
AUG
SEP
DEC
1 CM INTERVAL
JAPAN 1971
SA6B
NUMBERS AT LENGTH
JUL
SEP
NOV
DEC
1 CM INTERVAL
JAPAN 1971
SA5Zs
NUMBERS AT LENGTH
JAN
FEB
DEC
1 CM INTERVAL

Fig. 17

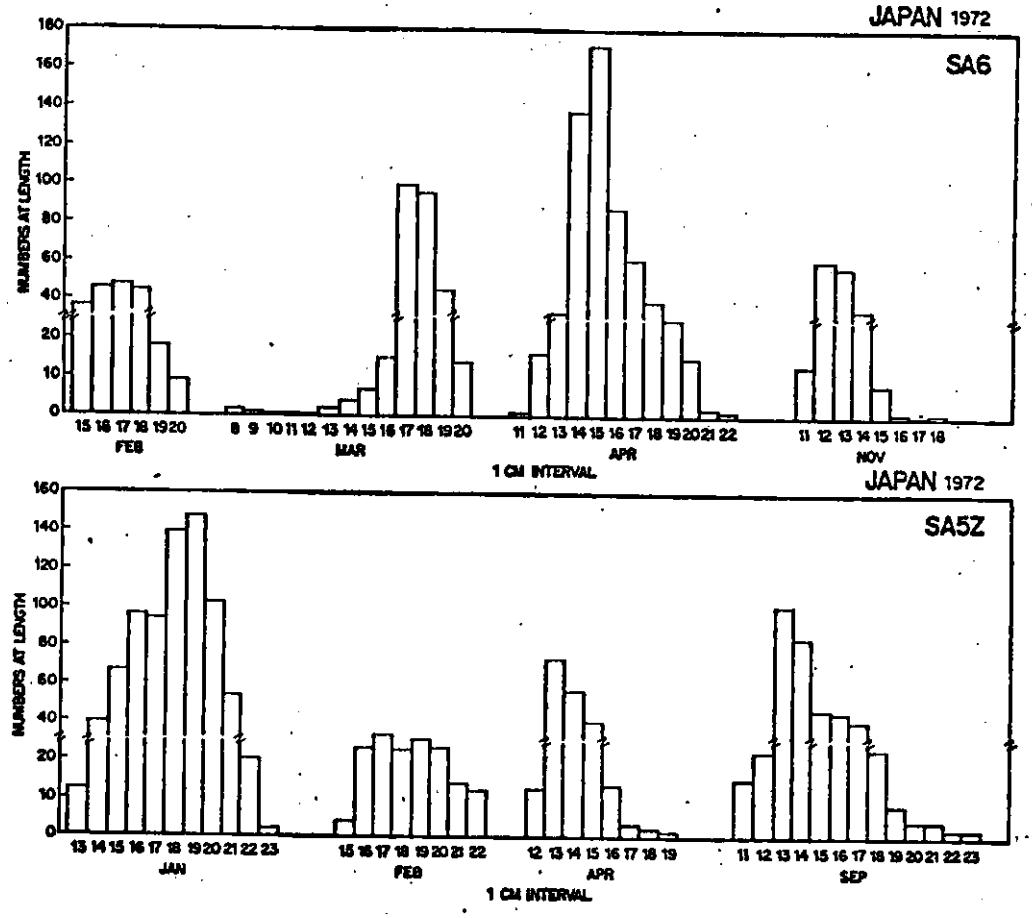

JAPAN 1972
SA6
NUMBERS AT LENGTH
FEB
MAR
APR
NOV
1 CM INTERVAL
JAPAN 1972
SA5Z
NUMBERS AT LENGTH
JAN
FEB
APR
SEP
1 CM INTERVAL

Fig. 18

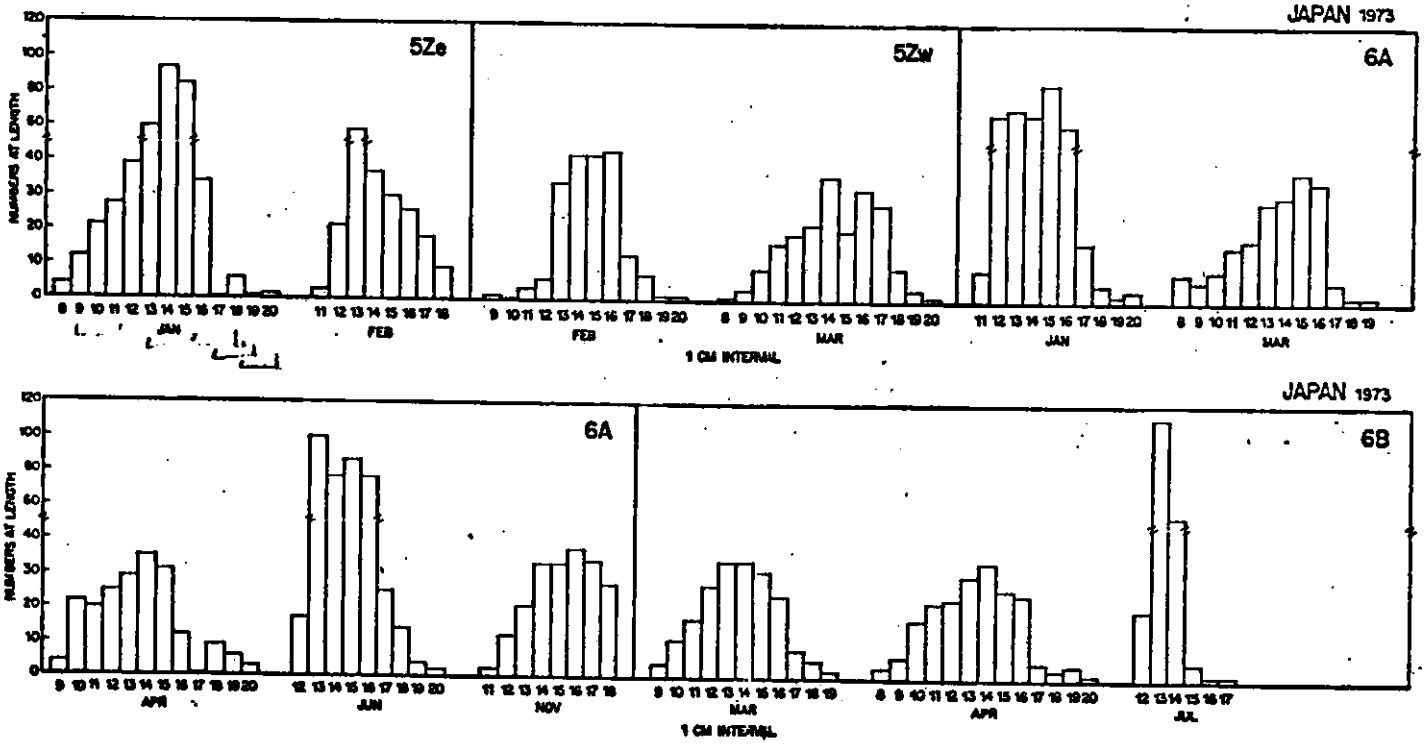

JAPAN 1973
5Ze
5Zw
6A
NUMBERS AT LENGTH
JAN
FEB
FEB
MAR
JAN
MAR
1 CM INTERVAL
JAPAN 1973
6A
6B
NUMBERS AT LENGTH
APR
JUN
NOV
MAR
APR
JUL
1 CM INTERVAL

Fig. 19

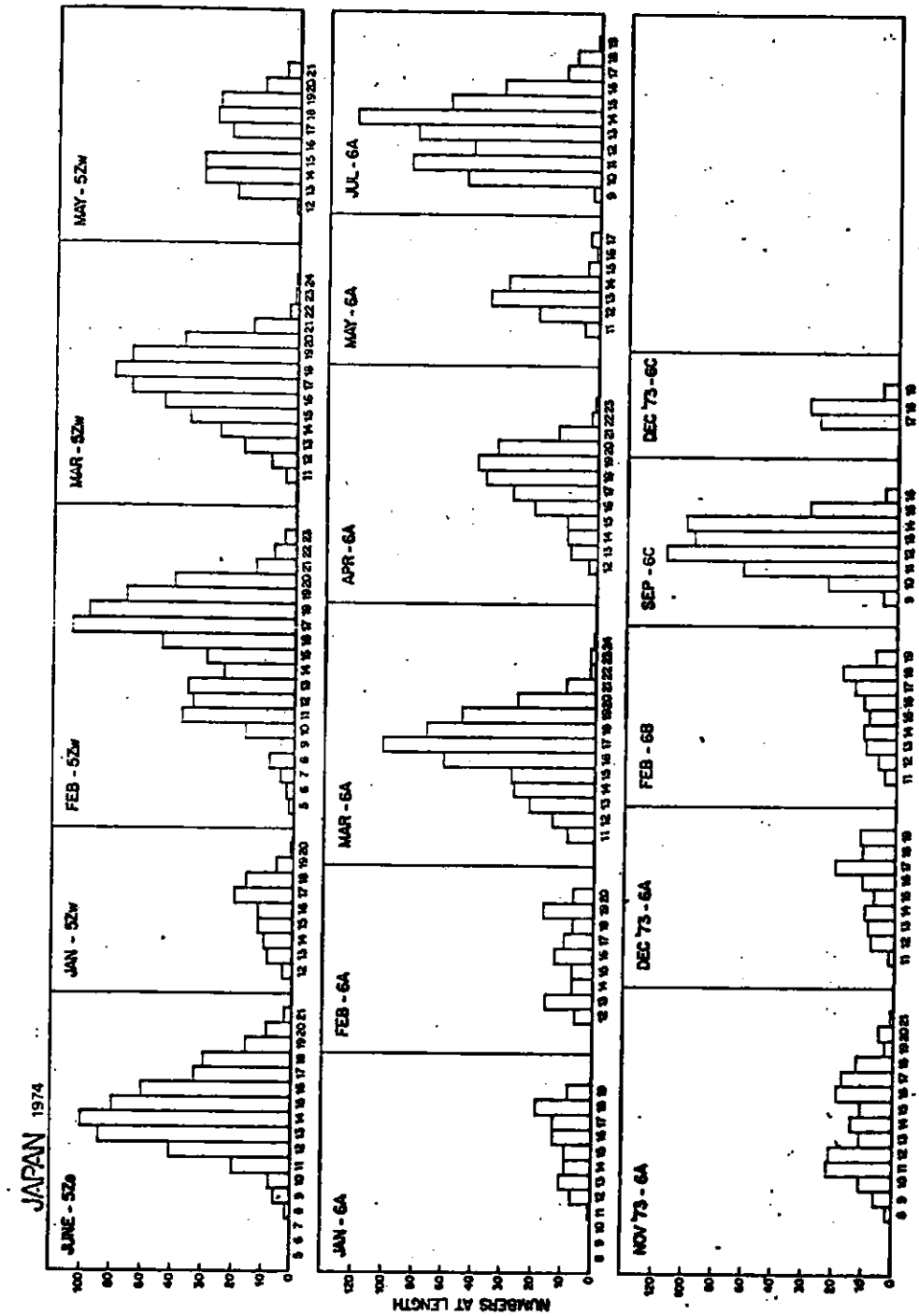

JAPAN 1974
JUNE - 52a
JAN - 52w
FEB - 52w
MAR - 52w
MAY - 52w
JAN - 6A
FEB - 6A
MAR - 6A
APR - 6A
MAY - 6A
JUL - 6A
NOV 73 - 6A
DEC 73 - 6A
FEB - 6B
SEP - 6C
DEC 73 - 6C
NUMBERS AT LENGTH
1 CM INTERVALS

Fig. 20

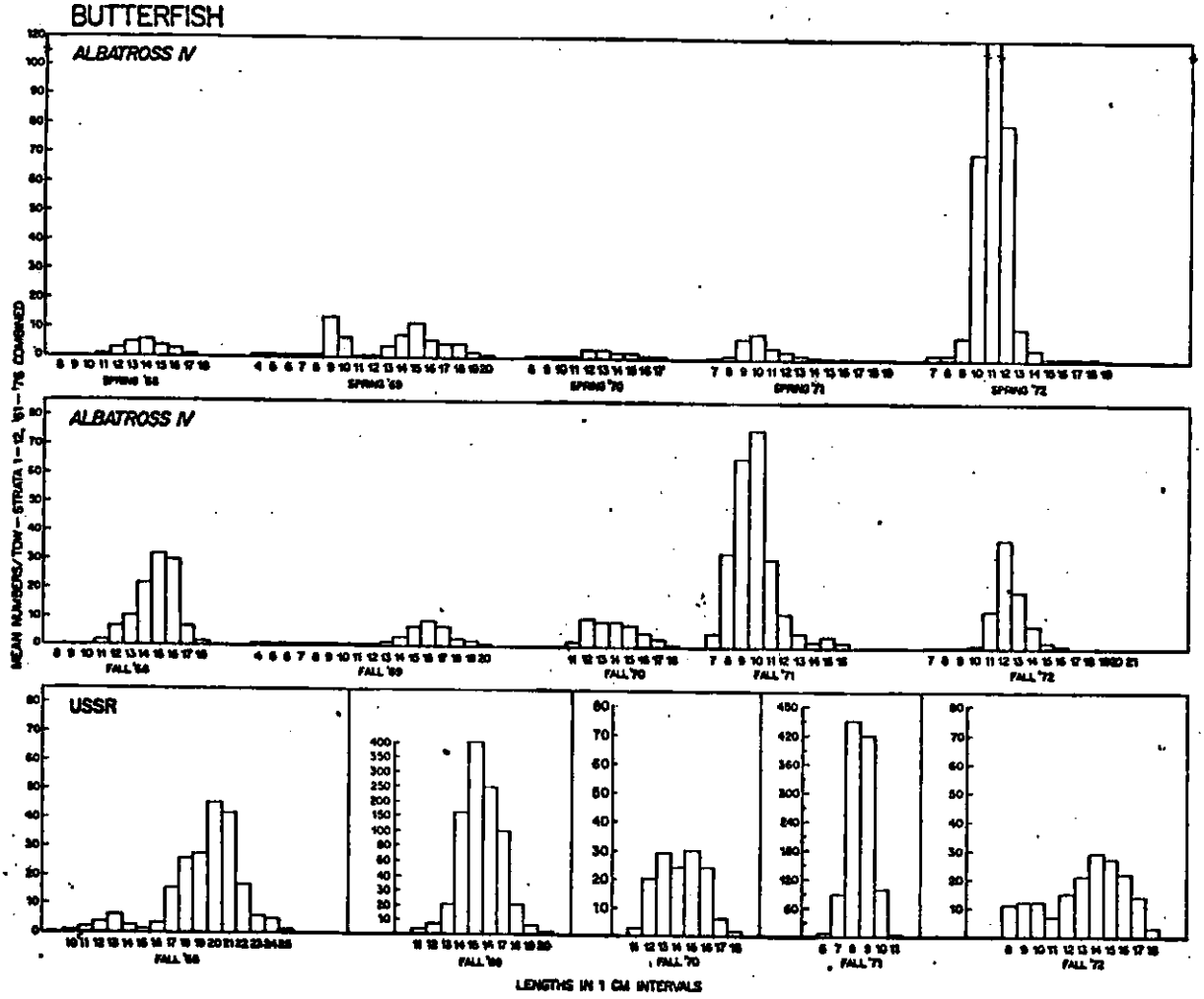

BUTTERFISH
ALBATROSS IV
SPRING '68
SPRING '69
SPRING '70
SPRING '71
SPRING '72
ALBATROSS IV
FALL '68
FALL '69
FALL '70
FALL '71
FALL '72
MEAN NUMBERS/TOW - STRATA 1-12, '61-'76 COMBINED
USSR
FALL '68
FALL '69
FALL '70
FALL '71
FALL '72
LENGTHS IN 1 CM INTERVALS

Fig. 21

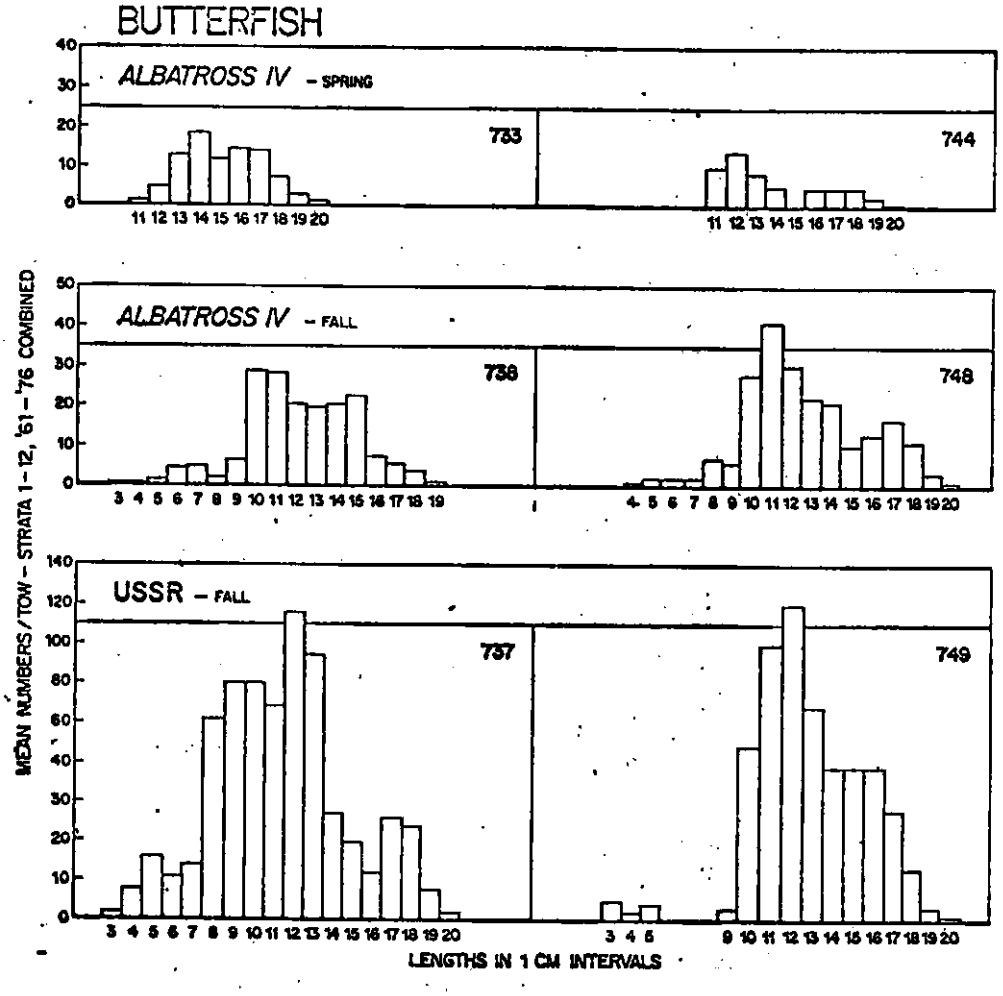
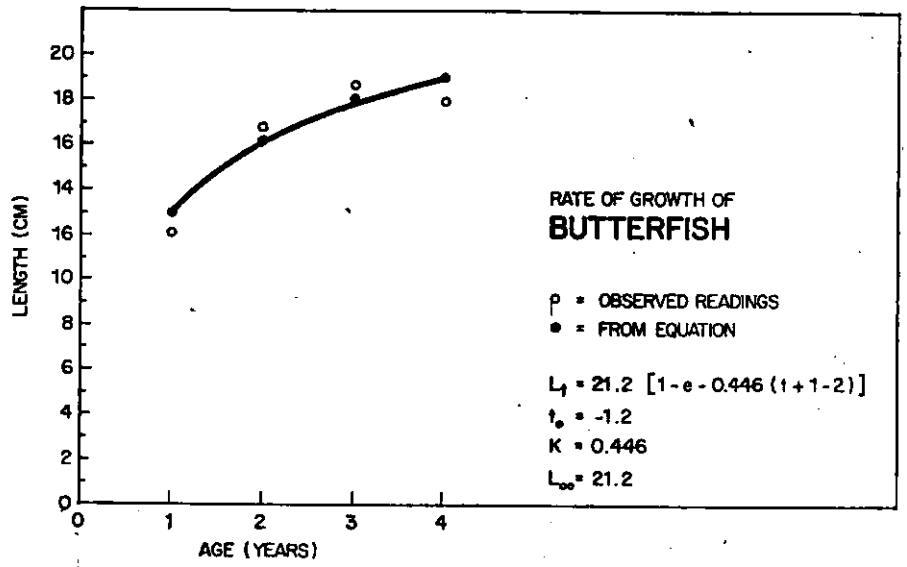

BUTTERFISH
ALBATROSS IV – SPRING
733
744
ALBATROSS IV – FALL
738
748
USSR – FALL
737
749
MEAN NUMBERS / TOW – STRATA 1 – 12, '61 – '76 COMBINED
LENGTHS IN 1 CM INTERVALS

Fig. 22


LENGTH (CM)
AGE (YEARS)
RATE OF GROWTH OF
BUTTERFISH
P = OBSERVED READINGS
● = FROM EQUATION
$L_t = 21.2\ [1 - e - 0.446\ (t + 1 - 2)]$
$t_o = -1.2$
K = 0.446
$L_\infty = 21.2$

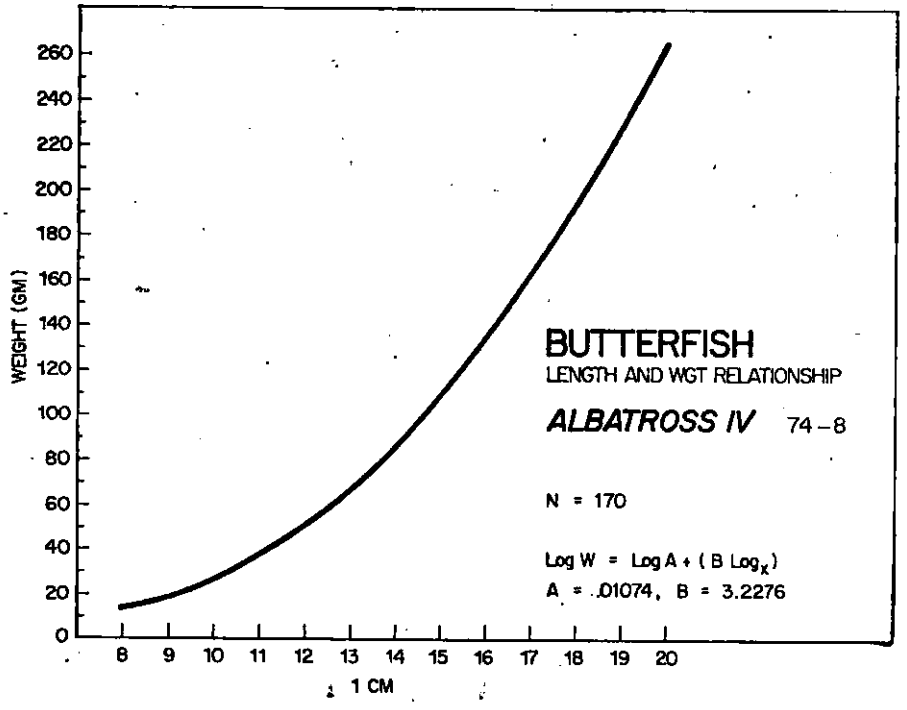

WEIGHT (GM)
1 CM
BUTTERFISH
LENGTH AND WGT RELATIONSHIP
ALBATROSS IV 74-8
N = 170
Log W = Log A + (B Log$_X$)
A = .01074, B = 3.2276

Figure 23