

## **Arctic Flounder**

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## Chapter 6 Arctic Flounder

### Results

#### *Relative Abundance and Distribution*

The following discussions of relative abundance and distribution of Arctic flounder result from two approaches to analyzing the spatial and temporal variation in daily catch rates (fish/d). First we employed a two-way ANOVA to address the overall relative contribution of years and sampling areas as sources of variation in CPUE over the 4-year study period. In the second set of analyses we addressed the spatial and intraseasonal variation observed in daily catch rates of Arctic flounder within each sampling year.

**Two-way ANOVA.**— The year and area main effects, plus the interaction term, were highly significant ( $P < 0.0013$ ) in the two-way analysis of Arctic flounder daily catch rates (Table 6.1). The model was marginally successful in explaining the overall observed variation ( $R^2 = 0.25$ ). The year main effect appeared to explain more variation than did the area effect, as evidenced by the relative apportionment of model sum of squares. This relationship held true regardless of the order in which the independent variables were entered in the computer algorithm. This suggests that Arctic flounder daily catch rates varied more over years than among sampling areas. The main effect means comparisons corroborate this premise, although a formal interpretation is confounded by the significant interaction effect. Comparisons among interaction levels showed that daily catch rates were generally highest in 1990 and 1991 and lowest in 1988 regardless of sampling area.

**Spatial differences.**— Within-year comparisons of daily catch rates (fish/d) among net stations indicated variability in the relative abundance of Arctic flounder (Table 6.2; Figure 6.1). During 1988, net station KL05 had higher daily catch rates than net stations SC01, KL10, JL12, and PB01. Net station KL05 daily catch rates did not differ significantly from those at net stations JL14 and PB02. In 1989, we documented the highest daily catch rates at net station KL05. We recorded the next highest daily catch rates at net stations SC04, KL10, and JL14. No differences were found between net stations JL12 and JL14. Net station SC01 had lower daily catch rates than all other net stations, excluding net station JL12. During 1990, we detected higher daily catch rates at net station BL02 than at net station BL04. No other within-year differences were observed. In 1991, net station KL05 had higher daily catch rates than net stations JL12 and BL04. We observed no other within-year differences in 1991.

We noted few significant differences among sampling area daily catch rates. In 1988, Kaktovik Lagoon had higher daily catch rates than Simpson Cove and Jago Lagoon (Table 6.3; Figure 6.2). Simpson Cove daily catch rates did not differ from those in Jago Lagoon. Catch rates in Pokok Bay did not differ from those in Kaktovik or Jago lagoons. During 1989, Kaktovik Lagoon daily

TABLE 6.1.— Two factor analysis of variance on log-transformed daily catch rates ( $\ln(\text{CPUE}+1)$ ) and Tukey means comparisons for Arctic flounder from coastal waters of the Arctic Refuge. Effects followed by the same letter are not significantly different ( $P > 0.05$ ).  $\text{Mean}_g$  = geometric mean.

Source	df	Sum of squares	Mean square	F-value	P-value
Model					
Year	3	576.29	192.09	112.39	0.0001
Area	3	112.55	37.52	21.95	0.0001
Year×Area	7	40.76	5.82	3.41	0.0013
Error	1281	2189.41	1.71		
Total	1294	2919.00			

Year	$\text{Mean}_g$	Tukey grouping
1990	3.07	A
1991	2.76	B
1989	2.21	C
1988	1.01	D

Area	$\text{Mean}_g$	Tukey grouping
Beaufort	2.76	A
Kaktovik	2.73	A
Jago	2.28	B
Simpson	2.21	B

Year×Area	$\text{Mean}_g$	Tukey grouping
1990-Kaktovik	3.31	A
1990-Jago	3.10	A
1990-Simpson	2.99	A
1991-Kaktovik	2.99	A
1989-Kaktovik	2.95	A
1990-Beaufort	2.88	A
1991-Simpson	2.72	A
1991-Jago	2.69	A
1991-Beaufort	2.64	A
1989-Jago	1.90	B
1989-Simpson	1.80	B
1988-Kaktovik	1.52	B
1988-Jago	0.51	C
1988-Simpson	0.47	C

TABLE 6.2.— Comparison of daily CPUE (fish/d) observations among fyke net stations for Arctic flounder in Arctic Refuge coastal waters, 1988-91. Within each year those net stations with the same letter are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons). Net stations with dashed lines were not fished within that year.

Station	Within year Scheffé groupings			
	1988	1989	1990	1991
SC01	B	D	A,B	A,B
SC04	--	B	A	A,B
KL05	A	A	A	A
KL10	B	B	A	A,B
JL12	B	C,D	A,B	B
JL14	A,B	B,C	A	A,B
PB01	B	--	--	--
PB02	A,B	--	--	--
BL02	--		A	A,B
BL04	--		B	B

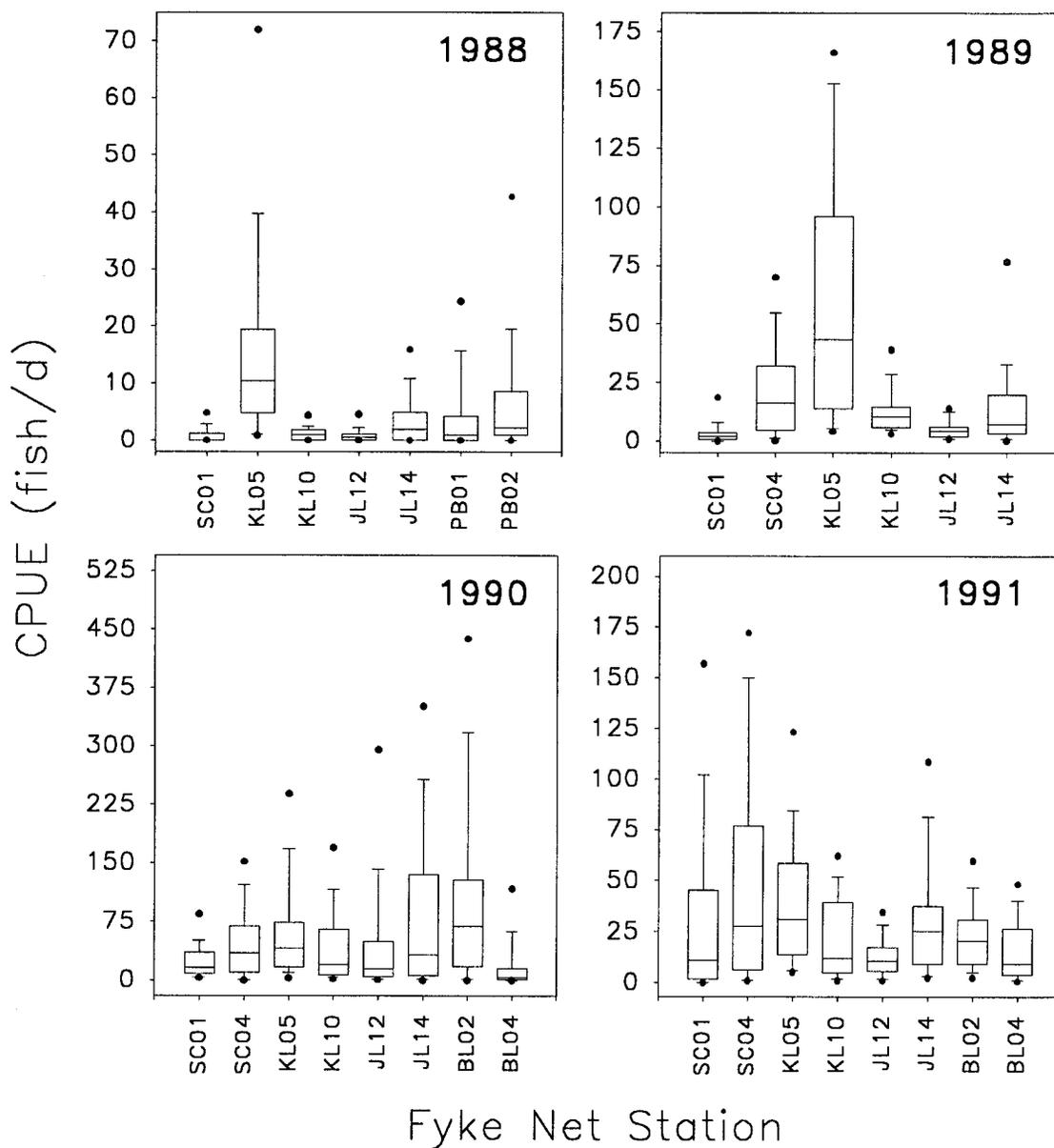


FIGURE 6.1.— Boxplots comparing daily CPUE (fish/d) observations among net stations for Arctic flounder in Arctic Refuge coastal waters, 1988-91.

TABLE 6.3.- Comparison of daily CPUE (fish/d) observations among sampling areas for Arctic flounder in Arctic Refuge coastal waters, 1988-91. Within each year those sampling areas with the same letter are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons). Sampling areas with dashed lines were not fished within that year.

Sampling area	Within year Scheffé groupings			
	1988	1989	1990	1991
Simpson Cove	C	B	A	A
Kaktovik Lagoon	A	A	A	A
Jago Lagoon	B,C	B	A	A
Pokok Bay	A,B	--	--	--
Beaufort Lagoon	--		A	A

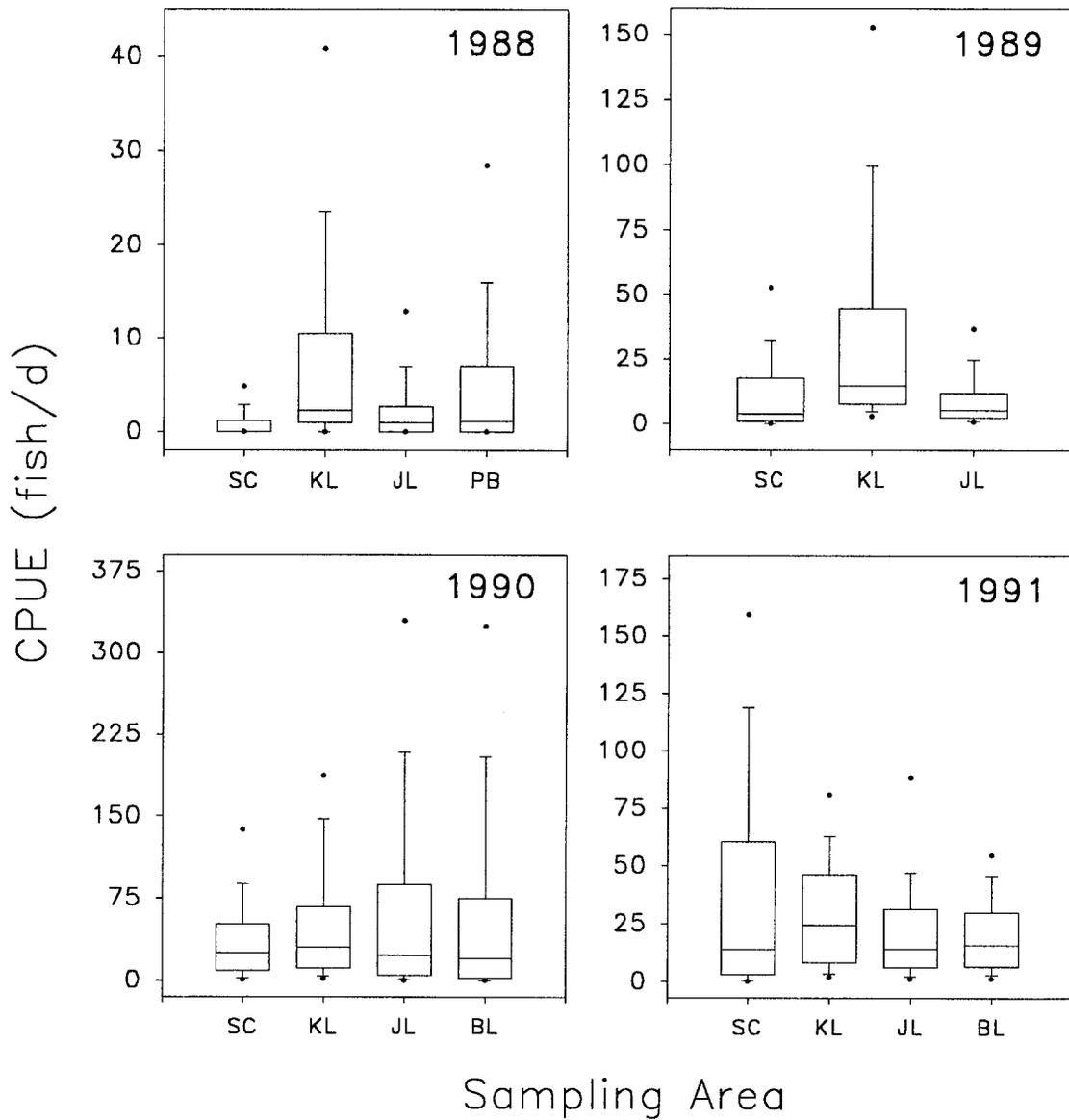


FIGURE 6.2.- Boxplots comparing daily CPUE (fish/d) observations among sampling areas for Arctic flounder in Arctic Refuge coastal waters, 1988-91. SC = Simpson Cove; KL = Kaktovik Lagoon; JL = Jago Lagoon; PB = Pokok Bay; BL = Beaufort Lagoon.

catch rates were higher than those in Simpson Cove or Jago Lagoon. Daily catch rates in these latter areas did not differ. We did not detect within-year differences among sampling areas during 1990 and 1991.

*Temporal differences.*— Net station SC01 daily catch rates were constant three out of four time periods in 1988, 1989 and 1990 (Table 6.4; Figures 6.3-6.6). During 1991 Arctic flounder daily catch rates were lower in the latter half of the sampling season. Daily catch rates at net station SC04 decreased during the sampling seasons of 1989, 1990, and 1991. Sampling area daily catch rates for Simpson Cove decreased at the end of the sampling season in each year.

Daily catch rates at net station KL05 were constant during three out of the four time periods in 1988, 1989, and 1990 (Table 6.5; Figures 6.7-6.10). Decreases in daily catch rates occurred during the latter half of the sampling season in 1989 and 1991. Net station KL10 also had constant daily catch rates during three of the four time periods in 1988 and 1989. In 1990 and 1991, Arctic flounder daily catch rates prior to August 15 were higher than those after this date. Daily catch rates in the Kaktovik Lagoon sampling area were constant during 1988, whereas declines were observed during 1989, 1990, and 1991.

Arctic flounder daily catch rates at net stations JL12 and JL14 decreased during the latter part of the sampling season in 1988-91 (Table 6.6; Figures 6.11-6.14). We observed a similar pattern of declining daily catch rates in the Jago Lagoon sampling area in each of the four years of study.

We also documented lower daily catch rates at the end of the sampling season at net stations PB01 and PB02, in 1988, and BL02 in 1990 and 1991 (Table 6.7; Figures 6.15-6.17). In contrast, net station BL04 had its lowest observed daily catch rates during early August in 1990. Also, Arctic flounder daily catch rates at net station BL04 in 1991 were highest during late August. Sampling area daily catch rates for Pokok Bay, 1988, and Beaufort Lagoon, 1990 and 1991, also indicated declines during the latter half of the sampling season.

For net stations SC01, KL05, KL10, JL12, and JL14, among-year comparisons indicated that 1988 Arctic flounder daily catch rates were the lowest of the four years (Table 6.8; Figures 6.18-6.21). At net station SC04 daily catch rates were stable among the years 1989-91. Arctic flounder daily catch rates in 1990 were higher than those in 1991 at net station BL04. For the Simpson Cove, Kaktovik and Jago lagoons sampling areas, among-year comparisons indicated that 1988 daily catch rates were the lowest (Table 6.8; Figures 6.18-6.21). Daily catch rates were stable between 1990 and 1991 in all sampling areas.

By time period, among-year comparisons of daily catch rates indicated that daily catch rates in 1988 were among the lowest observed at net station SC01 (Table 6.9; Figures 6.22, 6.23). At net station SC04, daily catch rates prior to August 14 were lowest in 1989. Daily catch rates were stable among years after August 15. Simpson Cove 1988 daily catch rates were among the lowest

TABLE 6.4.— Comparison of daily CPUE (fish/d) observations among time periods for Arctic flounder in Simpson Cove. For each net station/sampling area those time periods with the same letter, within each year, are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons). Time period 1 corresponds to the period from the first sampling day to July 31. Time period 2 corresponds to the period from August 1 to August 14. Time period 3 corresponds to the period from August 15 to August 31. Time period 4 corresponds to the period from September 1 to the last sampling day. Locations with dashed lines were not fished during that time period.

Time Period	Within year Scheffé groupings			
	1988	1989	1990	1991
Net Station - SC01				
1	A,B	B	A	A
2	A	A,B	A	A
3	B	A	A	B
4	B	B	A	B
Net Station - SC04				
1	--	A	A	A
2	--	B	A	A
3	--	B	B	B
4	--	C	B	--
Simpson Cove				
1	A,B	A	A	A
2	A	A	A,B	A
3	B	A	B	B
4	B	B	C	C

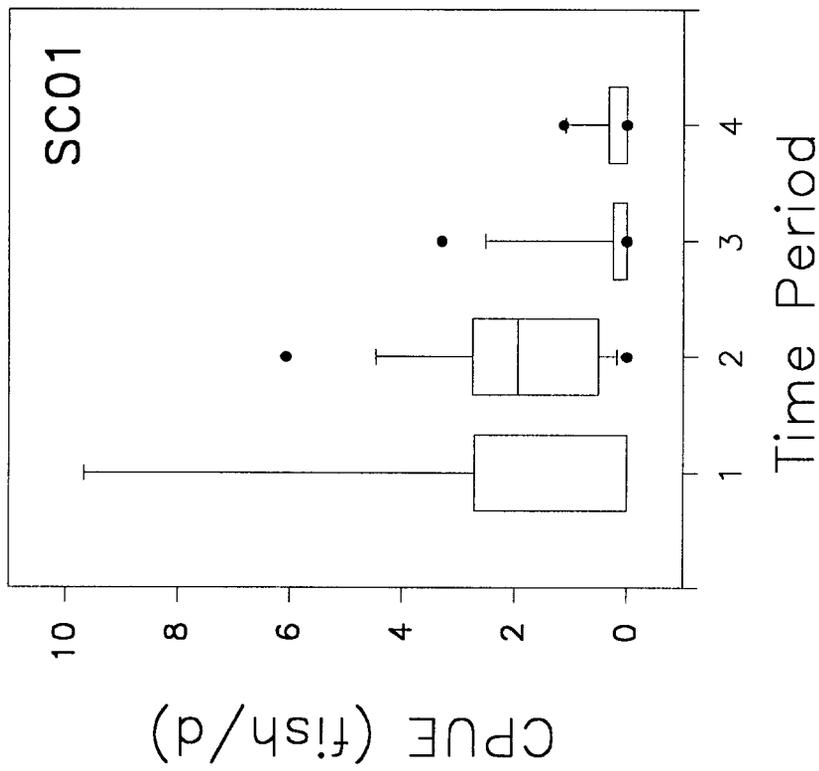


FIGURE 6.3.- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic Flounder in Simpson Cove in 1988. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

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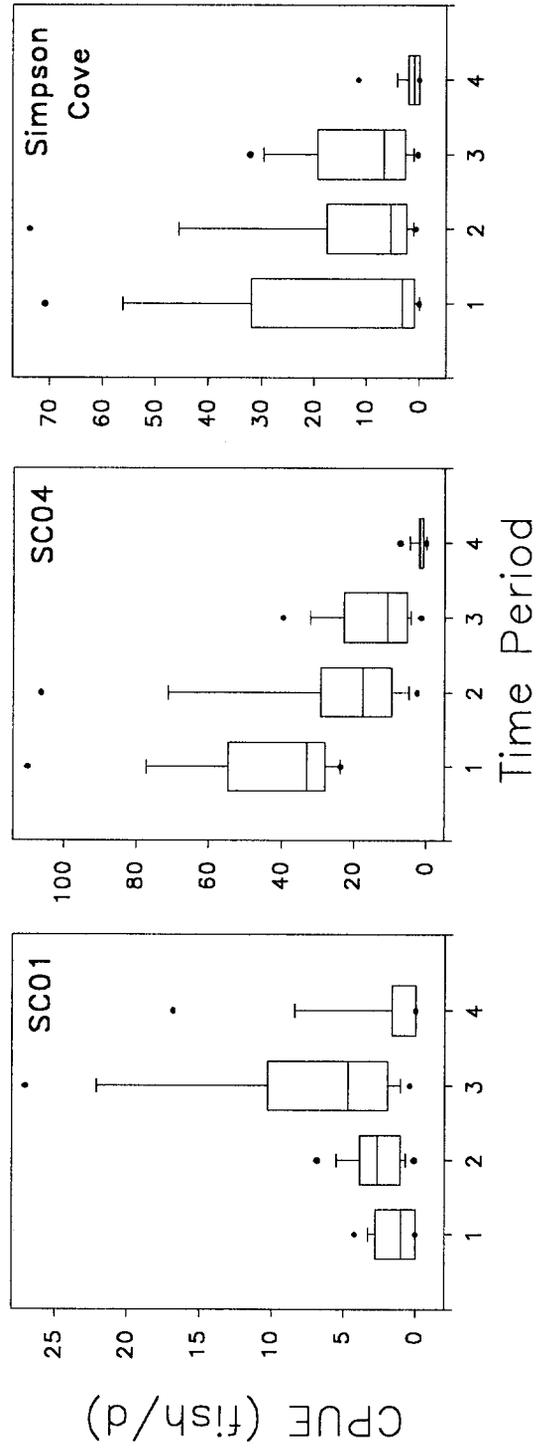


FIGURE 6.4.- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Simpson Cove in 1989. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

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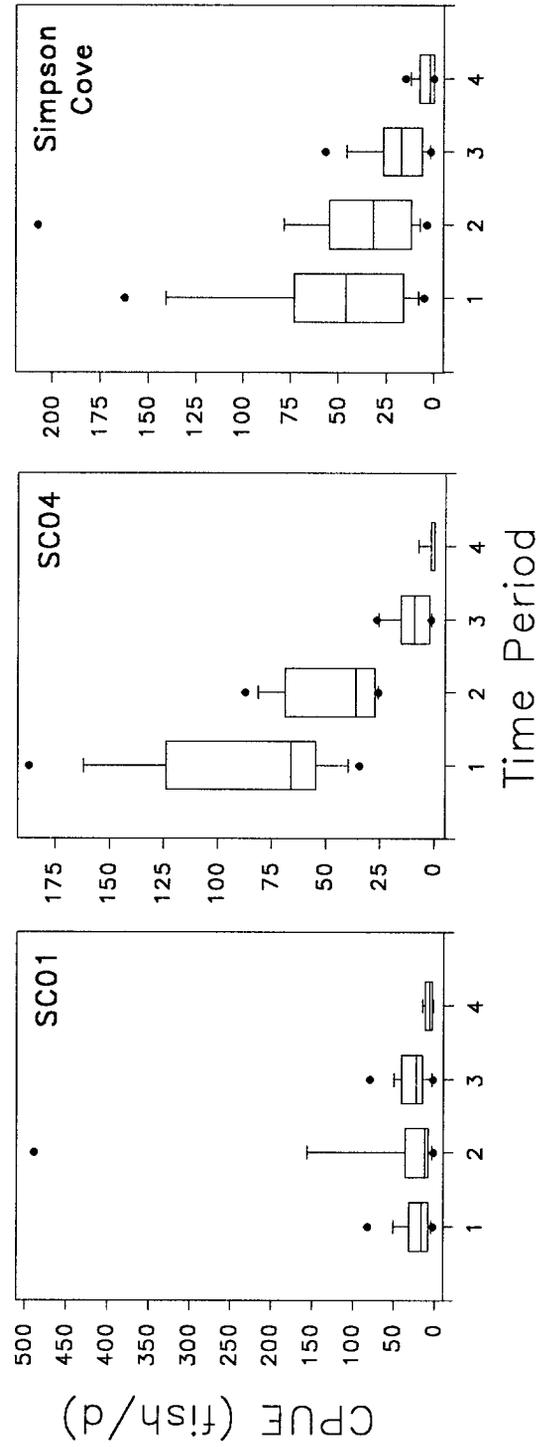


FIGURE 6.5.- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Simpson Cove in 1990. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

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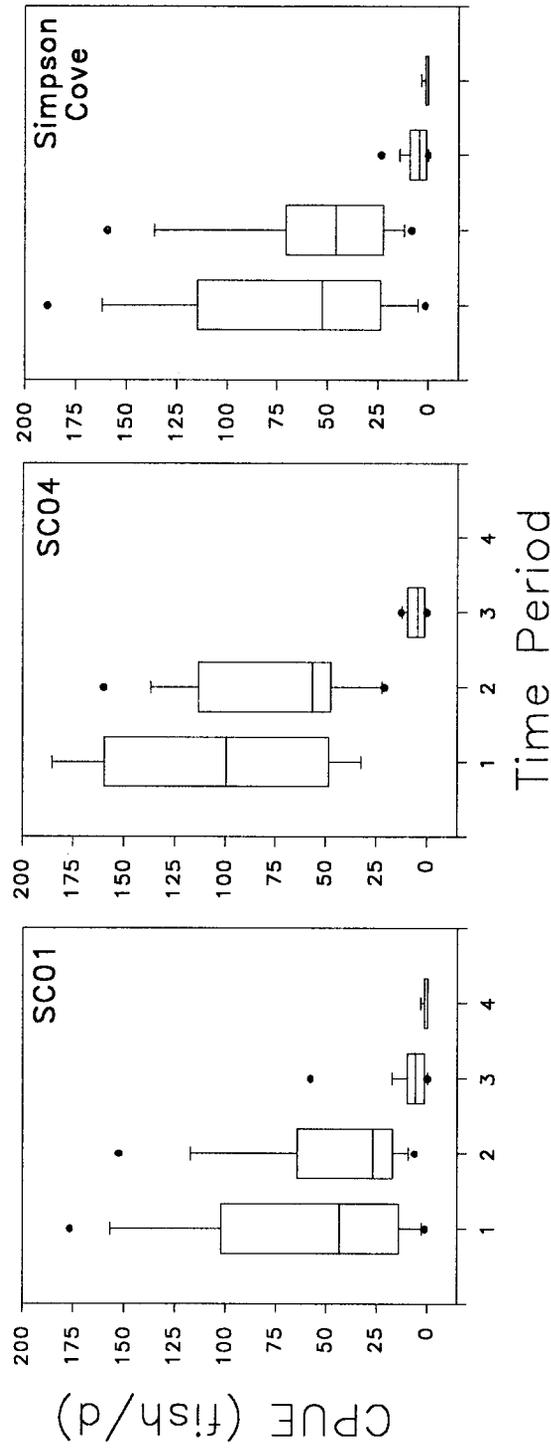


FIGURE 6.6.— Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Simpson Cove in 1991. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

TABLE 6.5.- Comparison of daily CPUE (fish/d) observations among time periods for Arctic flounder in Kaktovik Lagoon, 1988-91. For each net station/sampling are those time periods with the same letter, within the same year, are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons). Time period 1 corresponds to the period from the first sampling day to July 31. Time period 2 corresponds to the period from August 1 to August 14. Time period 3 corresponds to the period from August 15 to August 31. Time period 4 corresponds to the period from September 1 to the last sampling day.

Within year Scheffé groupings				
Time Period	1988	1989	1990	1991
<b>Net Station - KL05</b>				
1	A	A	A,B	A
2	A	A	B	A,B
3	A	A	A	B,C
4	A	B	A,B	C
<b>Net Station - KL10</b>				
1	A	B	A	A
2	B	B	A	A
3	A,B	A	B	B
4	B	A,B	B	B
<b>Kaktovik Lagoon</b>				
1	A	A,B	A	A
2	A	A	A,B	A
3	A	A	B	B
4	A	B	B	C

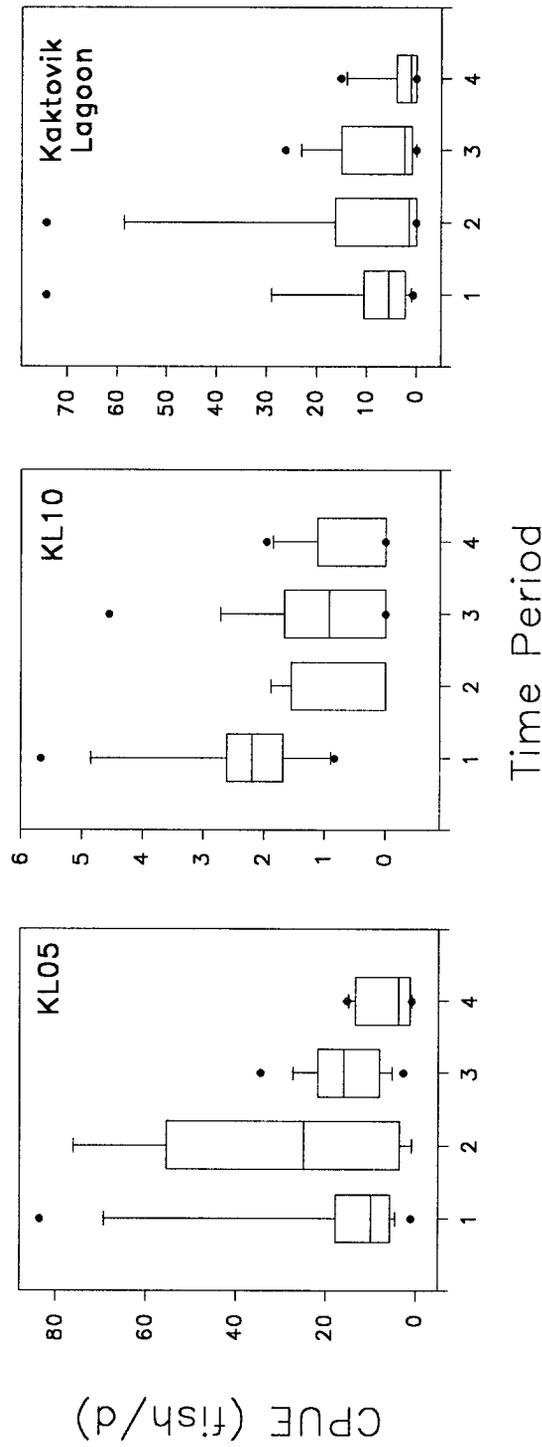


FIGURE 6.7.- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Kaktovik Lagoon in 1988. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

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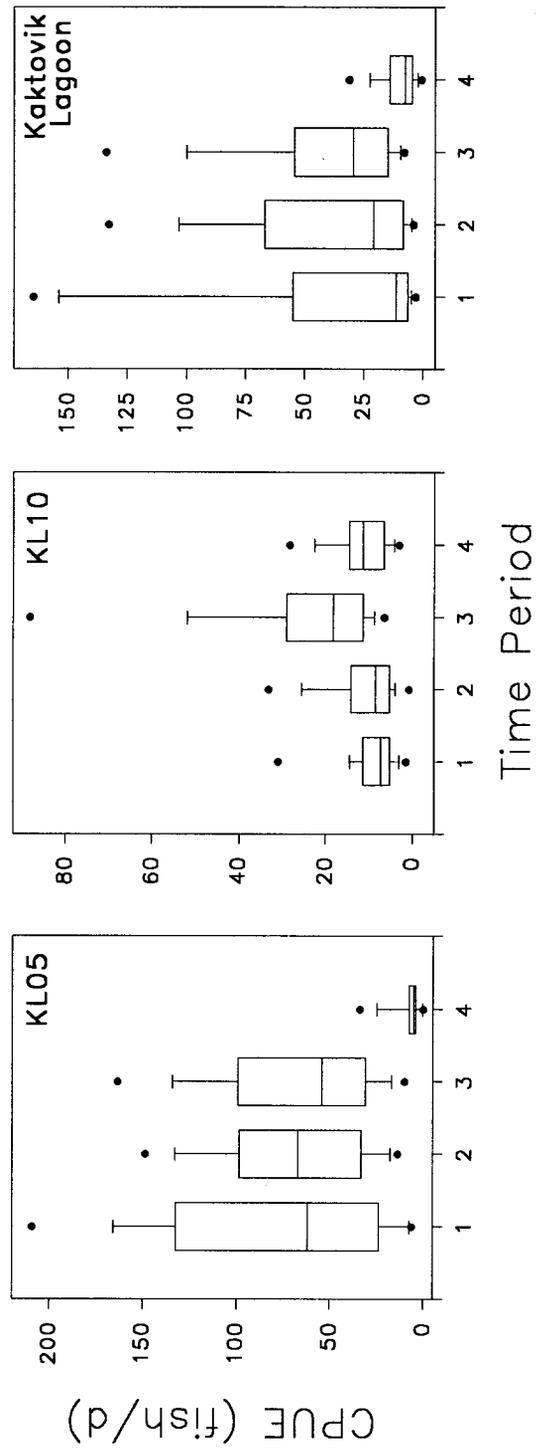


FIGURE 6.8.- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Kaktovik Lagoon in 1989. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

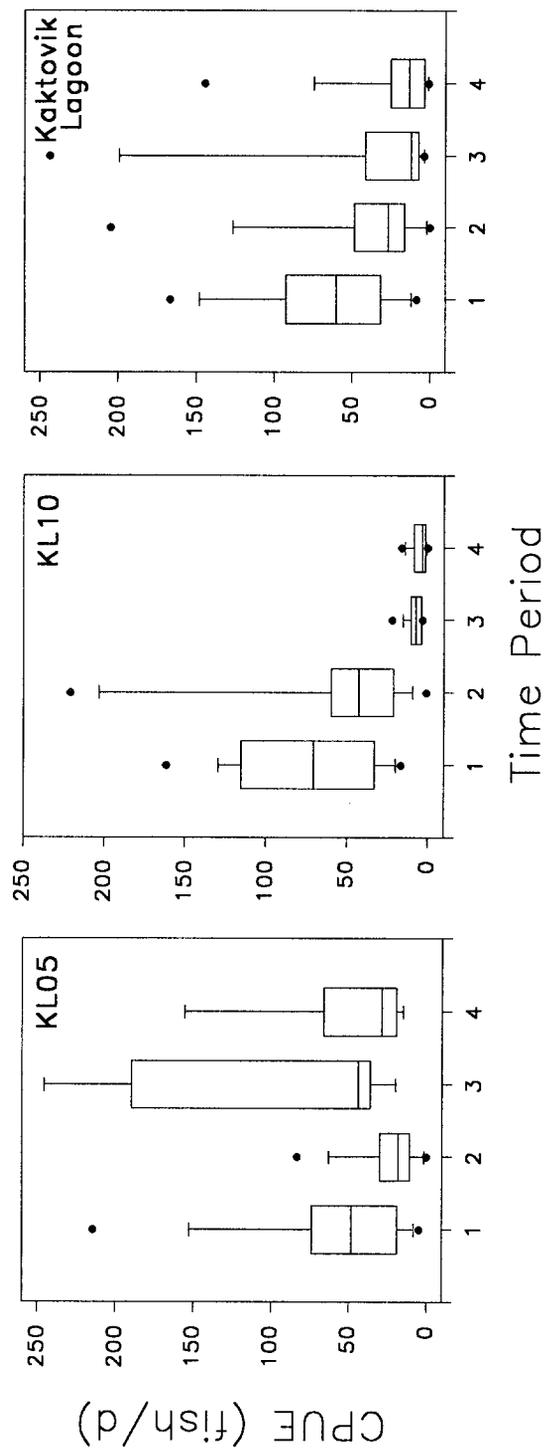


FIGURE 6.9.- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Kaktovik Lagoon in 1990. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

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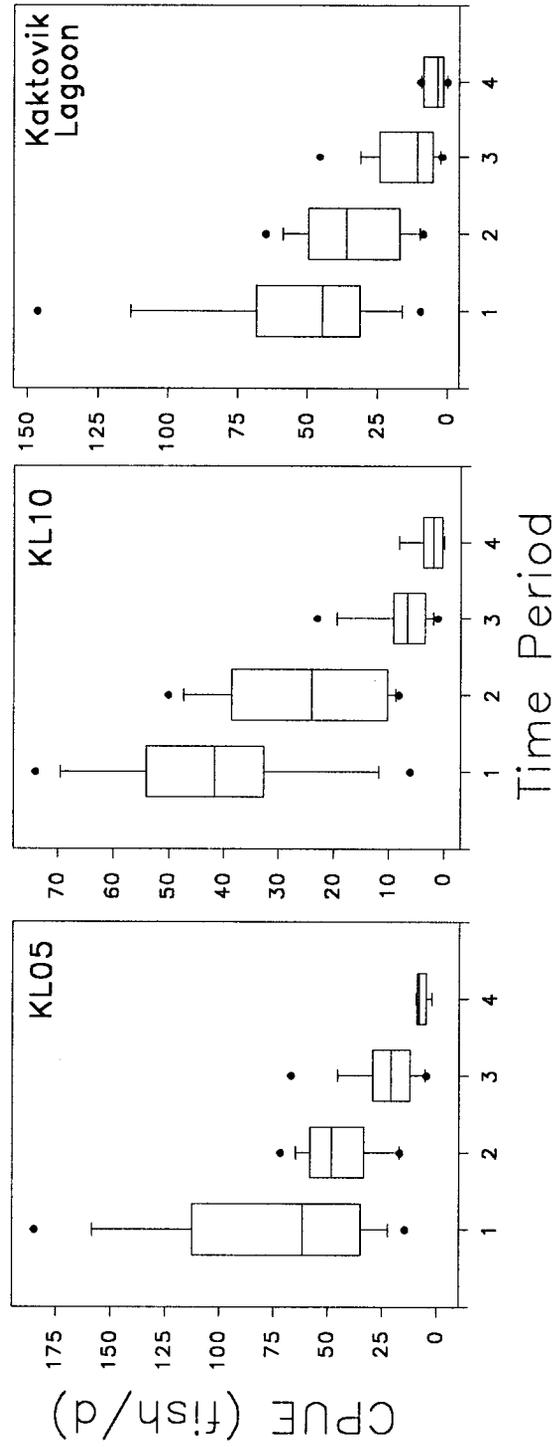


FIGURE 6.10.— Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Kaktovik Lagoon in 1991. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

TABLE 6.6.— Comparison of daily CPUE (fish/d) observations among time periods for Arctic flounder in Jago Lagoon, 1988-91. For each net station/sampling area those time periods with the same letter, within the same year, are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons). Time period 1 corresponds to the period from the first sampling day to July 31. Time period 2 corresponds to the period from August 1 to August 14. Time period 3 corresponds to the period from August 15 to August 31. Time period 4 corresponds to the period from September 1 to the last sampling day.

Within year Scheffé groupings				
Time Period	1988	1989	1990	1991
<b>Net Station - JL12</b>				
1	A,B	A,B	A	A
2	A	A	A,B	A
3	A,B	B,C	C	A,B
4	B	C	B,C	B
<b>Net Station - JL14</b>				
1	A	A	A	A
2	A,B	A	A,B	A,B
3	A	A	B,C	B,C
4	B	B	C	C
<b>Jago Lagoon</b>				
1	A	A	A	A
2	A	A	B	A,B
3	A	A	C	B
4	B	B	C	C

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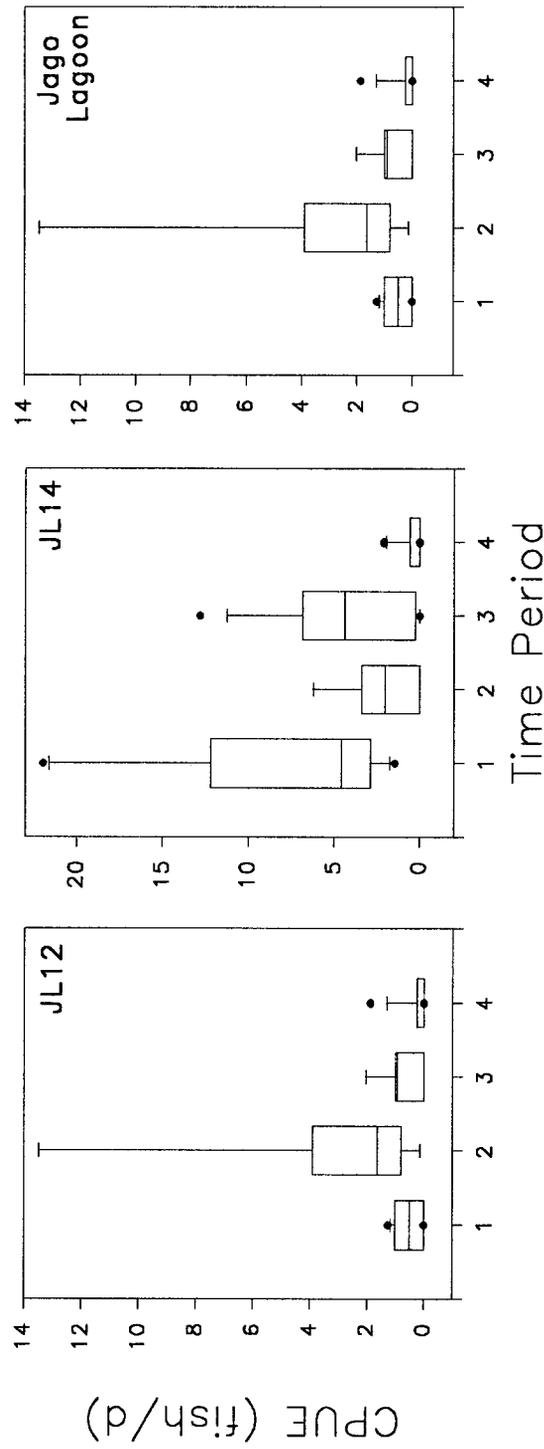


FIGURE 6.11.- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Jago Lagoon in 1988. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

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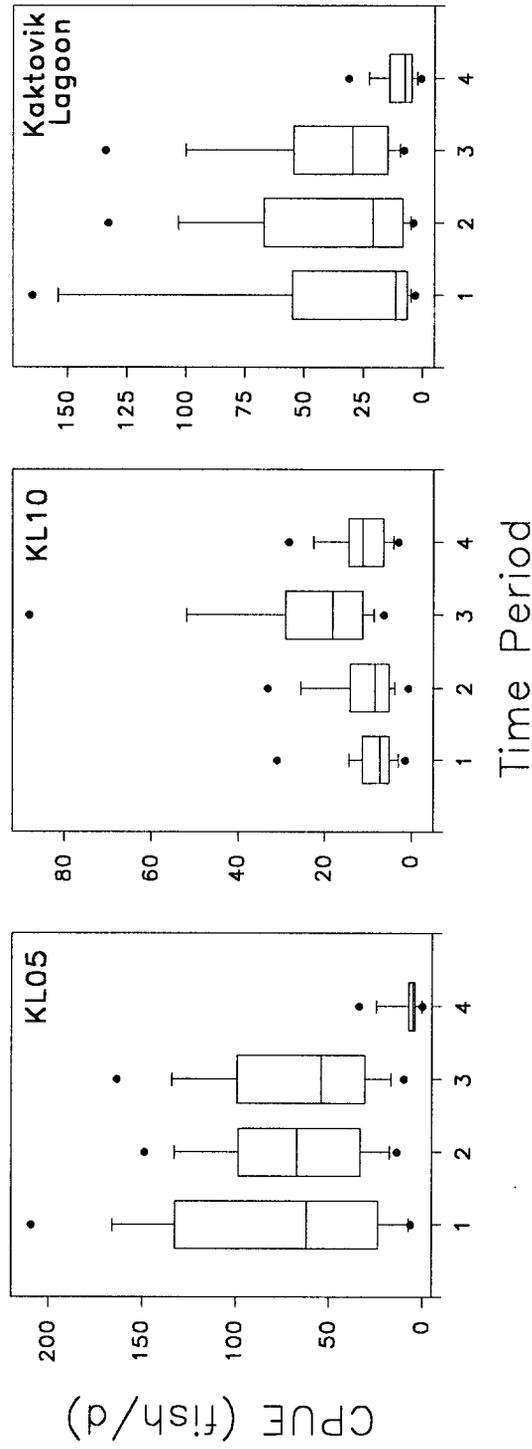


FIGURE 6.12.- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Jago Lagoon in 1989. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

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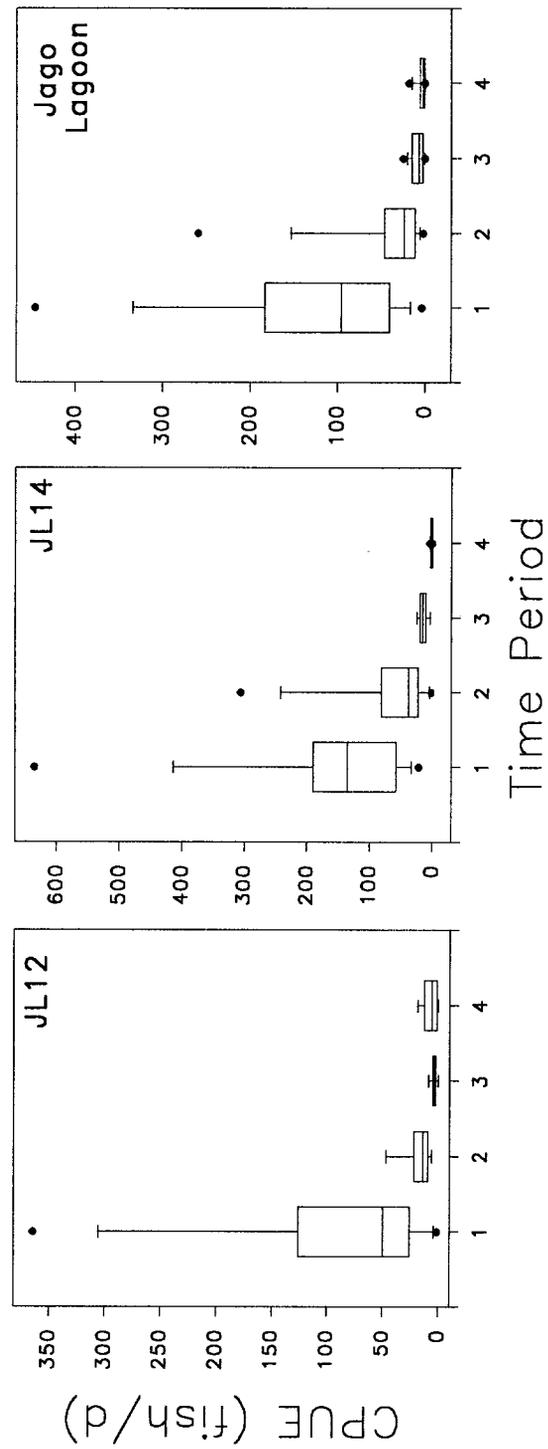


FIGURE 6.13.-- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Jago Lagoon in 1990. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

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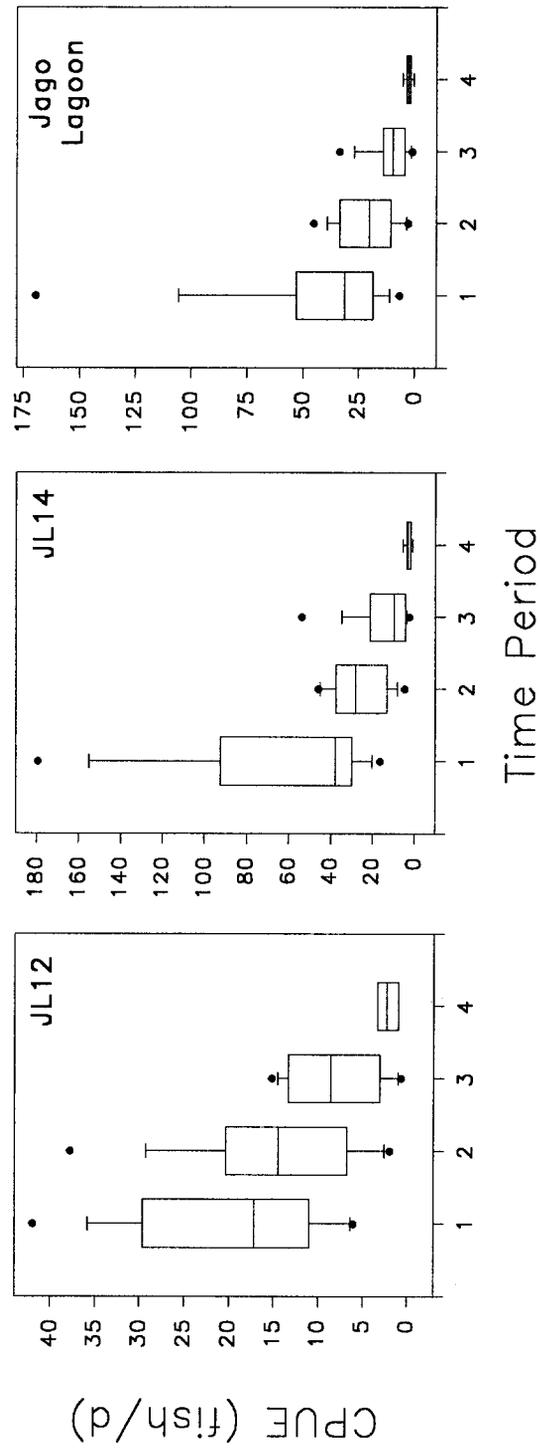


FIGURE 6.14.— Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Jago Lagoon in 1991. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

TABLE 6.7.- Comparison of daily CPUE (fish/d) observations among time periods for Arctic flounder in Pokok Bay/Beaufort Lagoon, 1988-91. For each net station/sampling area those time periods with the same letter, within the same year, are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons). Time period 1 corresponds to the period from the first sampling day to July 31. Time period 2 corresponds to the period from August 1 to August 14. Time period 3 corresponds to the period from August 15 to August 31. Time period 4 corresponds to the period from September 1 to the last sampling day. Locations with dashed lines were not fished during that time period.

Time Period	Within year Scheffé groupings		
	1988	1990	1991
	PB01	BL02	
1	A	A	A
2	A	A	A
3	B	B	A
4	B	C	B
	PB02	BL04	
1	--	A	B
2	A	B	B
3	A,B	A	A
4	B	A	B
	Pokok Bay	Beaufort Lagoon	
1	A	A	A
2	A	A	A
3	B	A	A
4	B	B	B

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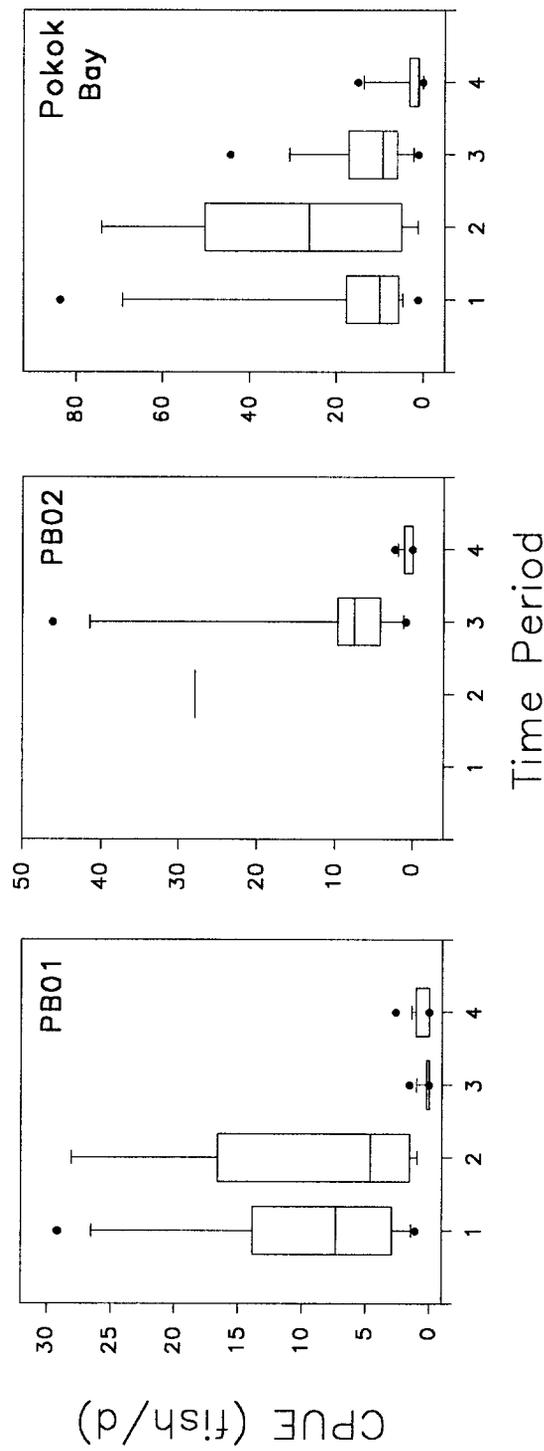


FIGURE 6.15.- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Pokok Bay in 1988. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

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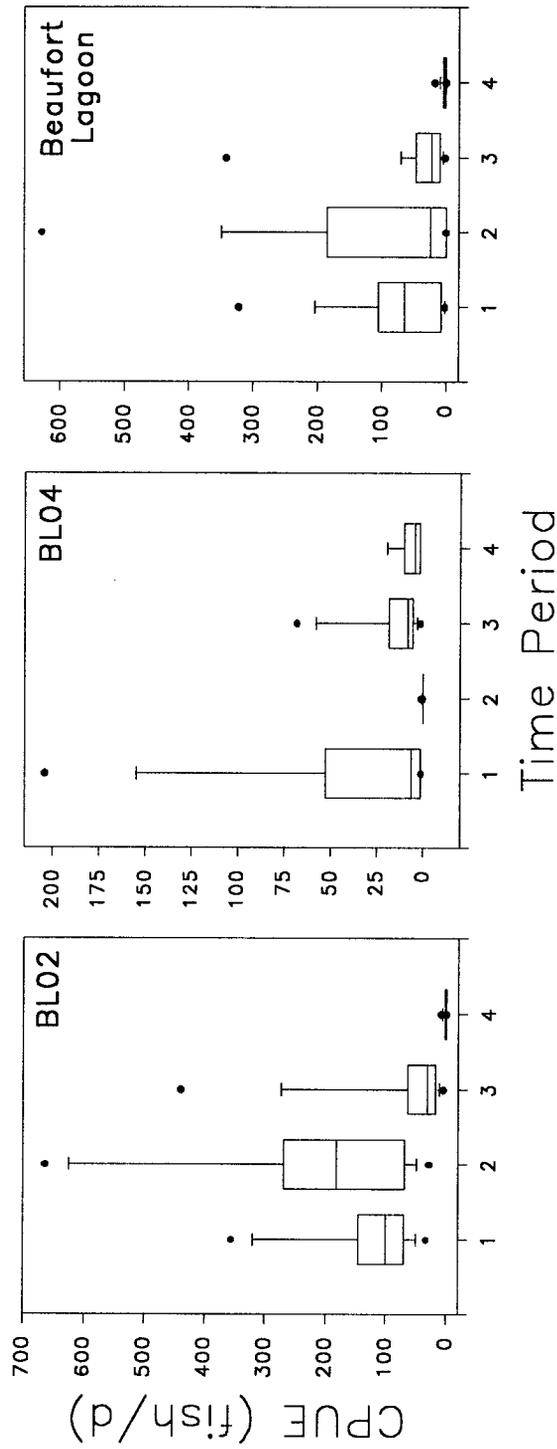


FIGURE 6.16.- Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Beaufort Lagoon in 1991. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

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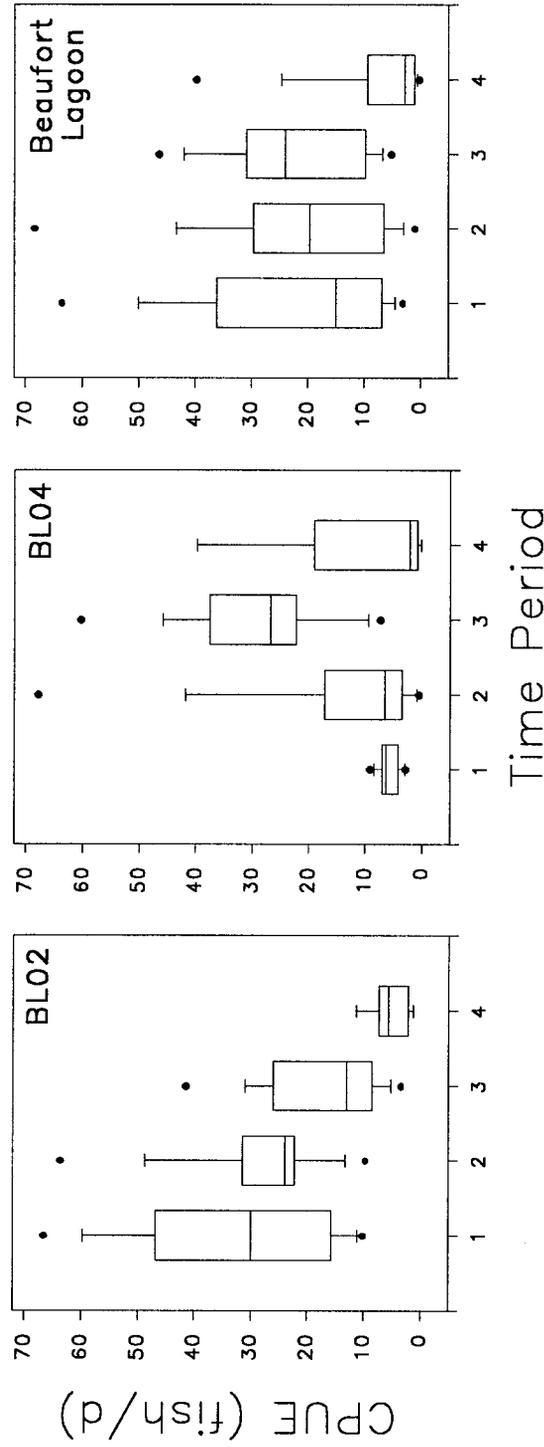


FIGURE 6.17. - Boxplots comparing daily CPUE (fish/d) observations among time periods for Arctic flounder in Beaufort Lagoon in 1991. 1 = the first sampling day to July 31; 2 = August 1 to 14; 3 = August 15 to 31; 4 = September 1 to the last sampling day.

TABLE 6.8.- Comparison of daily CPUE (fish/d) observations among years for Arctic flounder. For each net station/sampling area those years with the same letter are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons). Locations with dashed lines were not fished during that year.

Year	Within location Scheffé groupings		
	Net Station	Net Station	Sampling Area
	<b>SC01</b>	<b>SC04</b>	<b>Simpson Cove</b>
1988	C	--	C
1989	B	A	B
1990	A	A	A
1991	A	A	A
	<b>KL05</b>	<b>KL10</b>	<b>Kaktovik Lagoon</b>
1988	B	B	B
1989	A	A	A
1990	A	A	A
1991	A	A	A
	<b>JL12</b>	<b>JL14</b>	<b>Jago Lagoon</b>
1988	C	C	C
1989	B	B	B
1990	A	A	A
1991	A	A	A
	<b>BL02</b>	<b>BL04</b>	<b>Beaufort Lagoon</b>
1990	A	B	A
1991	B	A	A

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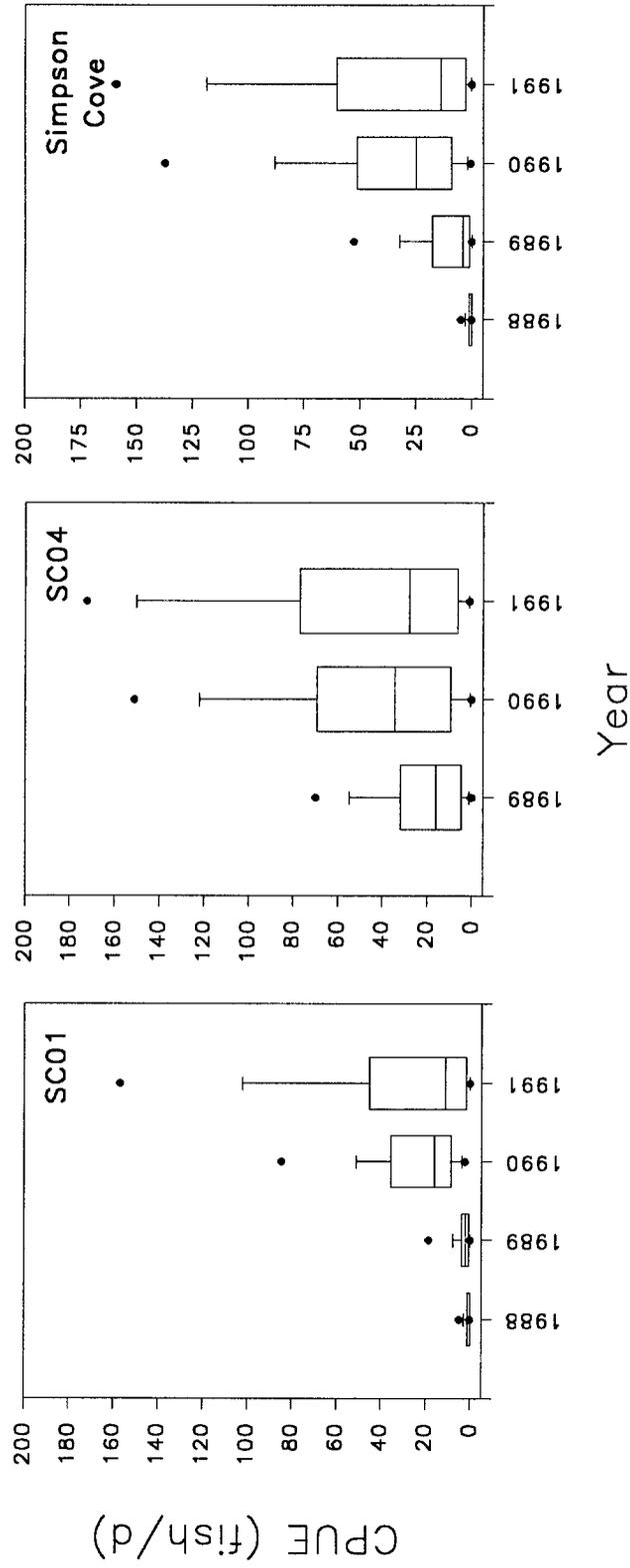


FIGURE 6.18.— Boxplots comparing daily CPUE (fish/d) observations among years for Arctic flounder in Simpson Cove.

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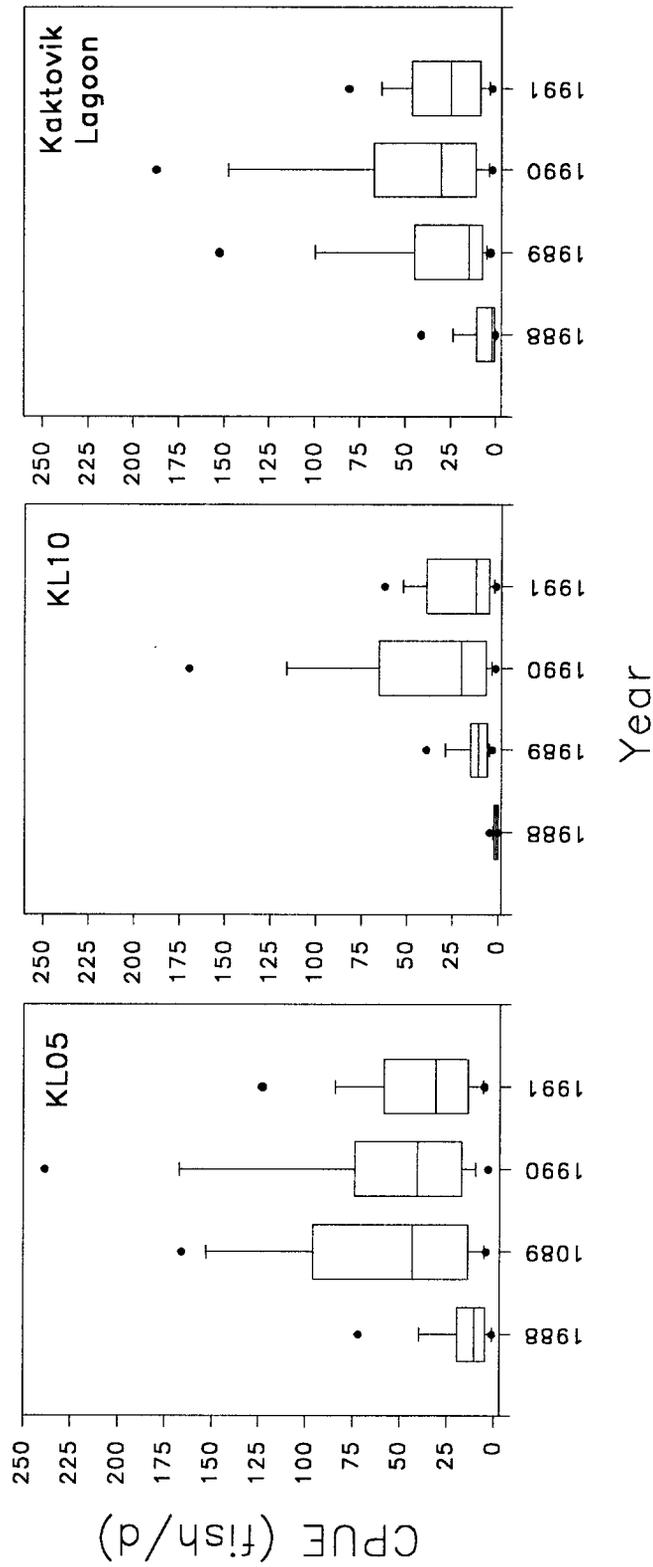


FIGURE 6.19.— Boxplots comparing daily CPUE (fish/d) observations among years for Arctic flounder in Kaktovik Lagoon.

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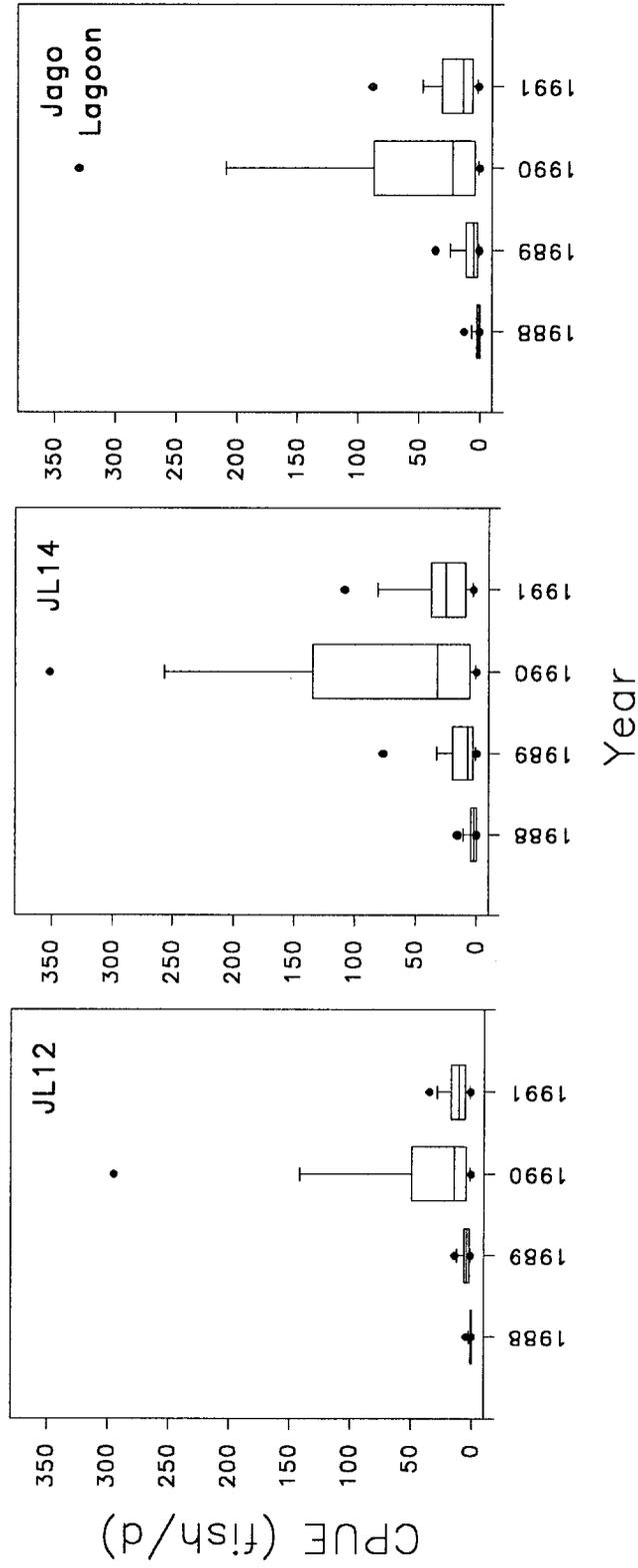


FIGURE 6.20.- Boxplots comparing daily CPUE (fish/d) observations among years for Arctic flounder in Jago Lagoon.

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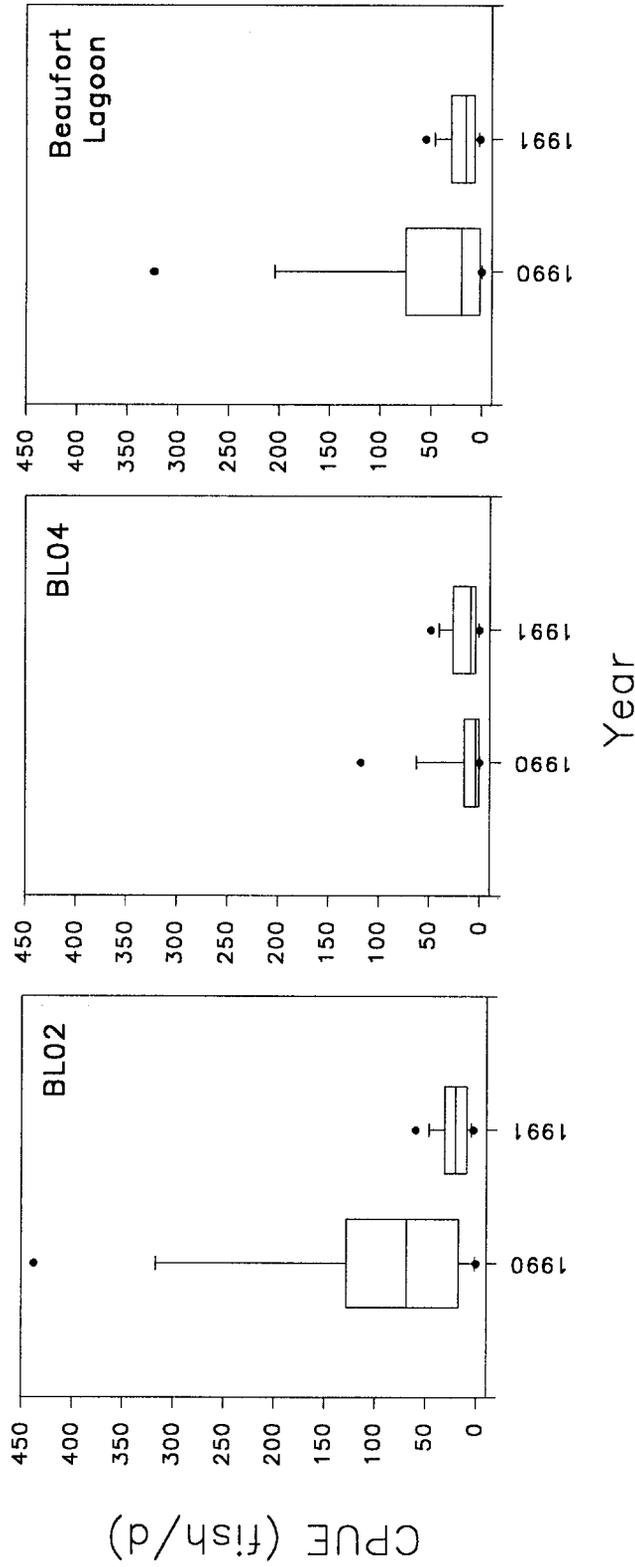


FIGURE 6.21.- Boxplots comparing daily CPUE (fish/d) observations between years for Arctic flounder in Beaufort Lagoon.

TABLE 6.9.- Comparison of daily CPUE (fish/d) observations among years for Arctic flounder in Simpson Cove. For each net station/sampling area those years with the same letter, within the time period, are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons). Locations with dashed lines were not sampled during that year.

Within location Scheffé groupings			
Year	SC01	SC04	Simpson Cove
Time Period 1 - first day to July 31			
1988	B	--	B
1989	B	B	B
1990	A	A	A
1991	A	A	A
Time Period 2 - August 1 to August 14			
1988	B	--	C
1989	B	B	B
1990	A	A	A
1991	A	A	A
Time Period 3 - August 15 to August 31			
1988	C	--	C
1989	B	A	B
1990	A	A	A
1991	B	A	B
Time Period 4 - September 1 to last day			
1988	B	--	A
1989	B	A	A
1990	A	A	A
1991	B	--	A

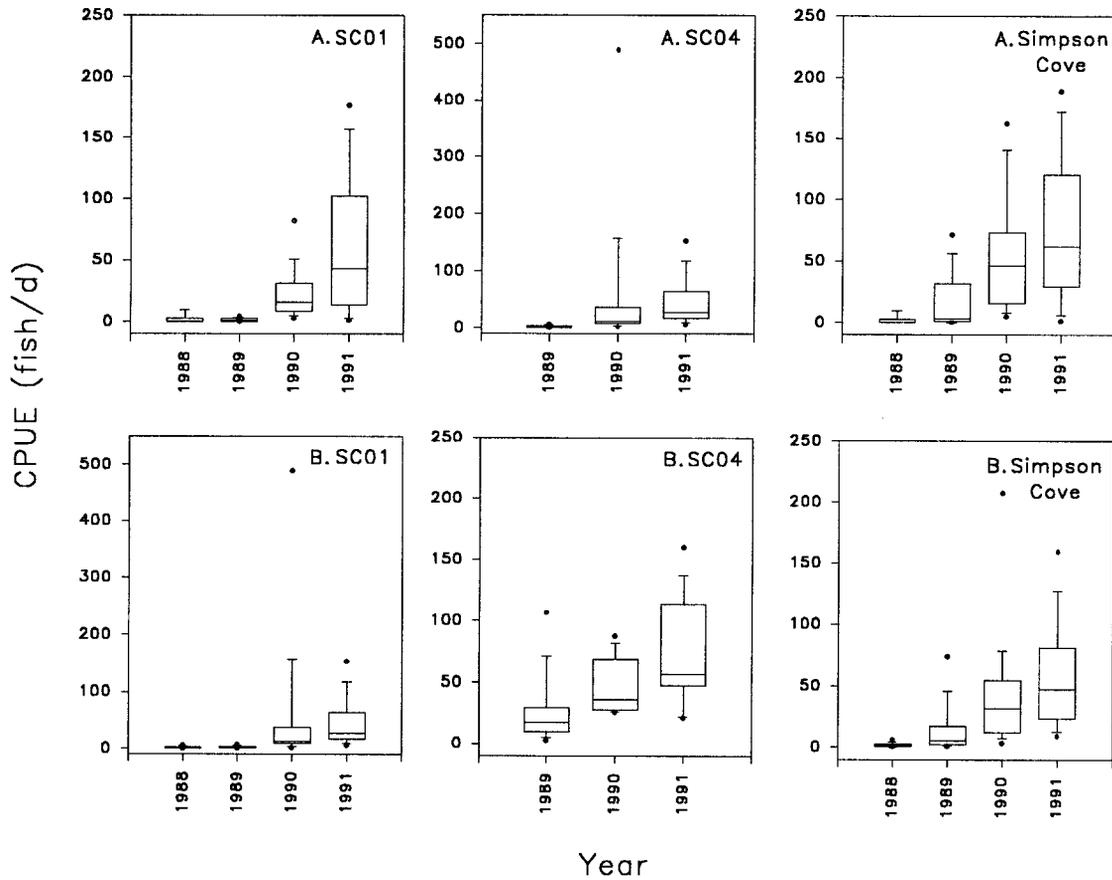


FIGURE 6.22.— Boxplots comparing daily CPUE (fish/d) observations among years for Arctic flounder in Simpson Cove. A = time period 1, the first sampling day to July 31. B = time period 2, August 1 to August 14.

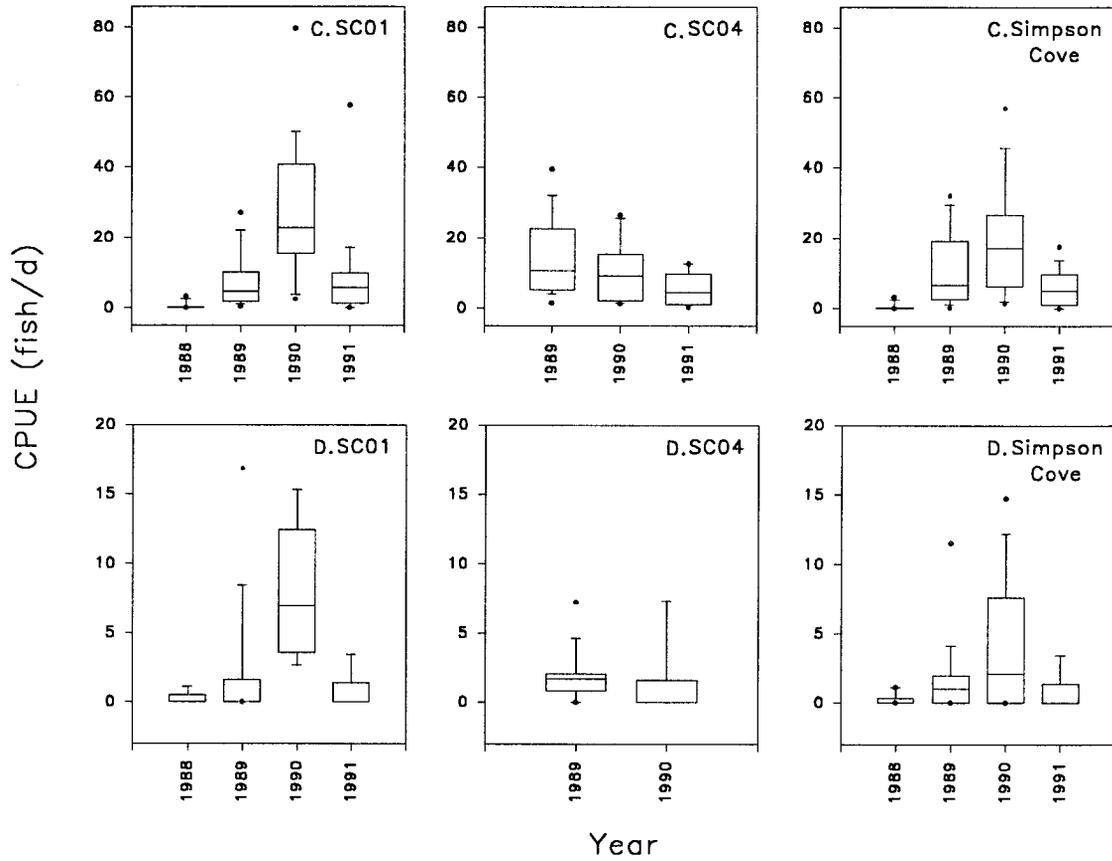


FIGURE 6.23.- Boxplots comparing daily CPUE (fish/d) observations among years for Arctic flounder in Simpson Cove. C = time period 3, August 15 to August 31. D = time period 4, September 1 to the last sampling day.

prior to September 1, after which they were stable among years.

Prior to August 15 and after August 31, net station KL05 daily catch rates were stable among at least three of the four years (Table 6.10; Figures 6.24, 6.25). Generally, net station KL10 catch rates during the first half of the sampling season increased over the four years. After August 15, daily catch rates were lowest during 1988, and then increased during 1989. Arctic flounder daily catch rates did not differ between 1990 and 1991. Daily catch rate trends for Kaktovik Lagoon were similar to those for net station KL10.

Net station JL12 daily catch rates were lowest in 1988 prior to August 1 (Table 6.11; Figures 6.26, 6.27). After August 1, daily catch rates were stable among at least three out of four years. Arctic flounder daily catch rates at net station JL14 were lower in 1988 and 1989 during the first half of the sampling season. After August 15 daily catch rates were constant among at least three of the four years. Daily catch rates increased from 1988-91 in the Jago Lagoon sampling area.

Arctic flounder daily catch rates were consistently lower in 1991 than in 1990 at net station BL02 during the sampling season (Table 6.12; Figures 6.28, 6.29). Net station BL04 daily catch rates were stable between 1990 and 1991 at the beginning and end of the sampling season. During August daily catch rates were higher in 1991. Beaufort Lagoon daily catch rates were highest in 1990 prior to July 31. After July we detected no differences between 1990 and 1991 daily catch rates.

### *Length Frequency Distributions*

Arctic flounder length frequency distributions generally indicated bimodal distributions when stratified by area, year, and time period (Figures 6.30-6.38). The first modes occurred at 50-150 mm TL, the second occurred at 200-250 mm TL. The strength of these modes varied among time periods and years.

During 1988 and 1989 in Simpson Cove, length frequency comparisons among years showed that we caught a higher percentage of fish grouped in the mode representing larger fish, 200-250 mm TL (Figures 6.30, 6.31). In contrast, the distributions for 1990 and 1991 indicated that we caught higher percentages of smaller Arctic flounder.

We observed trends in Kaktovik and Jago lagoons similar to those in Simpson Cove. Early-season length frequencies indicated the presence of a higher percentage of large Arctic flounder in 1988 and 1989. This distribution shifted to smaller fish in 1990 and 1991 (Figures 6.32, 6.33).

In Pokok Bay, the 1988 distributions indicated bimodal trends with a higher percentage of larger fish (Figure 6.36) during the entire sampling season. In Beaufort Lagoon, the length frequency distribution generally showed a higher percentage of smaller fish (50-150 mm TL) for 1989-91. An exception was in 1989, from July 9 to 31, when fish from the larger size classes appeared to be more abundant (Figure 6.37).

TABLE 6.10.- Comparison of daily CPUE (fish/d) observations among years for Arctic flounder in Kaktovik Lagoon. For each net station/sampling area those years with the same letter, within the time period, are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons).

Within location Scheffé groupings			
Year	KL05	KL10	Kaktovik Lagoon
Time Period 1 - first day to July 31			
1988	B	C	C
1989	A	B	B
1990	A,B	A	A
1991	A	A	A
Time Period 2 - August 1 to August 14			
1988	A,B	C	B
1989	A	B	A
1990	B	A	A
1991	A,B	A,B	A
Time Period 3 - August 15 to August 31			
1988	B	C	C
1989	A	A	A
1990	A	B	A,B
1991	B	B	B,C
Time Period 4 - September 1 to last day			
1988	B	C	B
1989	B	A	A
1990	A	A,B	A
1991	B	B,C	A,B

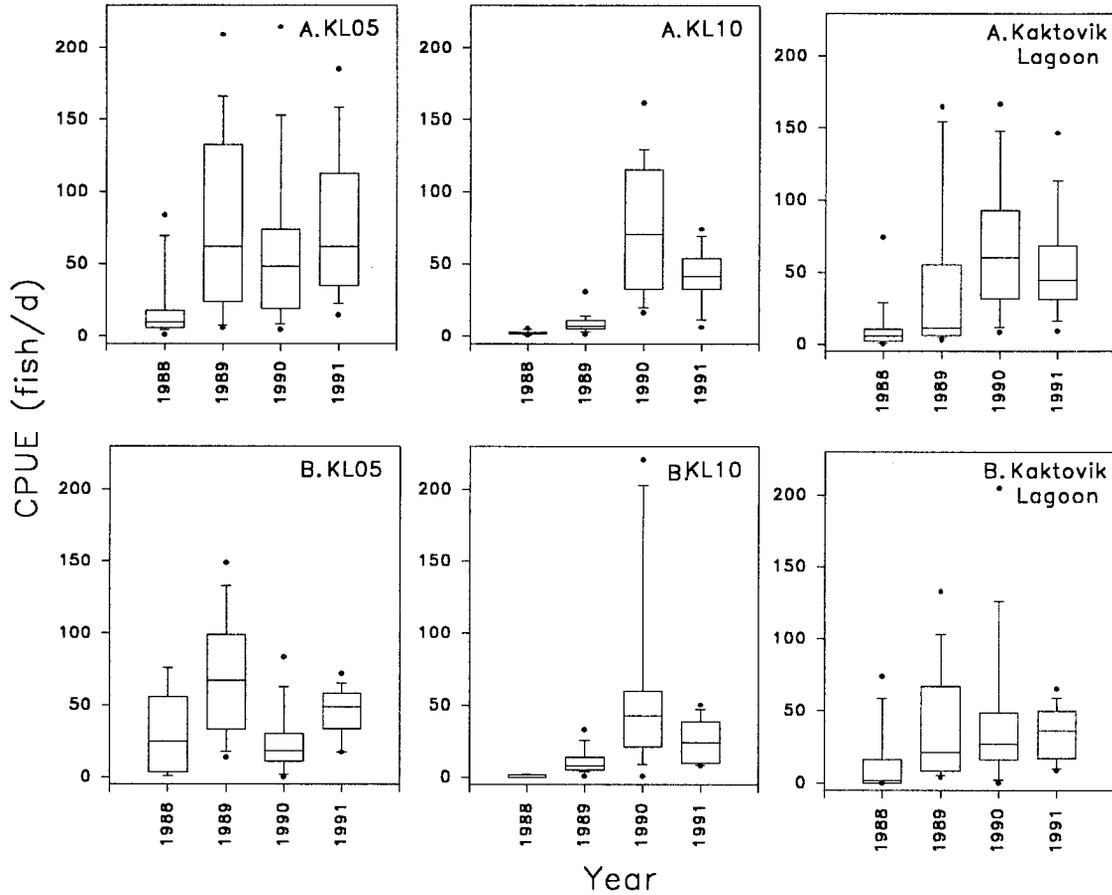


FIGURE 6.24.- Boxplots comparing daily CPUE (fish/d) observations among years for Arctic flounder in Kaktovik Lagoon. A = time period 1, the first sampling day to July 31. B = time period 2, August 1 to August 14.

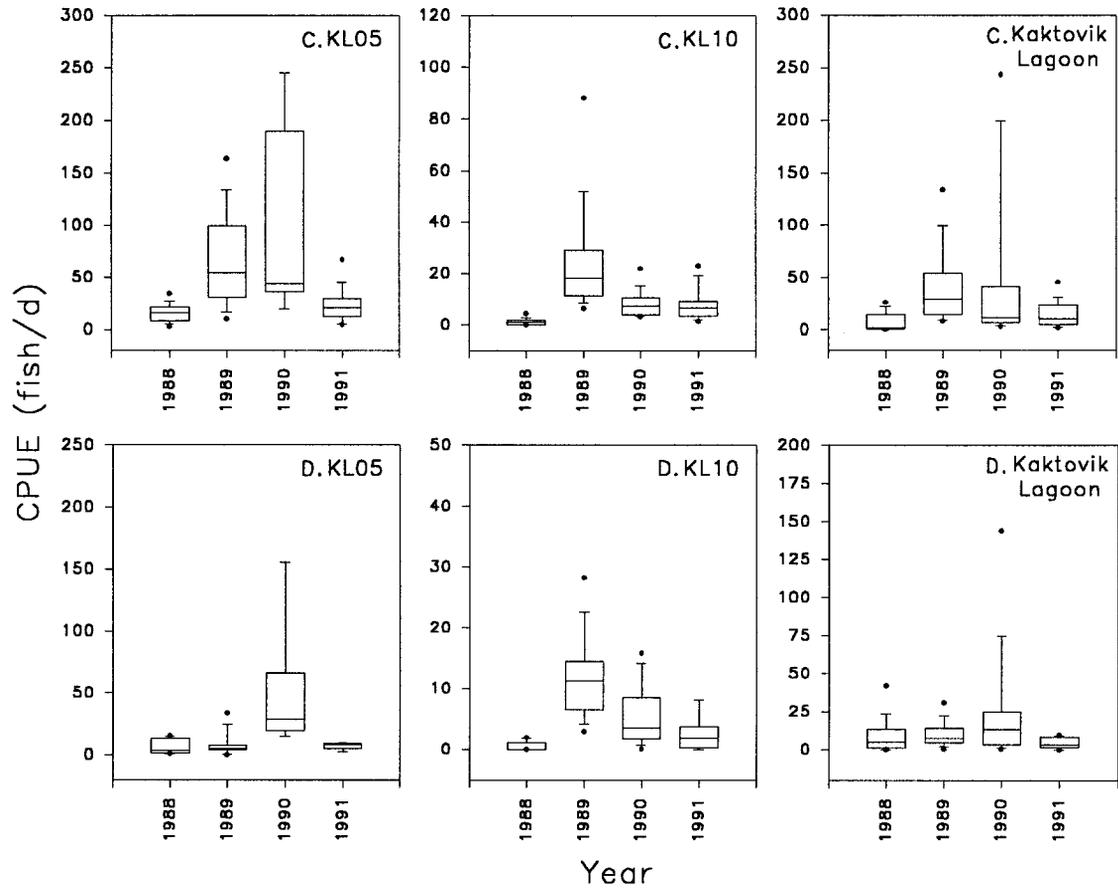


FIGURE 6.25.- Boxplots comparing daily CPUE (fish/d) observations among years for Arctic flounder in Kaktovik Lagoon. C = time period 3, August 15 to August 31. D = time period 4, September 1 to the last sampling day.

TABLE 6.11.— Comparison of daily CPUE (fish/d) observations among years for Arctic flounder in Jago Lagoon. For each net station/sampling area those years with the same letter, within the time period, are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons).

Year	Within location Scheffé groupings		
	JL12	JL14	Jago Lagoon
Time Period 1 - first day to July 31			
1988	C	B	D
1989	B	B	C
1990	A	A	B
1991	A	A	A
Time Period 2 - August 1 to August 14			
1988	B	B	C
1989	A,B	B	B
1990	A	A	A
1991	A	A	A
Time Period 3 - August 15 to August 31			
1988	B	A	B
1989	A	A	A,B
1990	A,B	A	A
1991	A	A	A
Time Period 4 - September 1 to last day			
1988	B	B	B
1989	A,B	A,B	A
1990	A	A,B	A
1991	A,B	A	A

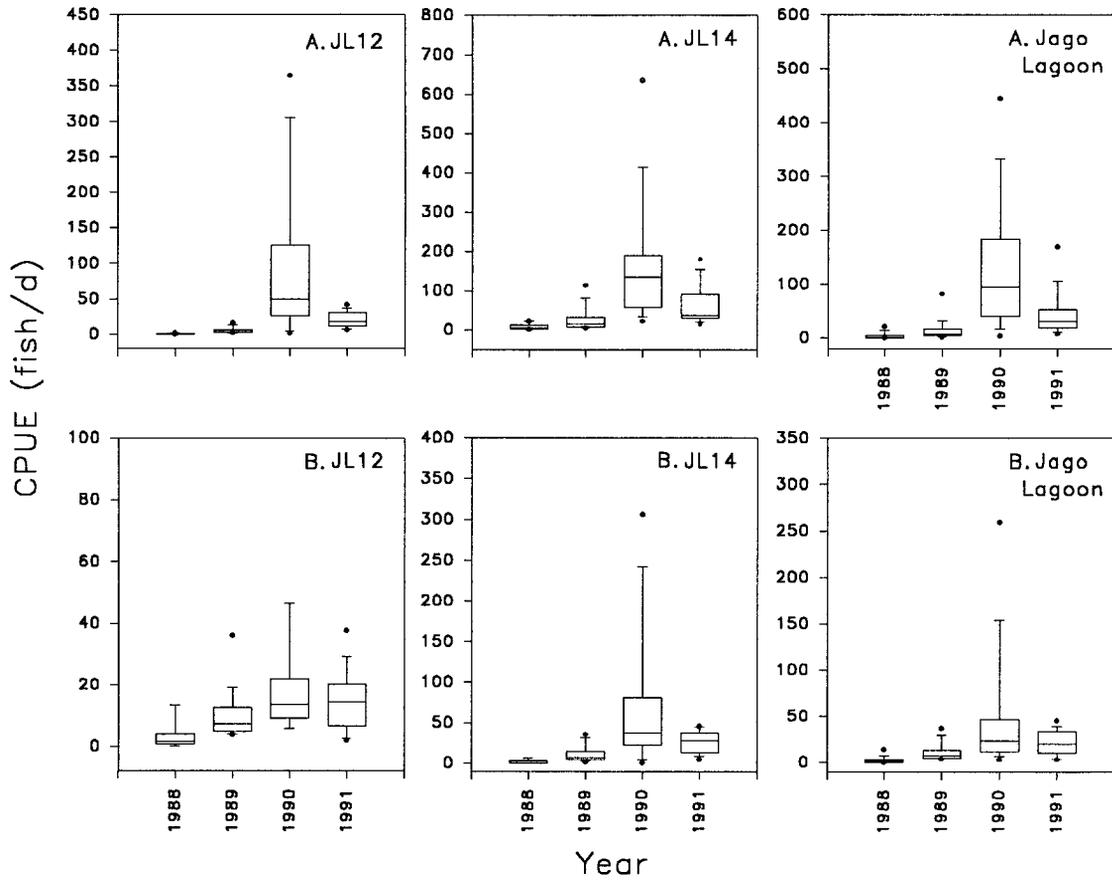


FIGURE 6.26.- Boxplots comparing daily CPUE (fish/d) observations among years for Arctic flounder in Jago Lagoon. A = time period 1, the first sampling day to July 31. B = time period 2, August 1 to August 14.

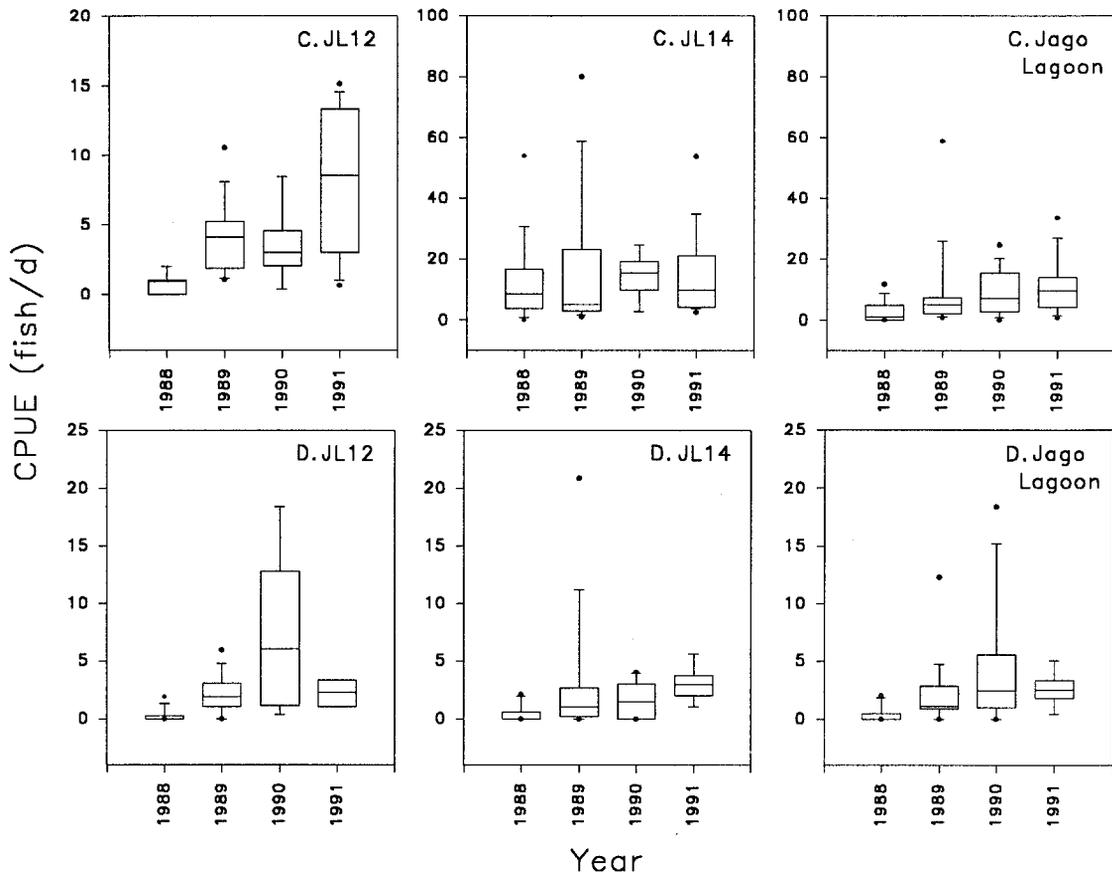


FIGURE 6.27.- Boxplots comparing daily CPUE (fish/d) observations among years for Arctic flounder in Jago Lagoon. C = time period 3, August 15 to August 31. D = time period 4, September 1 to the last sampling day.

TABLE 6.12.— Comparison of daily CPUE (fish/d) observations between years for Arctic flounder in Beaufort Lagoon. For each net station/sampling area those years with the same letter, within the same time period, are not significantly different (Kruskal-Wallis test with Scheffé multiple comparisons).

Within location Scheffé groupings			
Year	BLO2	BLO4	Beaufort Lagoon
Time Period 1 - first day to July 31			
1990	A	A	A
1991	B	A	B
Time Period 2 - August 1 to August 14			
1990	A	B	A
1991	B	A	A
Time Period 3 - August 15 to August 31			
1990	A	B	A
1991	B	A	A
Time Period 4 - September 1 to last day			
1990	A	A	A
1991	B	A	A

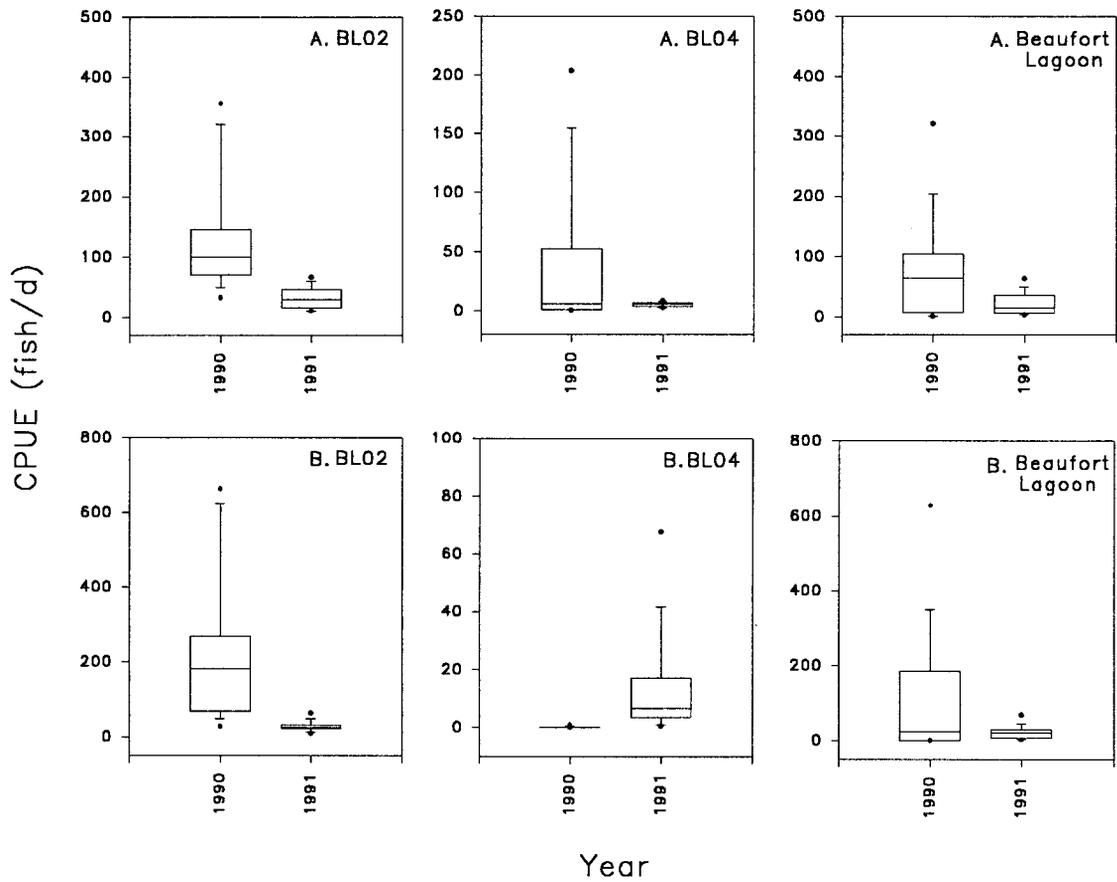


FIGURE 6.28.— Boxplots comparing daily CPUE (fish/d) observations between years for Arctic flounder in Beaufort Lagoon. A = time period 1, the first sampling day to July 31. B = time period 2, August 1 to August 14.

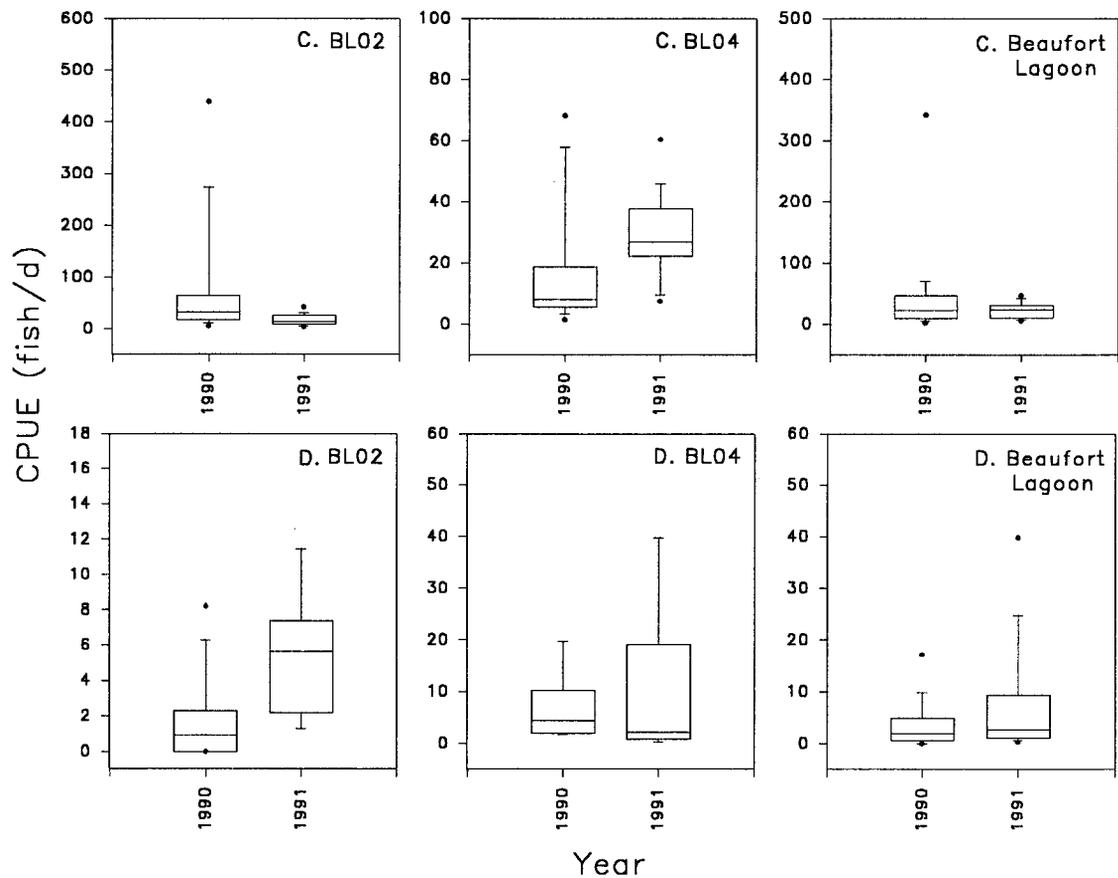


FIGURE 6.29.— Boxplots comparing daily CPUE (fish/d) observations between years for Arctic flounder in Beaufort Lagoon. C = time period 3, August 15 to August 31. D = time period 4, September 1 to the last sampling day.

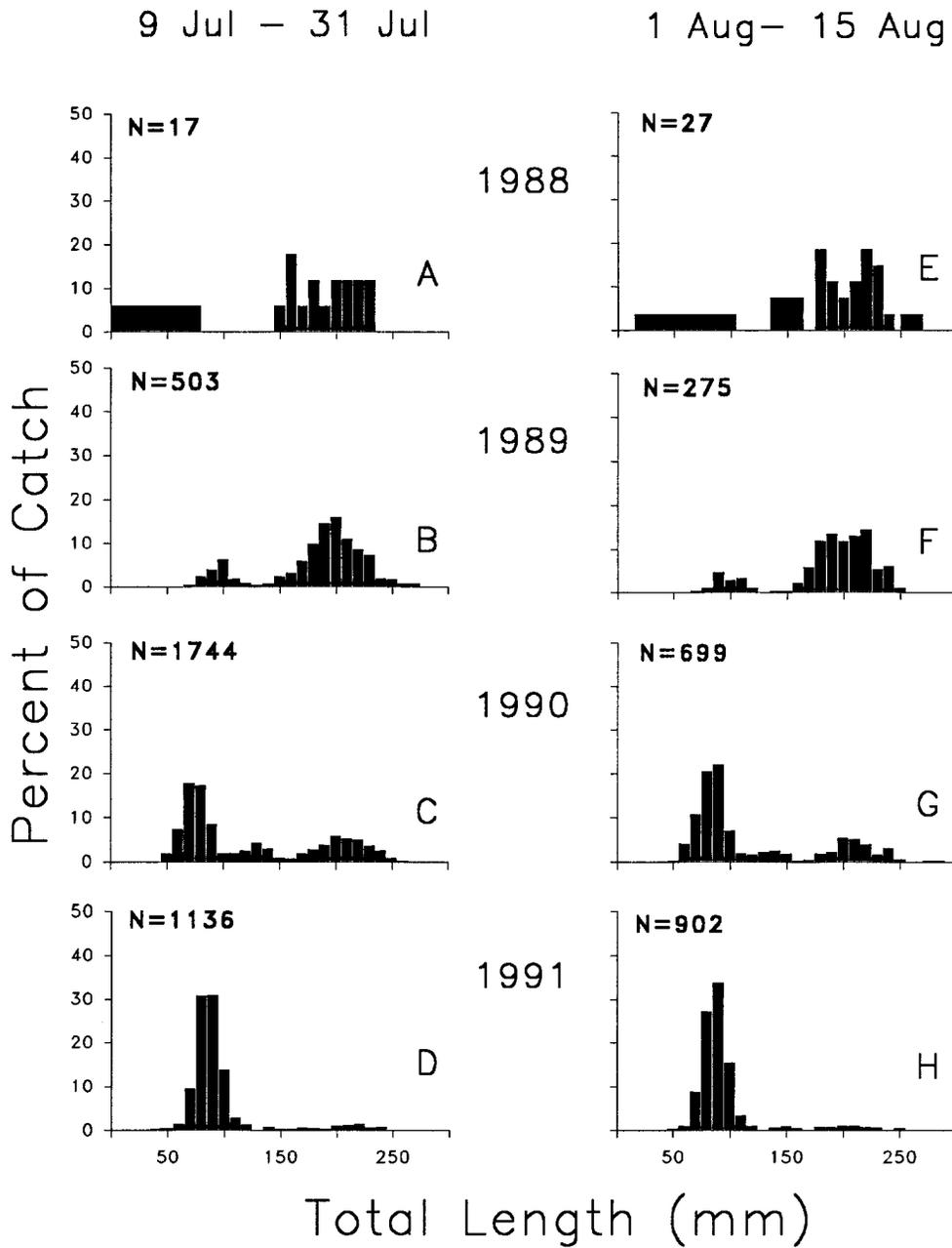


FIGURE 6.30.— Length frequencies of Arctic flounder captured by fyke nets in Simpson Cove, plotted by year for July 9 to August 15.

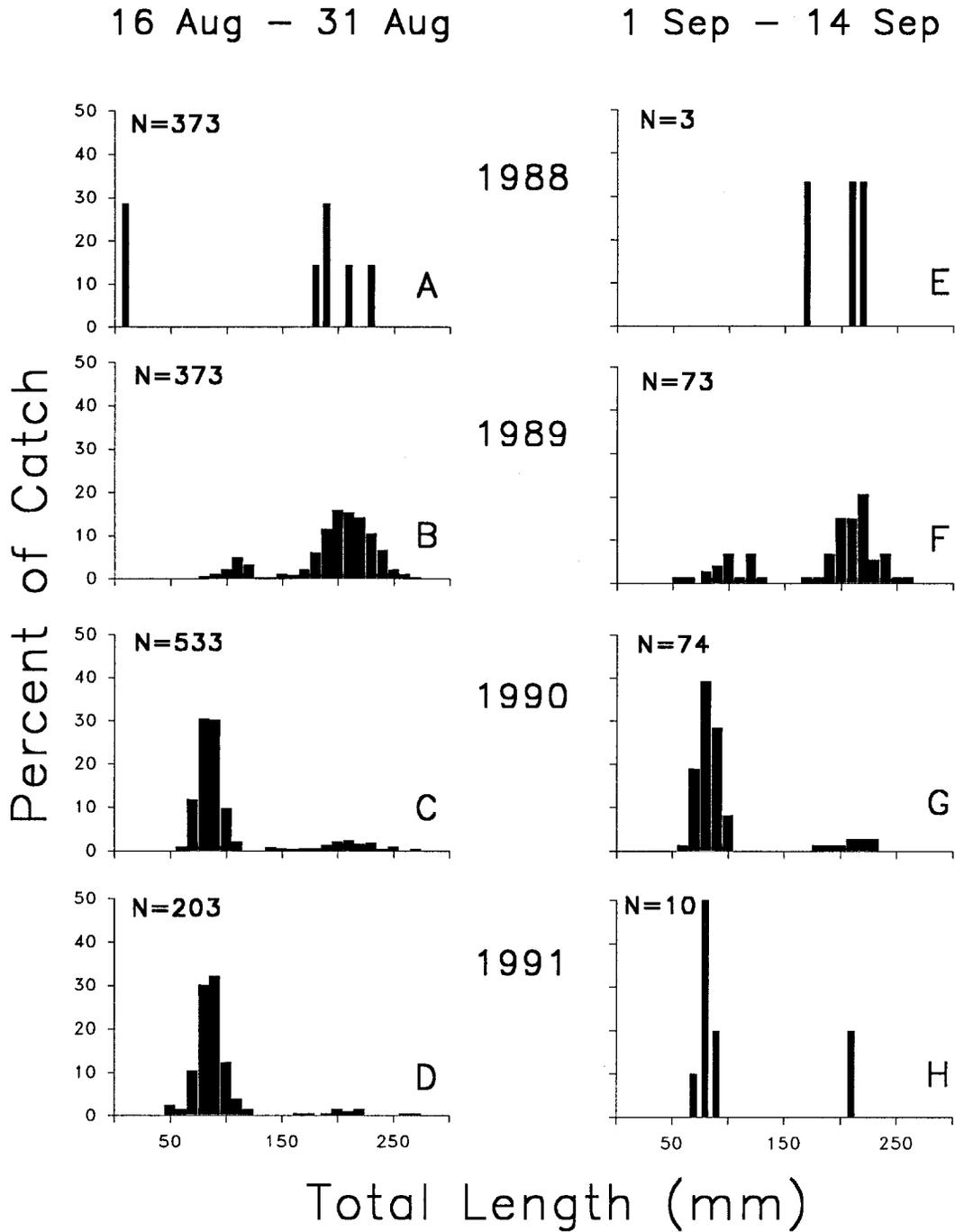


FIGURE 6.31.— Length frequencies of Arctic flounder captured by fyke nets in Simpson Cove, plotted by year for August 16 to September 14.

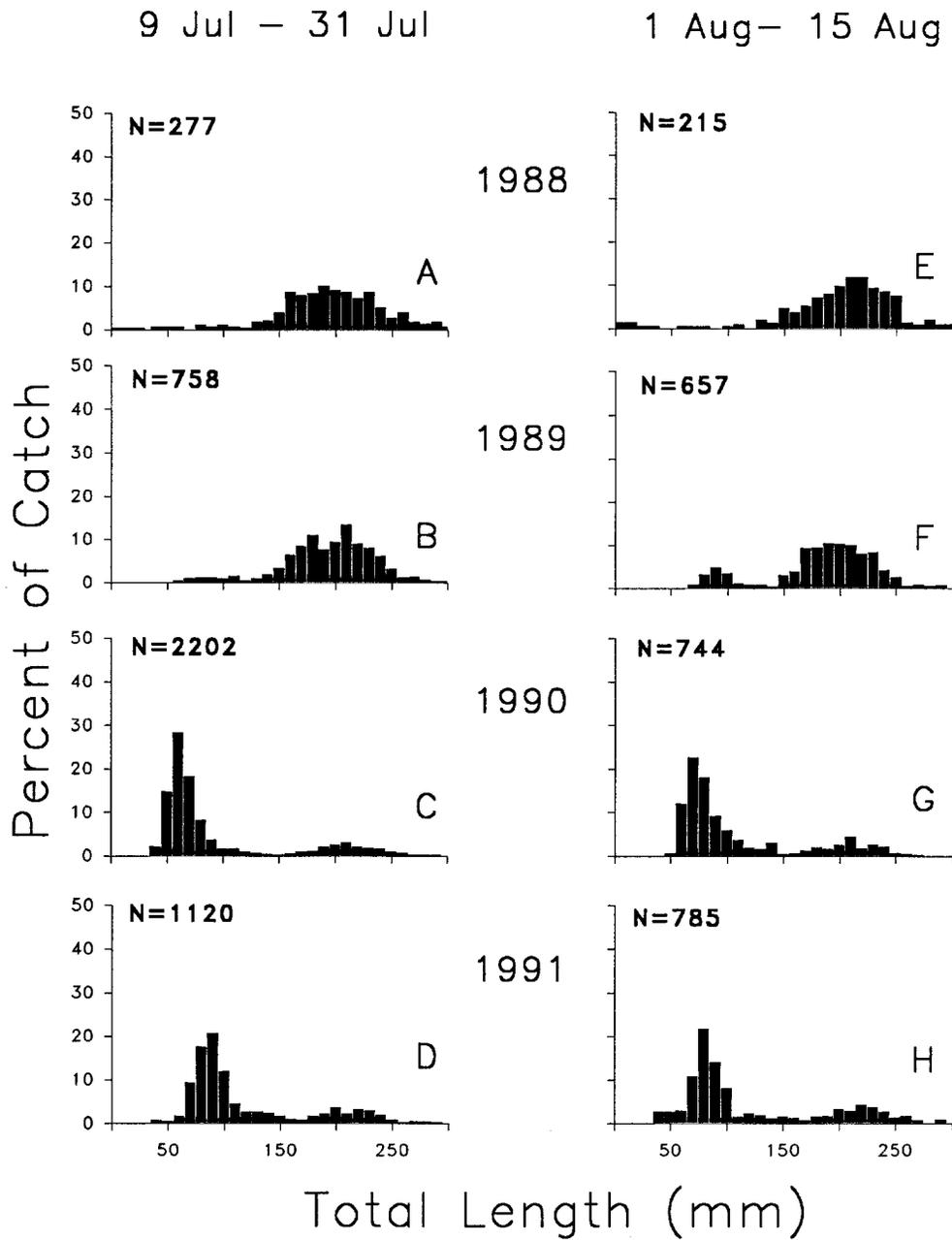


FIGURE 6.32.— Length frequencies of Arctic flounder captured by fyke nets in Kaktovik Lagoon, plotted by year for July 9 to August 15.

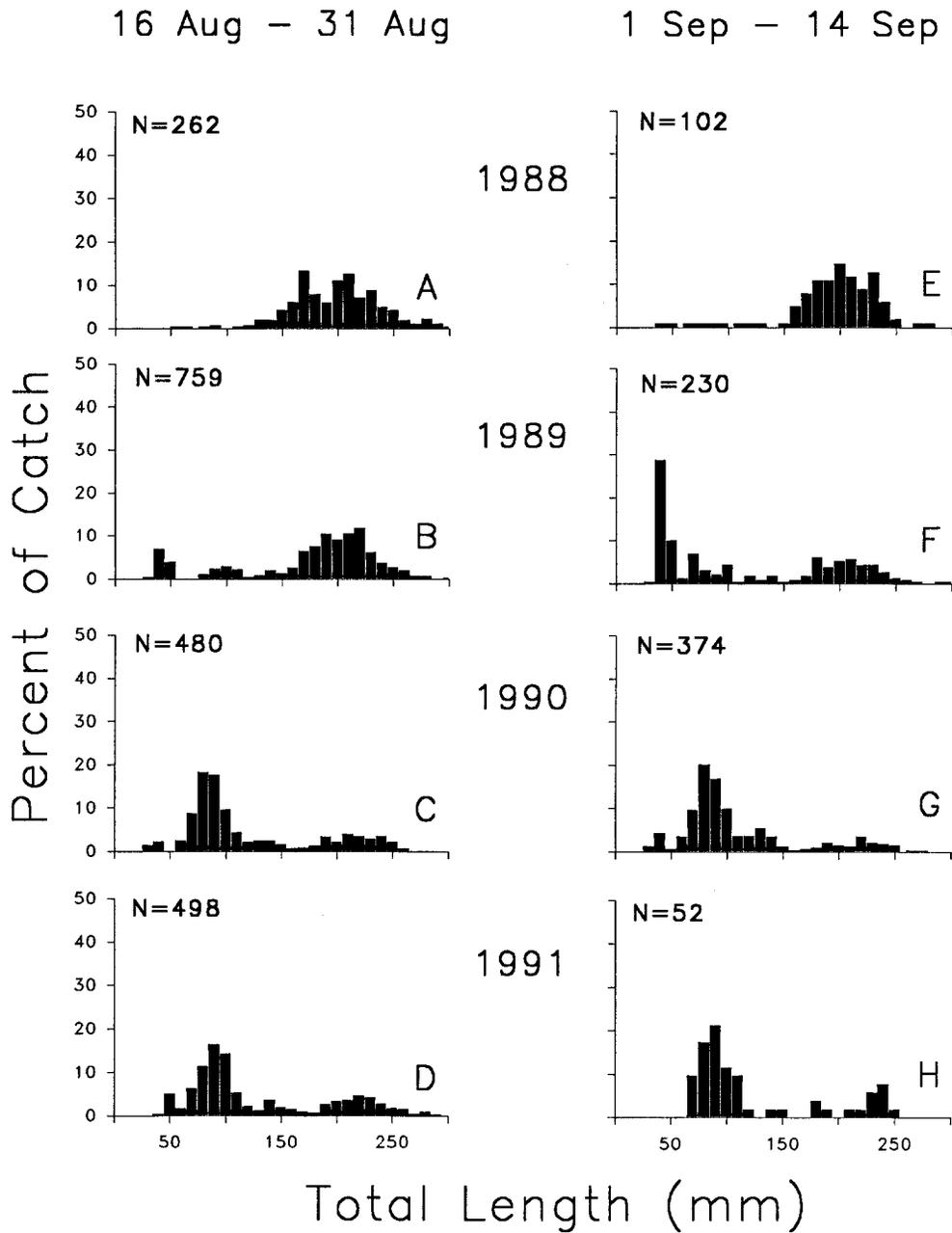


FIGURE 6.33.— Length frequencies of Arctic flounder captured by fyke nets in Kaktovik Lagoon, by year for August 16 to September 14.

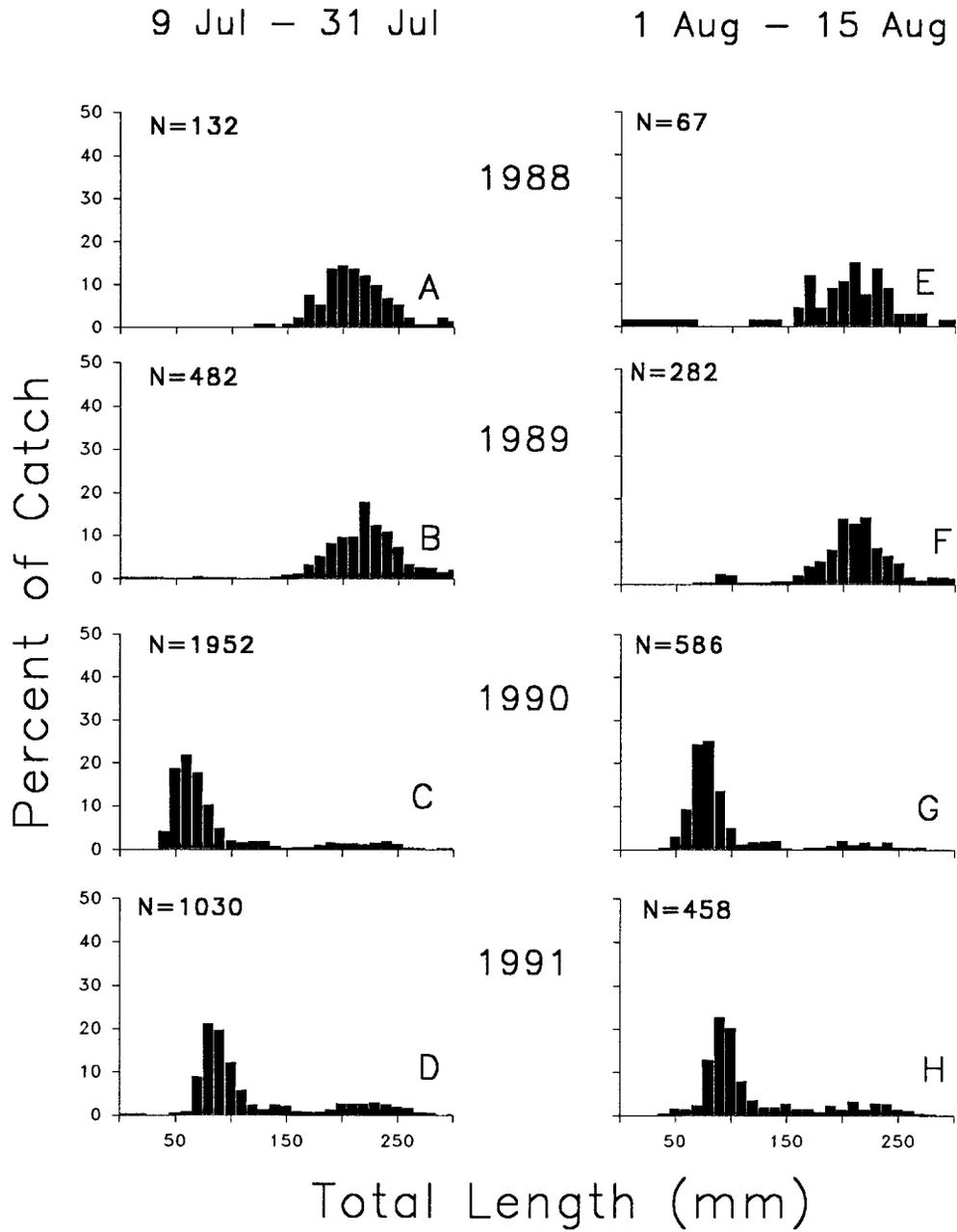


FIGURE 6.34.— Length frequencies of Arctic flounder captured by fyke nets in Jago Lagoon, plotted by year for July 9 to August 15.

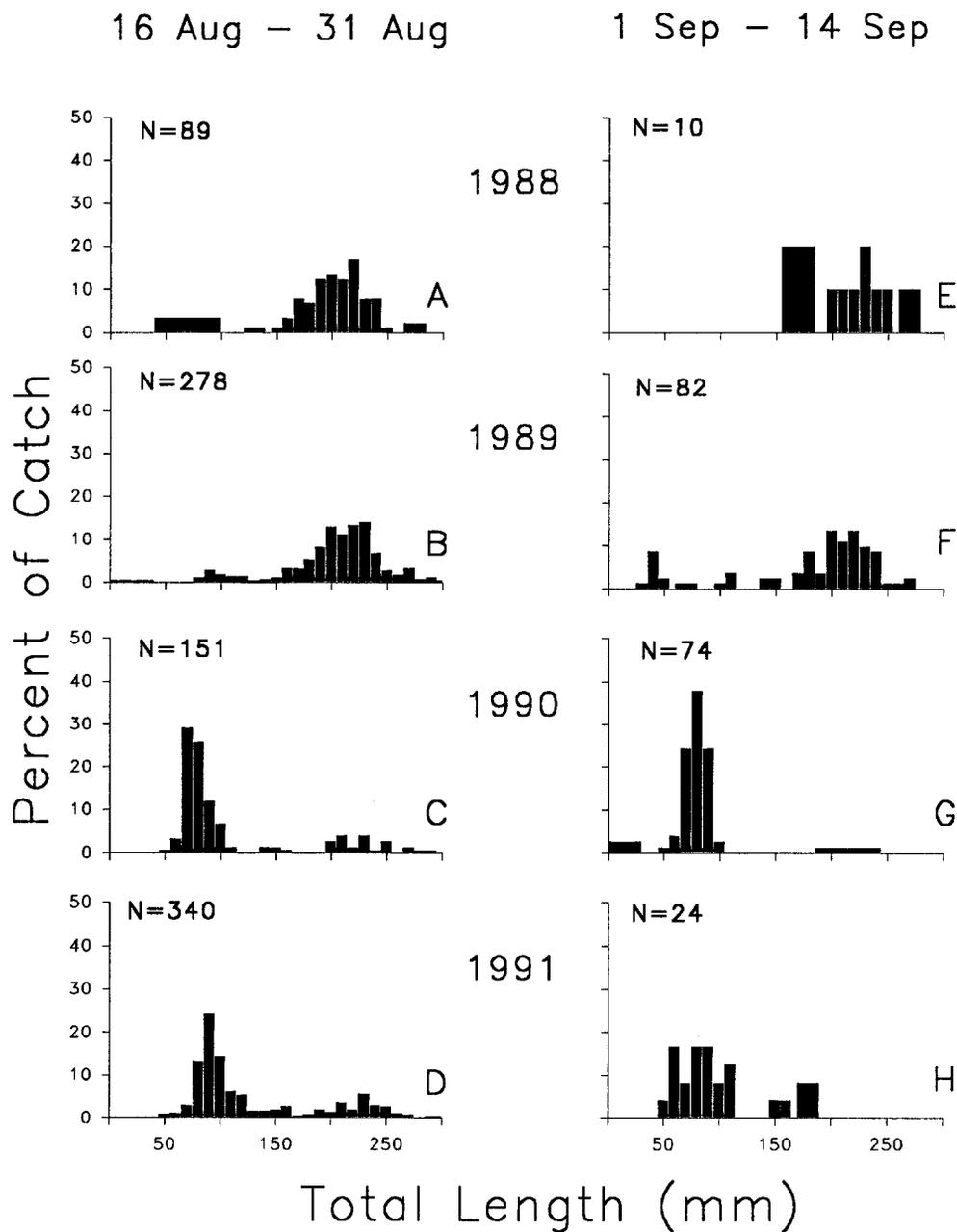


FIGURE 6.35.— Length frequencies of Arctic flounder captured by fyke nets in Jago Lagoon, plotted by year for August 16 to September 14.

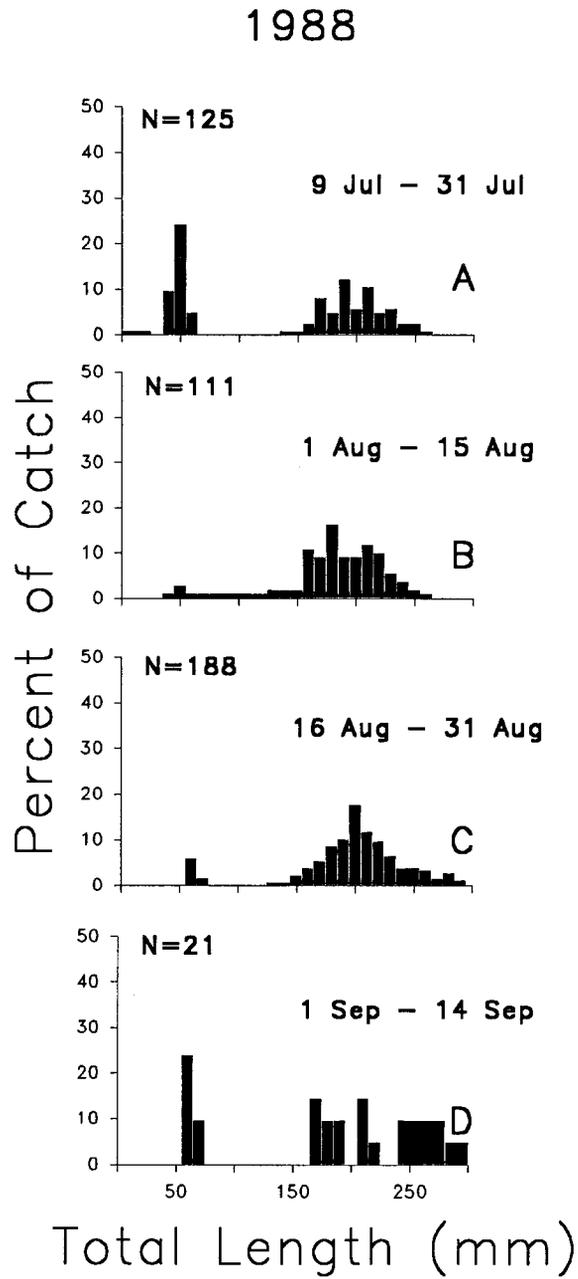


FIGURE 6.36.- Length frequencies of Arctic flounder captured by fyke nets in Pokok Bay, plotted for July 9 to September 14, 1988 only.

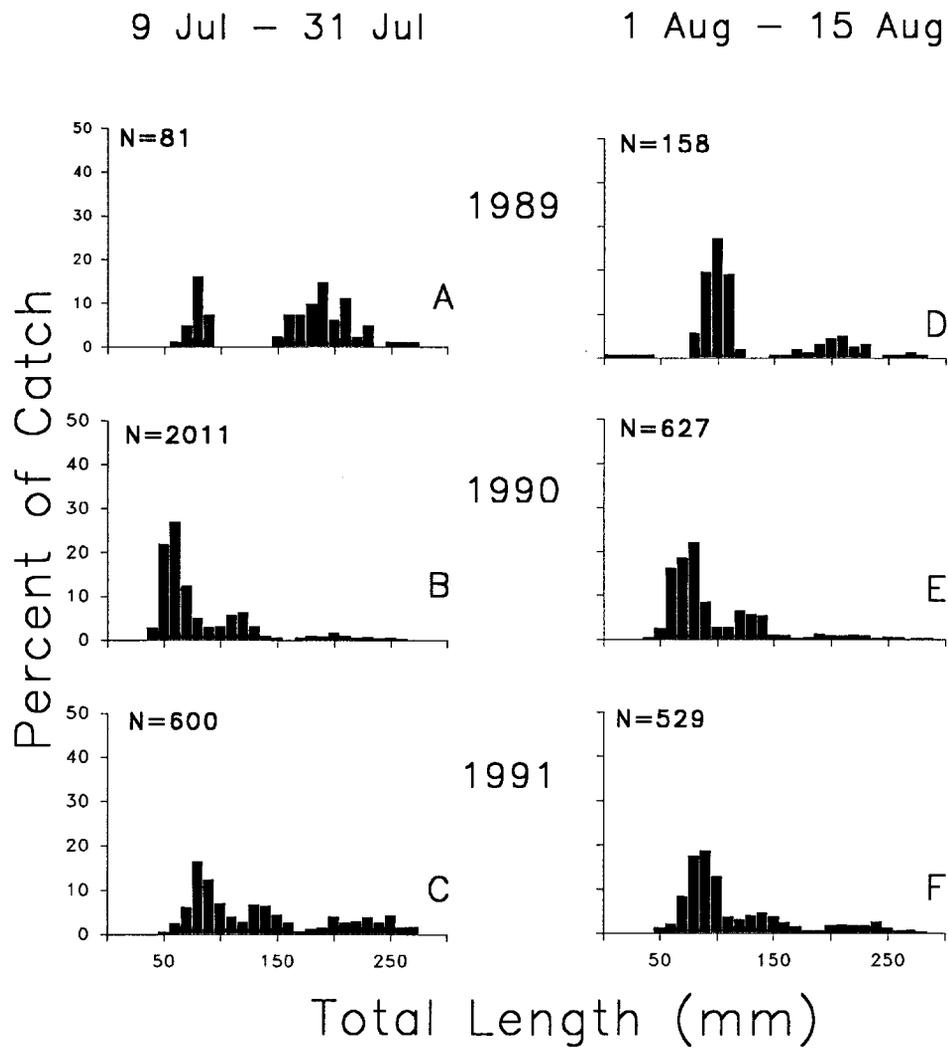


FIGURE 6.37.— Length frequencies of Arctic flounder captured by fyke nets in Beaufort Lagoon, plotted by year for July 9 to August 15.

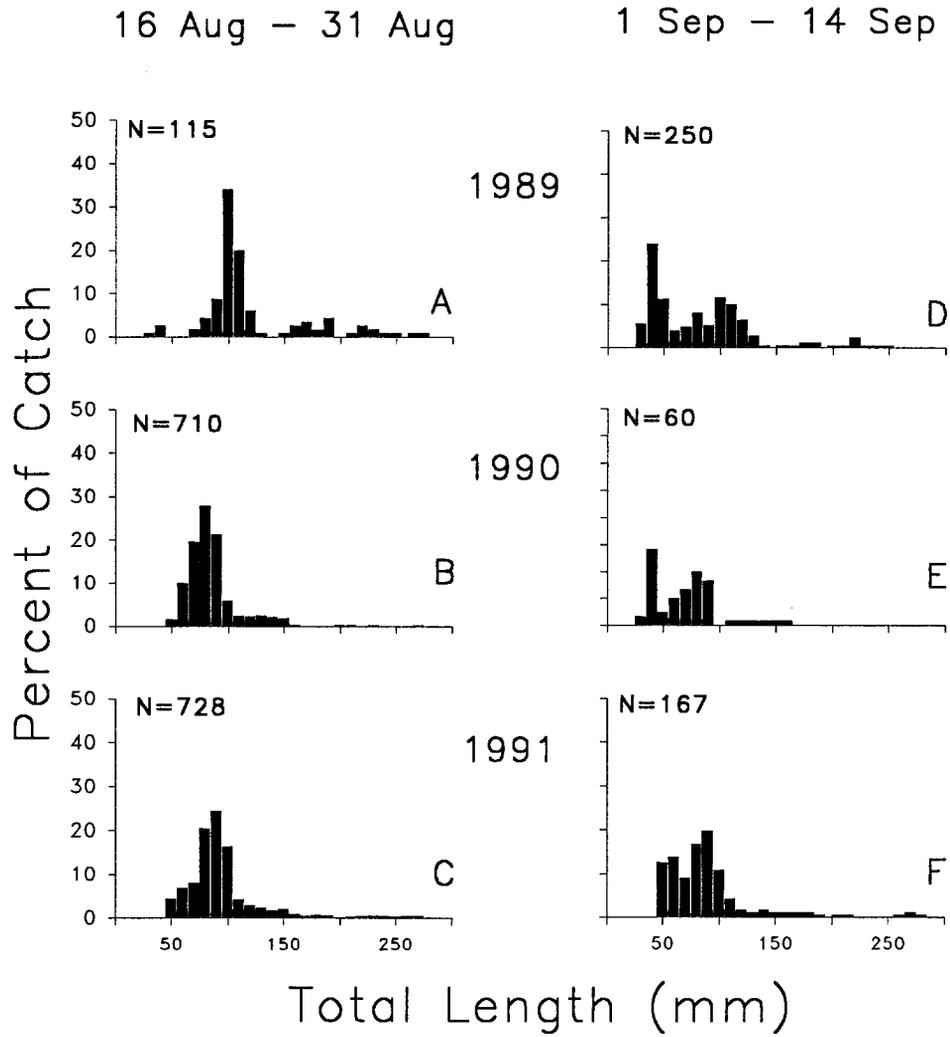


FIGURE 6.38.— Length frequencies of Arctic flounder captured by fyke nets in Beaufort Lagoon, plotted by year for August 16 to September 14.

### *Condition*

*Gender differences.*— During July, we found significant differences in condition between female and male Arctic flounder in the pooled year analyses. The intercept values indicated that the condition of female Arctic flounder was higher than that for males (Table 6.13). Plots of transformed data (Figure 6.39A, B) showed fewer small males present. The presence or absence of outliers did not affect the results of the analysis. Our sample sizes were inadequate for analyses of within-year data.

*Seasonal differences.*— Early and late Arctic flounder had significantly different condition in analyses pooled over years and within each year (Table 6.14). Intercept-values were higher in the late group which indicated that Arctic flounder were of higher condition late in the season. The only exception occurred in 1990 when condition was slightly higher early in the sampling season. Plots of transformed data indicated similar sizes of Arctic flounder were used in each group (Figure 6.39C, D). The presence of outliers affected only 1990 results. In this case, the removal of outliers resulted in slope estimates which were significantly different, precluding statements about condition.

*Overwintering.*— Significant declines in condition occurred between fall and the following spring when data from the winters of 1989-90 and 1990-91 were analyzed (Table 6.15). Intercept values in post-winter samples were lower than pre-winter samples indicating lower condition after the passage of winter. The fall 1988 sample did not meet minimum sample size and prevented analysis of the 1988-89 winter data. Plots of transformed data from the other winters showed similar size ranges of fish in each sample (Figure 6.40). Removal of outliers allowed detection of significant differences in slopes, precluding statements about condition.

*Spatial differences.*— Differences in slope from July data, pooled over years, precluded statements about spatial differences in condition unless outliers were removed (Table 6.16). With outliers removed, pairwise tests indicated that Beaufort Lagoon fish were significantly different from those of Kaktovik and Jago lagoons, but neither differed from Simpson Cove fish. Intercept values indicated condition of Arctic flounder in Beaufort Lagoon was higher than in Kaktovik and Jago lagoons. Plots of transformed data showed similar size ranges of fish in each area (Figure 6.41).

Results from July within 1990 and 1991 differed from each other and the pooled data results. In 1990, after outliers were removed, we detected significant differences in condition although pairwise comparisons differed from the pooled results (Table 6.16). Intercept values indicated that fish from Kaktovik and Jago lagoons had higher condition than those fish in Beaufort Lagoon. In 1991, slope differences precluded statements about condition.

We did not detect spatial differences in condition after August 27 in the pooled data until we removed outliers (Table 6.17). Pairwise comparisons indicated Beaufort Lagoon differed from the other areas. Intercept values

TABLE 6.13.— Condition comparisons between female and male Arctic flounder collected in July. Analyses were for combined years. Asterisks (\*) indicate significant differences in condition.

Group	N	Slopes		Intercepts		$r^2$
		$b(SE)$	$P$ -values	$\log_e a(SE)$	$P$ -values	
Females	112	3.13 (0.05)		-11.90 (0.25)		0.98
Males	57	3.14 (0.05)		-12.03 (0.25)		0.99
			$P = 0.90$		$P = 0.003$	*
	Without outliers		$P = 0.42$		$P = 0.0006$	*