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AN ANALYSIS OF SOUTH UNIMAK AND SHUMAGIN ISLANDS JUNE FISHERIES SOCKEYE SALMON GUIDELINE HARVEST LEVEL TIME PERIODS

By

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And

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INTRODUCTION

In 1975, the Alaska Board of Fisheries (BOF) implemented an allocation plan effecting the South Unimak and Shumagin Islands June fisheries (Figure 1). The BOF established sockeye salmon, *Oncorhynchus nerka*, guideline harvest levels that were distributed over set time periods to avoid excessive impacts on any segment of the sockeye salmon runs. In recent years, the interception of chum salmon, *Oncorhynchus keta*, in these fisheries has become a major issue for the BOF. In 1989, the time period guideline harvest levels were modified in an attempt to decrease the overall harvest of chum salmon (ADF&G 1992, 5 AAC 09.365 South Unimak and Shumagin Islands June salmon management plan). Heightening concerns, were the poor runs that occurred in 1993 among Western Alaska chum stocks, mostly in the Arctic-Yukon-Kuskokwim area. In March of 1994, the BOF considered and approved a proposal to minimize chum salmon interception in the South Unimak and Shumagin Islands June fisheries by eliminating the time periods and allowing the Alaska Department of Fish and Game (ADF&G) to establish fishing periods based on favorable sockeye-to-chum salmon ratios. Aside from allocative, processing, or other concerns, the main considerations here were whether the elimination of time periods would excessively impact any segment of the sockeye salmon runs and what the decrease in the chum salmon harvest would be.

The data and analysis presented in this report were provided to the BOF at the March 1994 meeting for guidance on the proposal for eliminating fishing time periods from the South Peninsula June fishery management plan. The data and analysis also provided guidance to the BOF on a companion regulatory change that gave inseason emergency order regulatory authority to modify the fishing seasons to correspond times when the ratio of sockeye-to-chum salmon is high.

ADF&G has little information on the run timing of sockeye salmon through the South Unimak and Shumagin Islands June fisheries. Most ADF&G stock identification effort has been directed toward chum salmon (Eggers et. al, 1991). During the 1989 BOF meeting, Dr. D.E. Rogers, University of Washington, presented a paper on sockeye salmon which the Board used to establish the current June time periods (Rogers 1989). Dr. Rogers believes that time periods are not necessary to avoid excessive impacts on any segment of the runs of sockeye salmon if the June fisheries occur between about June 13 to late June; there is enough overlap in the run timing of stocks through the fisheries to prevent excessive impacts on any sockeye salmon stock (D.E. Rogers, Fisheries Research Institute, University of Washington, personal communication).

Beginning in 1975, BOF implemented an allocation plan where the South Unimak and Shumagin Islands June fisheries were managed through the use of time periods to reduce the possibility of overharvesting any segment of the Bristol Bay run, the guideline harvest level was allocated to discrete time periods based on historical catch data.

During the years 1975-89 there were four time periods (June 1-11, 12-18, 19-25, and 26-30; Table 1). The total guideline harvest was divided between the South Unimak fishery and the

Shumagin Islands fishery, then each fishery's guideline harvest was further divided into allocations to each time period. The allocation to each time period was based on historical catches (e.g., 51% of the South Unimak guideline harvest was allocated to the June 19-25 time period).

During 1990-93, the South Unimak and Shumagin Islands June guideline harvest was partitioned into three time periods (June 13-18, June 19-25, and June 26-30; Table 2). Thirtyfive percent of the sockeye allocation was apportioned to the first period, 45% to the second, and 20% to the last period. This allocative method was based on a combination of historic catch data and testimony presented to the BOF (Rogers 1989).

In the past, fishery managers closed the June fisheries due to attainment of a period's allocation and waited to reopen the fishery until the beginning of the next allocation period. Data indicated that, by deferring 20% of the guideline harvest level to the last allocative period (June 26-30), the management plan may unnecessarily increase the catch of chum salmon. In seven of the last ten years, the June fisheries have been open to commercial salmon fishing after June 25 (Table 3). In the seven years in which the June fishery was open after June 25, the sockeye-to-chum salmon ratio was lower than both the June 13-18 and June 19-25 periods in five years and lower than the June 19-25 ratio in all seven years.

Another noticeable trend is that the June 19-25 period tended to have the highest sockeye-to-chum salmon ratio in the years 1984-89, but, since the fishery has been managed under the 1990-93 allocation time periods, the June 13-18 period has tended to have the highest sockeye-to-chum salmon ratio (Table 3). For example, in 1993, the June 13-18 period had a catch of 7.0 sockeye for every chum salmon, the next period, June 19-25 had a catch of 5.8 sockeye per chum salmon, and the last period where 20% of the total guideline harvest was allocated, had a ratio of only 2.9 sockeye per each chum salmon.

Past trends in the sockeye-to-chum ratio using the current allocation periods, suggest that, in general, the total June sockeye allocation could be harvested with a lower catch of chum salmon by attaining the June sockeye salmon guideline harvest prior to the last period (June 26-30).

To determine what gains in the sockeye-to-chum salmon ratio could be realized by concentrating fishing effort early after the June 13 opening, we modeled the catch of sockeye and chum salmon that would have occurred in the South Unimak and Shumagin Islands June fisheries had those fisheries been open on June 13 and fished continuously until they closed due to attaining the sockeye salmon allocation or due to reaching the chum salmon cap for each year. The results from the model fisheries and comparison with the actual fishery performances for 1984 through 1993 are presented in this report.

MATERIALS AND METHODS

Data used in this analysis are: 1) catch of sockeye and chum salmon per day by gear type (purse seine or drift gillnet), 2) number of permits participating per day by gear type, and 3) hours of fishery openings by day in the Shumagin Islands and South Unimak June fisheries for the years 1984 through 1993. Catch and permit participation data were obtained from the ADF&G Fish Ticket Database System. Hours of fishery openings per day for the South Unimak and Shumagin Islands June fisheries of 1984 through 1993 are presented in Tables 4 and 5.

Data from the set gillnet fishery were not included in the analysis, since set gillnet gear accounts for only a small portion of the sockeye and, particularly, chum salmon harvest in the South Unimak and Shumagin Islands June fisheries (Shaul et al. 1993).

Catch per unit effort (CPUE) of a species for a day by gear type was computed by using "permit-hours" (i.e., the number of permits participating on that day, times, the number of hours open to fishing on that day) as the measure of effort. That is, the CPUE for species s (sockeye or chum) by gear type g (purse seine or drift gillnet) on day d (June 13 to the last observed day of fishing) of year y (1984 through 1993) in fishery f (South Unimak or Shumagin Islands) was computed as

$$CPUE_{sgdyf} = \frac{C_{sgdyf}}{P_{gdyf}H_{dyf}},$$

where,

C_{sgdyf} is the observed catch of species s by gear type g on day d of year y in fishery f,

P_{gdyf} is the observed number of permits that participated by gear type g on day d of year y in fishery f, and

H_{dyf} is the observed number of hours open to fishing on day d of year y in fishery f.

We estimated the catch of species s by gear type g on day d of year y in fishery f that would have occurred in the 1984 through 1993 South Unimak and Shumagin Islands June fisheries in modeled fisheries that opened on 13 June and remained open until closure by

$$\hat{C}_{sgdyf} = \hat{CPUE}_{sgdyf}\hat{P}_{gdyf}\hat{H}_{dyf},$$

where,

$\hat{C}PUE_{sgdyf}$ is the modeled CPUE of species s by gear type g on day d of year y in fishery f,

$\hat{P}_{gdyf}$ is the modeled number of permits that participated by gear type g on day d of year y in fishery f, and

$\hat{H}_{dyf}$ is the modeled effective number of hours open to fishing on day d of year y in fishery f.

If fishery f was in fact open on day d of year y, $\hat{CPUE}_{sgdyf}$ and $\hat{P}_{gdyf}$ were set to the observed values, $CPUE_{sgdyf}$ and P_{gdyf}, respectively. When the actual fisheries were closed for some of the days that we attempted to model the fishery, it was necessary to estimate the CPUE of sockeye and chum by gear type that likely would have been realized and the number of permits by gear type that would have participated had the fishery been open. In such cases, $\hat{CPUE}_{sgdyf}$ and $\hat{P}_{gdyf}$ were determined for gear type g on day d using linear interpolation between adjacent observed values; i.e.,

$$\hat{CPUE}_{sgdyf} = \frac{CPUE_{gd_1yf}(d-d_1) + CPUE_{gd_2yf}(d_2-d)}{d_2-d_1},$$

and

$$\hat{P}_{gdfy} = \frac{P_{gd_1yf}(d-d_1) + P_{gd_2yf}(d_2-d)}{d_2-d_1},$$

where d_1 is the last day prior to day d that fishery f was open in year y and d_2 is the first day after day d that the fishery was open. For example, in 1993 the South Unimak and Shumagin Islands fisheries was open on June 13 and June 15, but not open on June 14. The modeled number of permits of gear type g that would have participated in fishery f on June 14, 1993 (had the fishery been open) is the average between the observed number of permits of gear type g that were observed on June 13 and June 15 1993; i.e.,

$$\hat{P}_{g,14,93,f} = \frac{P_{g,13,93,f}(14-13) + P_{g,15,93,f}(15-14)}{15-13}$$

$$= \frac{P_{g,13,93,f} + P_{g,15,93,f}}{2}.$$

CPUE and permit participation for a day are affected by factors that we can neither model or estimate, including the run strength of a species, weather and tides, the decisions of individual fishers, and the effect of the number of permits participating on CPUE. Nonetheless, in the observed data CPUE for a day tends to follow that of the preceding day's CPUE. So, estimating CPUE and permit participation by linear interpolation for a day that was not open to fishing seems reasonable, although there is not enough data to either support or refute this belief. Although we feel comfortable using interpolation to estimate CPUE and permit participation for a day that was directly preceded by and followed by openings in the actual fishery, we feel less

comfortable using interpolation to model a period with more than two consecutive days of closure in the actual fishery. In this regard, note that the models for the 1984 and 1985 South Unimak and Shumagin Islands June fisheries are based largely on interpolated values; in particular, the 1984 South Unimak model is based on interpolation between two days of openings, June 13 and June 19 (Tables 4 and 5).

CPUE for a day open to fishing for less than 24 hours is not affected by the daylight and other limitations that would tend to lower the day's CPUE if the opening was extended to a full 24 hours. So, using a value of 24 for $\hat{H}_{dyf}$ to compute $\hat{C}_{sgdyf}$ for a day that is modeled to have been open to fishing for 24 hours would probably overestimate catch when $\hat{CPUE}_{sgdyf}$ is based on an observed H_{dyf} of less than 24 hours. Accordingly, for days in which the observed CPUE data was based on an opening of less than 20 hours, we used a value of $\hat{H}_{dyf} = 20$ to compute $\hat{C}_{sgdyf}$ for a day that was modeled to have an opening of 20 or more hours. In cases where the observed CPUE data was based on openings of 20 or more hours, we set $\hat{H}_{dyf}$ equal to the observed hours of opening to compute $\hat{C}_{sgdyf}$ for a day that was modeled to have an opening longer than what was actually observed.

We made no attempt to model a fishery for a given year prior to the observed first day of opening or beyond the observed last day of opening in that year. Consequently, for the 1991 and 1992 fisheries, our models begin on June 15, since that was the date of first opening in those years (Tables 4 and 5). The 1988 Shumagin Islands June fishery opened prior to June 13 (Table 5), but there was no participation by purse seiners until June 18. So, our model of the Shumagin Islands June fishery for 1988 likewise begins on June 18.

All model fisheries except those of 1986, 1988, 1990, and 1991 were closed at the end of the first hour that the June sockeye allocation for the fishery was attained by the combined purse seine and drift gillnet fleets (for this model the 1984-89 regulation of no more than 96 hours per seven day period and no more than 72 hours of consecutive fishing time in each fishery "window regulation" was eliminated). The 1990 model could not attain the sockeye allocation under the continuous opening scenario by the last day of observed fishing. The actual 1986, 1988, and 1991 fisheries were closed well below the sockeye allocations due to either low sockeye-to-chum ratios in the catch or by hitting the year's "chum cap". Accordingly, the model 1986, 1988, and 1991 fisheries were closed on the hour that the observed chum catch for the fishery was attained.

RESULTS

Compared to the actual fisheries for 1984 through 1993, the model fisheries for the total South Peninsula purse seine and drift gillnet June fisheries produced higher sockeye-to-chum salmon ratios in four years (1984, 1985, 1991, and 1993), no appreciable difference in the sockeye-to-chum ratio in four years (1987, 1988, 1990, and 1992), and lower sockeye-to-chum ratios in two years (1986 and 1989; Table 6, Figure 2).

A lower sockeye-to-chum salmon ratio was calculated for two years: 1986 and 1989. In 1986, the lower calculated value was a result of the low sockeye-to-chum salmon ratio found during the entire fishery and the loss of the last period's sockeye allocation for the 1986 season. The regulation eliminating the last period's sockeye salmon harvest was in effect for only the 1986 season but it effected both the actual and the modeled catch. In 1989, poor early season sockeye-to-chum salmon ratios effected the modeled catch. After the 1989 season, BOF eliminated fishing during June 1-12 because of the poor early season sockeye-to-chum salmon ratios and moved that period's sockeye allocation to other time periods. The model fishery for 1989 is the only year that showed a lower than observed sockeye-to-chum salmon ratio for a year that was not closed due to the catch of chum salmon.

For those years that were closed before attainment of the sockeye allocation due to the catch of chum salmon (1986, 1988, and 1991), the model fishery sockeye-to-chum ratio was higher than observed for one year (1991), lower than observed for one year (1986), and showed no appreciable difference for the remaining year (1988).

For the past four years (1990-93), the fisheries were managed under the current allocation time periods. During those years, the model fishery showed higher sockeye-to-chum salmon ratios than the actual fisheries in two years (1991 and 1993) and no appreciable difference from the actual fisheries in the remaining two years (1990 and 1992).

Taken separately, the modeled South Unimak fishery sockeye-to-chum ratio was higher than observed in six years (1984, 1985, 1988, 1991, 1992, and 1993), there was no appreciable difference during two years (1987, and 1990), and there was a lower than observed ratio during two years (1986 and 1989; Table 7, Figure 3).

The model Shumagin Islands fishery sockeye-to-chum salmon ratio was higher than observed in four years (1984, 1985, 1991, and 1993), there was no appreciable difference during four years (1986, 1987, 1988, and 1990), and there was a lower than observed ratio during two years (1989 and 1992; Table 8, Figure 4). During the last four years (1990-93), which is the time period of the current management plan, only in the Shumagin Islands during 1992 was the modeled sockeye-to-chum salmon ratio less that the observed ratio.

CONCLUSIONS

Our results are not meant to indicate that the South Peninsula fisheries should or, even, could be managed under the scenario used for our model. Concentrating fishing effort immediately after the June 13 opening can occasionally produce an unnecessarily low sockeye-to-chum ratio in the harvest (e.g., 1986 and 1989). However, data from past fisheries indicates that openings in the late June period should generally be avoided to reduce the catch of chum salmon and our model fisheries indicate that the sockeye allocations could usually be attained prior to the late June period with a reduction in the catch of chum salmon. In the rare years in which the early post-

June 13 sockeye-to-chum ratio is low, unnecessarily high catches of chum salmon can still be avoided by the fishery managers' use of test fisheries and daily fisheries performance data. Closure of the fisheries prior to attainment of the sockeye guideline harvest level due to low sockeye-to-chum salmon ratios may be unavoidable in some years (e.g., 1986, 1988, and 1991). Our model, however, indicates that the sockeye catch in 1991 would have been closer to the guideline harvest level if fishing were concentrated early, after the first opening (Figure 5).

Our model was developed to approximate sockeye and chum salmon catches. We believe that with active-flexible management of the South Peninsula June fisheries, through the elimination of the management plans established time periods, that ADF&G managers should be able to reduce the total June chum salmon harvest.

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Table 1. South Unimak and Shumagin Islands June time periods and guideline harvest levels, 1975-89.

	Guideline Harvest	
Time Period	South Unimak	Shumagin Islands
June 1-11	5%	9%
June 12-18	29%	28%
June 19-25	51%	41%
June 26-30	15%	22%
	100%	100%

Table 2. South Unimak and Shumagin Islands June time periods and guideline harvest levels, 1990-93.

Time Period	Guideline Harvest
June 13-18	35%
June 19-25	45%
June 26-30	20%
	100%

Table 3. Sockeye-to-chum salmon ratios in the South Peninsula June fisheries by allocation period, 1984-93.

Year	Period		
	June 13-18	June 19-25	June 26-30
1984	4.5	6.4	1.1
1985	5.3	7.2	3.1
1986	1.0	2.2	-
1987	1.5	2.2	2.0
1988	1.6	1.6	0.8
1989	3.0	5.5	-
1990	3.4	2.4	1.9
1991	2.7	1.8	-
1992	5.7	5.8	5.7
1993	7.0	5.8	2.9
Average	3.6	4.9	2.5

Table 4. Number of hours fished per day during June, South Unimak, 1984-93.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
June										
1										
2										
3	24	16								
4	24									
5		16								
6										
7		16								
8				16						
9		16								
10				18		16				
11			24	22	14					
12	24	16								
13	8						18			16
14		16	16	18			22			
15				22	14			16	18	18
16			6		14	16	18		24	24
17				18			22	18	24	18
18			12	16	6		24	24	14	
19	18	16				18	24	24	22	18
20				18		22	24	22		22
21		16	18	24	15		24		18	
22				20	9		24		14	12
23		16	24		22	12	24	18		
24			24				22	24		
25			24	12				12		
26				22			16		5	18
27					16					22
28							5			
29										8
30										
Total	98	144	148	226	110	84	267	158	139	176

Table 5. Number of hours fished per day during June, Shumagin Islands, 1984-93.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
June										
1										
2										
3	24	16								
4	24									
5		16								
6										
7		16								
8				16						
9										
10				16		16				
11			24		14					
12	24	16								
13	8						16			16
14		14	16	16						
15					14		18	16	16	16
16			6		16	16	24			
17					22		22	18	8	16
18			12		16		24	22		
19	18	16				18	24		12	18
20				16		22	24	16		24
21		16	18		15		24		4	22
22							22	16		
23			24		20					
24			24		22					
25			24							
26	24	16		12					2.5	16
27					12					
28		16								12
29										
30										
Total	122	142	148	76	151	72	198	88	42.5	140

Table 6. South Peninsula June purse seine and drift gillnet fishery: observed and modeled sockeye and chum salmon catch, and sockeye-to-chum salmon ratio, 1984-93.[a]

Year	Sockeye Allocation		First Date	Last Date	Sockeye Catch	Chum Catch	Sockeye:Chum Ratio	+ -
1984	1356	Observed	3	26	1363	336	4.1	
		Modeled	13	16	1358	292	4.7	(+)
1985	1685	Observed	3	28	1756	426	4.1	
		Modeled	13	16	1697	330	5.1	(+)
1986	1107	Observed	11	25	440	344	1.3	
		Modeled	13	16	351	346	1.0	(-)
1987	775	Observed	8	26	746	438	1.7	
		Modeled	13	22	777	447	1.7	(0)
1988	1542	Observed	11	27	662	513	1.3	
		Modeled	13	21	720	512	1.4	(0)
1989	1463	Observed	10	23	1674	449	3.7	
		Modeled	13	16	1486	575	2.6	(-)
1990	1327	Observed	13	28	1290	513	2.5	
		Modeled	13	25	1313	522	2.5	(0)
1991	1920	Observed	15	25	1457	762	1.9	
		Modeled	15	24	1804	758	2.4	(+)
1992	2391	Observed	15	26	2332	419	5.6	
		Modeled	15	22	2410	420	5.7	(0)
1993	2899	Observed	13	29	2831	521	5.4	
		Modeled	13	21	2927	425	6.9	(+)

[a]The "First" and "Last" dates refers to dates of gear participation; "+" denotes a modeled ratio of 10% or more than observed; "-" denotes an observed ratio of 10% or more than modeled; "0" denotes otherwise.

Table 7. South Unimak June purse seine and drift gillnet fishery: observed and modeled sockeye and chum salmon catch, and sockeye-to-chum salmon ratio, 1984-93.[a]

Year	Sockeye Allocation		First Date	Last Date	Sockeye Catch	Chum Catch	Sockeye:Chum Ratio	+ -
1984	1111	Observed	3	19	1120	228	4.9	
		Modeled	13	16	1113	206	5.4	(+)
1985	1380	Observed	3	23	1438	323	4.5	
		Modeled	13	16	1391	250	5.6	(+)
1986	907	Observed	11	25	309	251	1.2	
		Modeled	13	16	231	253	0.9	(-)
1987	635	Observed	8	26	639	403	1.6	
		Modeled	13	22	636	403	1.6	(0)
1988	1263	Observed	11	27	459	462	1.0	
		Modeled	13	18	512	461	1.1	(+)
1989	1199	Observed	10	23	1313	405	3.2	
		Modeled	13	16	1221	539	2.3	(-)
1990	1087	Observed	13	28	1072	454	2.4	
		Modeled	13	25	1090	461	2.4	(0)
1991	1573	Observed	15	25	1190	666	1.8	
		Modeled	15	24	1499	662	2.3	(+)
1992	1959	Observed	15	26	1958	320	6.1	
		Modeled	15	22	1970	293	6.7	(+)
1993	2375	Observed	13	29	2300	374	6.1	
		Modeled	13	20	2392	347	6.9	(+)

[a]The "First" and "Last" dates refers to dates of gear participation; "+" denotes a modeled ratio of 10% or more than observed; "-" denotes an observed ratio of 10% or more than modeled; "0" denotes otherwise.

Table 8. Shumagin Islands June purse seine fishery: observed and modeled sockeye and chum salmon catch, and the sockeye-to-chum salmon ratio, 1984-93.[a]

Year	Sockeye Allocation		First Date	Last Date	Sockeye Catch	Chum Catch	Sockeye:Chum Ratio	+ -
1984	245	Observed	3	26	243	108	2.2	
		Modeled	13	15	245	86	2.9	(+)
1985	305	Observed	3	28	318	103	3.1	
		Modeled	13	16	306	80	3.8	(+)
1986	200	Observed	11	25	131	93	1.4	
		Modeled	13	16	120	93	1.3	(0)
1987	140	Observed	8	26	107	35	3.1	
		Modeled	13	17	141	44	3.2	(0)
1988	279	Observed	18	27	203	51	4.0	
		Modeled	18	21	208	51	4.1	(0)
1989	264	Observed	10	20	361	44	8.1	
		Modeled	13	16	265	36	7.3	(-)
1990	240	Observed	13	22	218	59	3.7	
		Modeled	13	22	223	61	3.7	(0)
1991	347	Observed	15	22	267	96	2.8	
		Modeled	15	21	305	96	3.2	(+)
1992	432	Observed	15	26	374	99	3.8	
		Modeled	15	17	440	127	3.5	(-)
1993	524	Observed	13	28	531	147	3.6	
		Modeled	13	21	535	78	6.8	(+)

[a]The "First" and "Last" dates refers to dates of gear participation; "+" denotes a modeled ratio of 10% or more than observed; "-" denotes an observed ratio of 10% or more than modeled; "0" denotes otherwise.

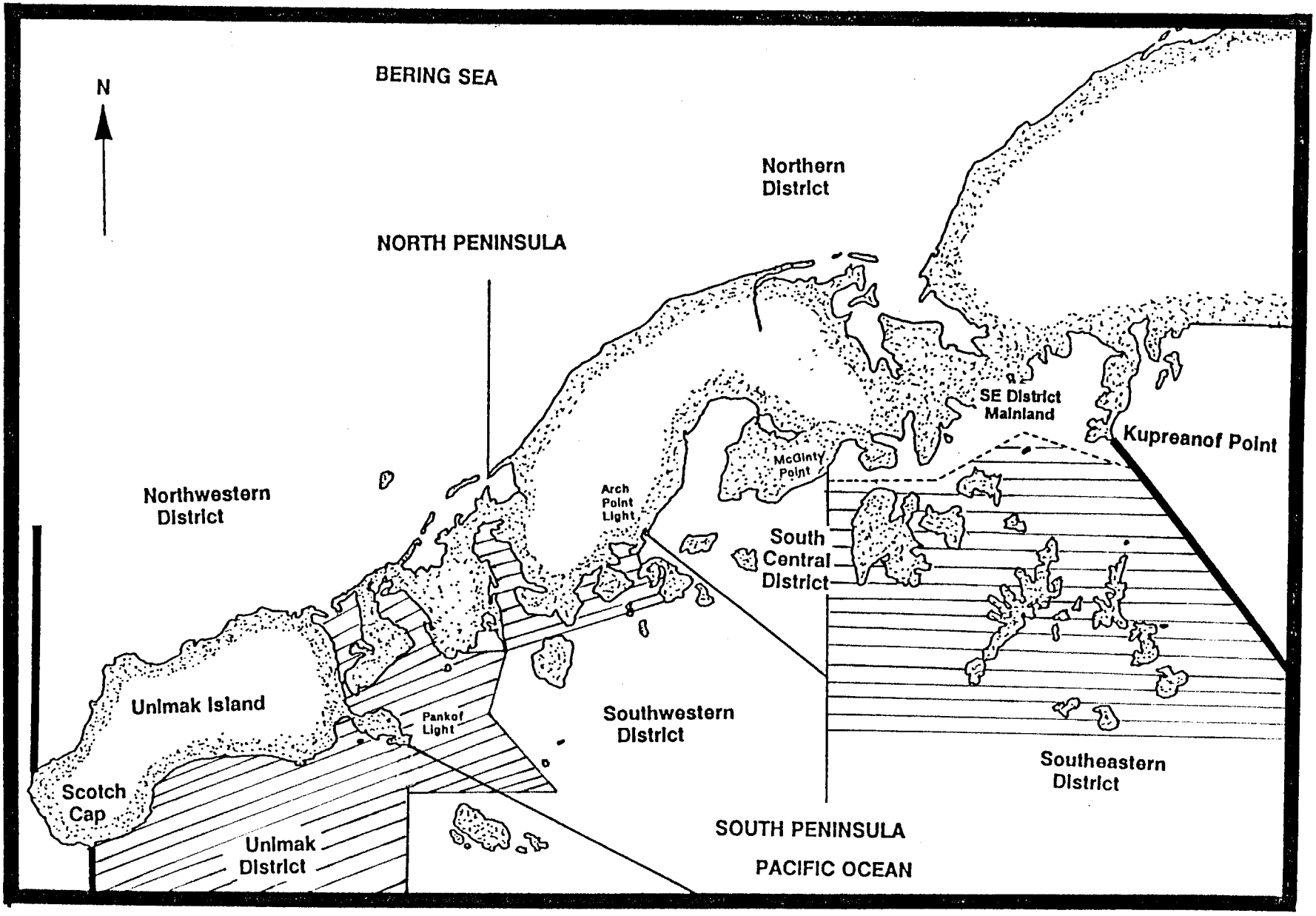

Figure 1. Map of the Alaska Peninsula Area from Kupreanof Point to Scotch Cap with those areas open under the South Unimak and Shumagin Islands June salmon management plan highlighted.

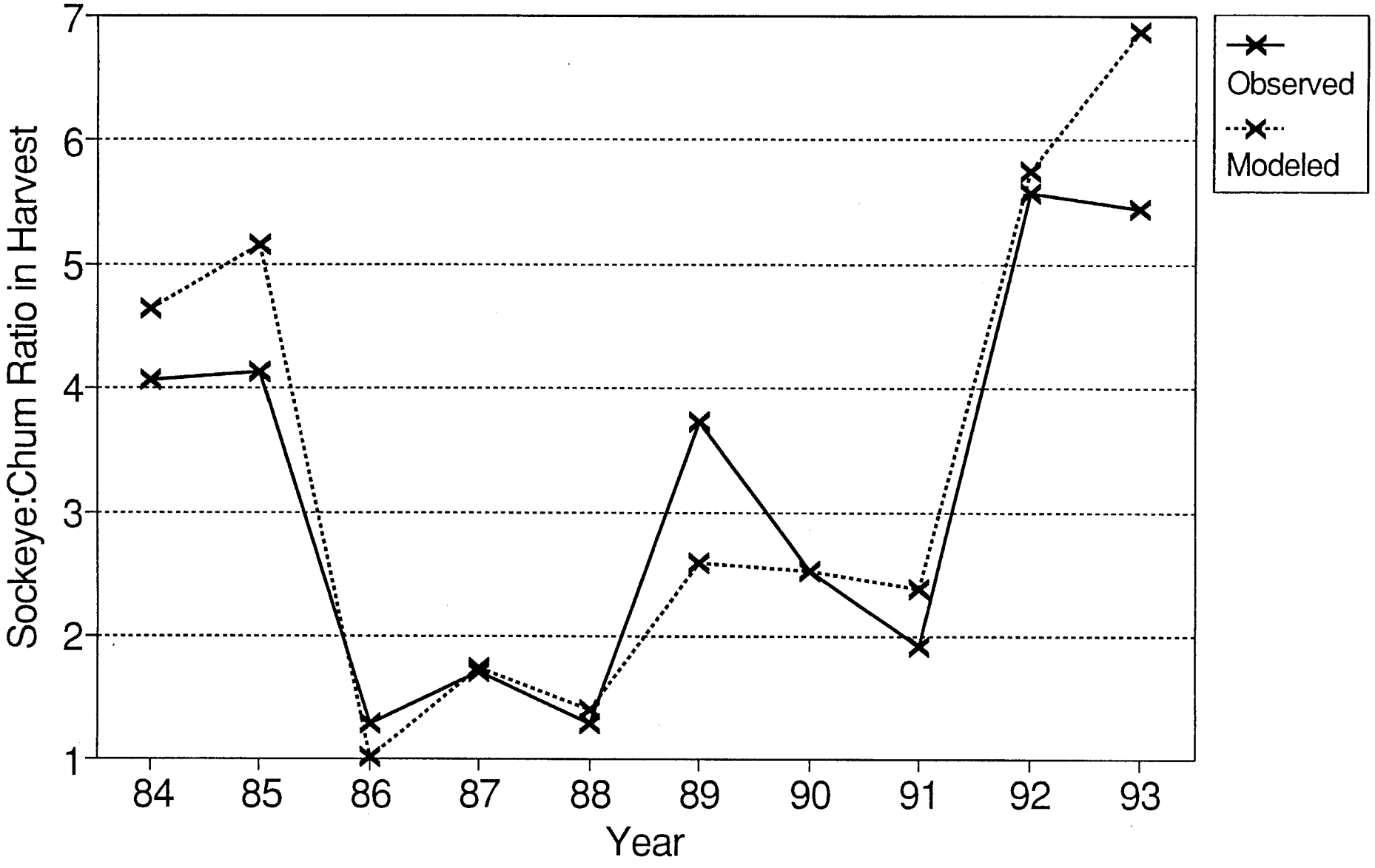

Figure 2. Observed and modeled sockeye-to-chum salmon ratios in the South Peninsula June purse seine and drift gillnet fishery, 1984-93.

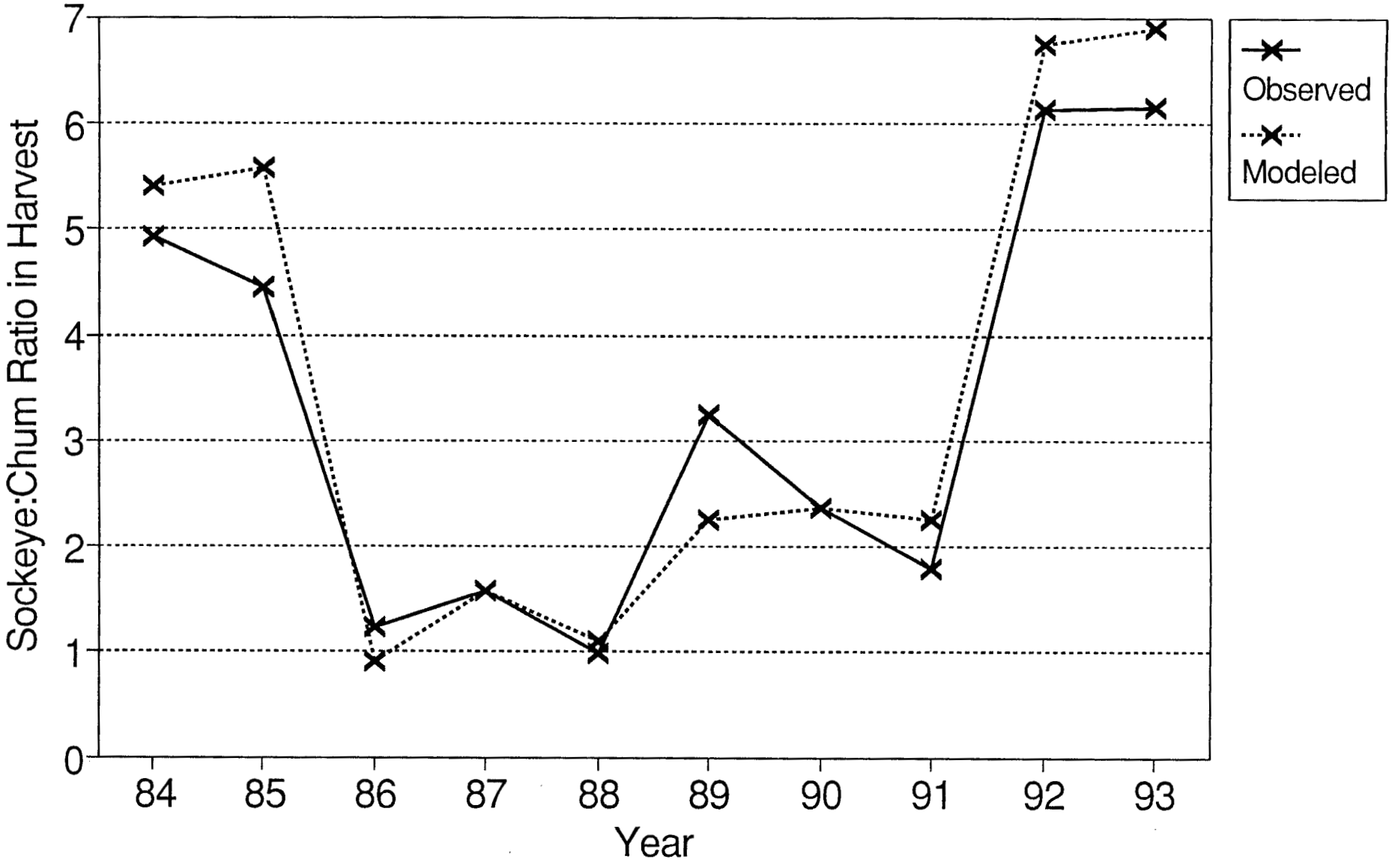

Figure 3. Observed and modeled sockeye-to-chum salmon ratios in the South Unimak June purse seine and drift gillnet fishery, 1984-93.

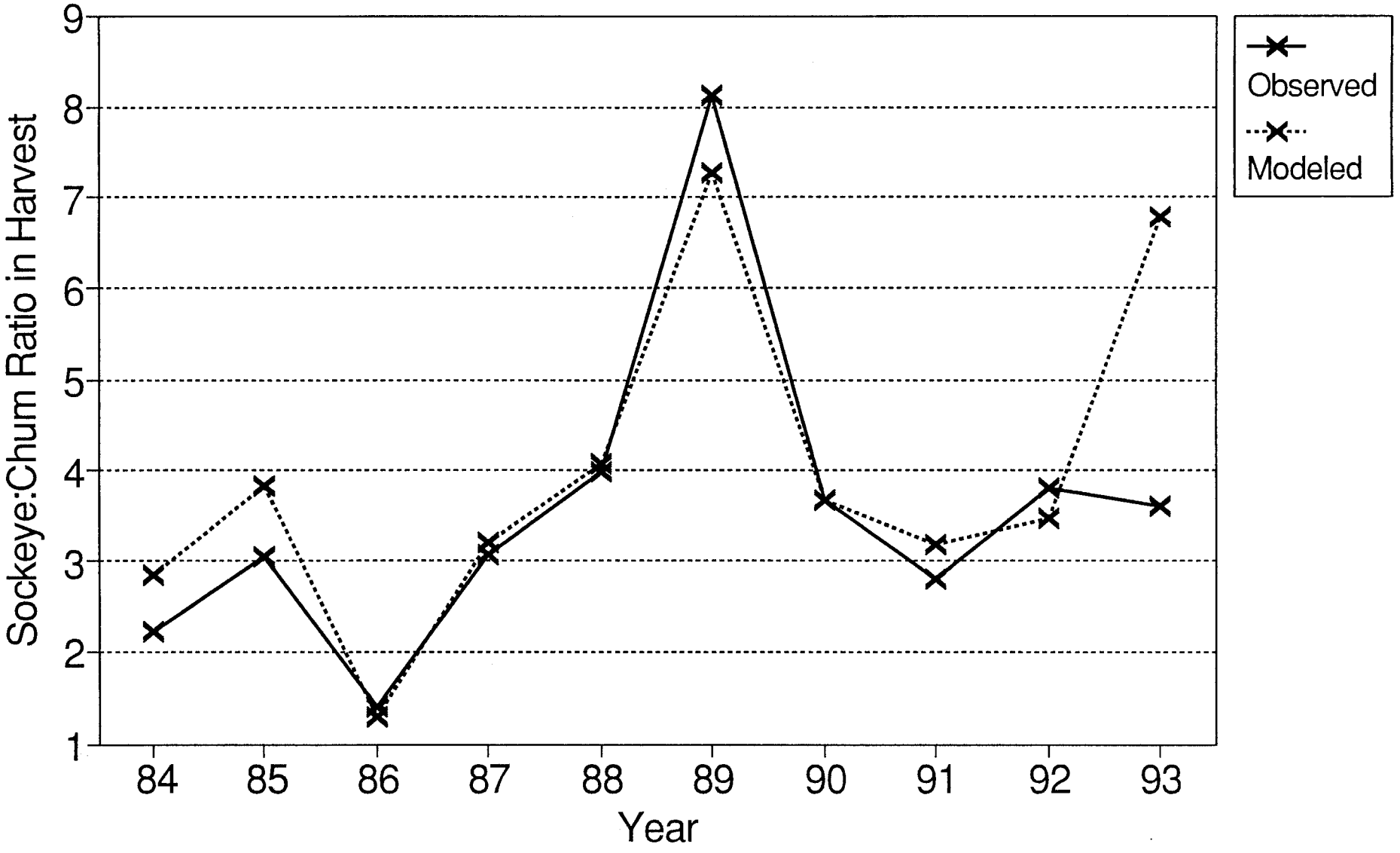

Figure 4. Observed and modeled sockeye-to-chum salmon ratios in the Shumagin Islands June purse seine fishery, 1984-93.

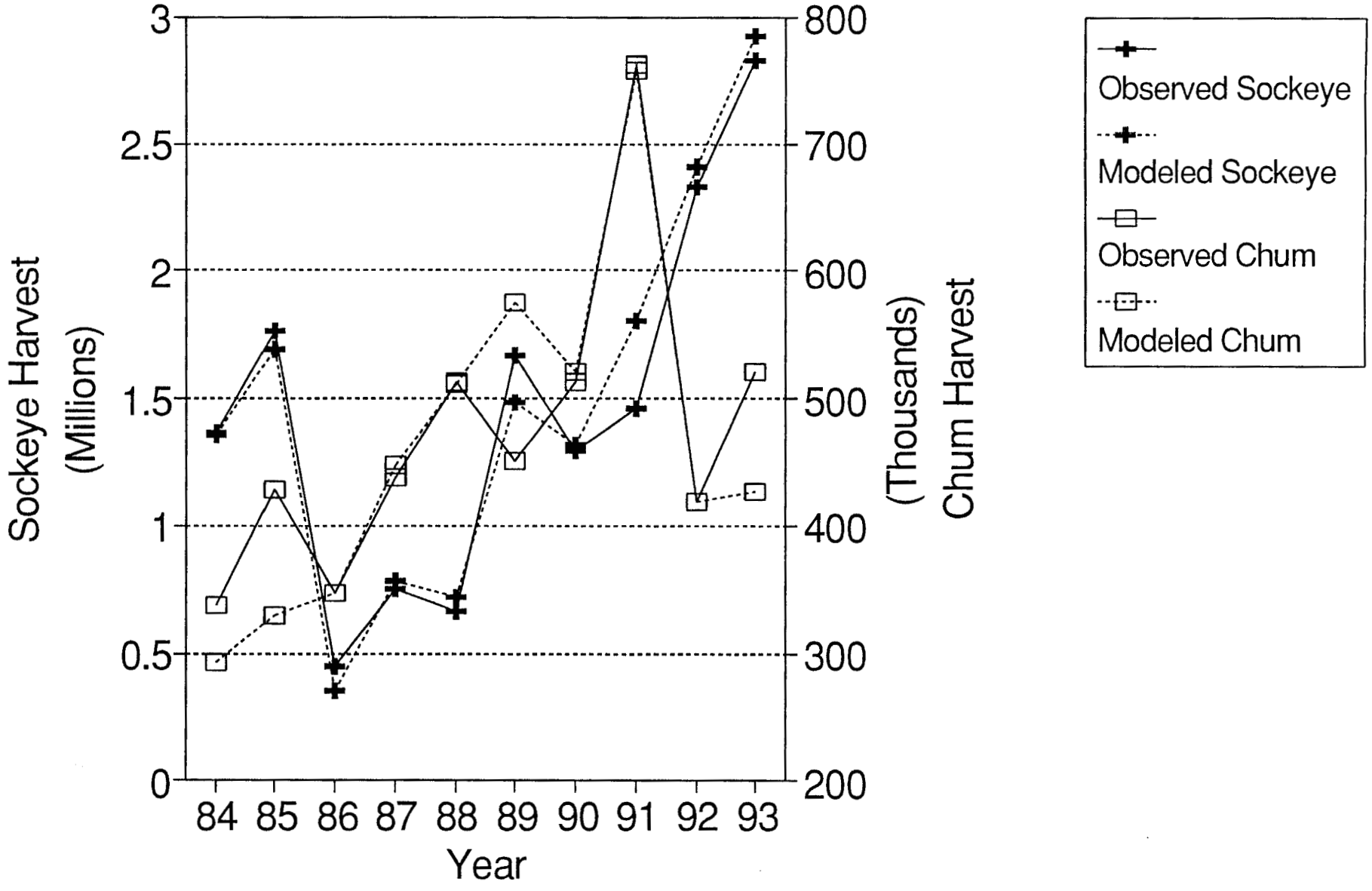

Figure 5. Observed and modeled sockeye and chum salmon harvest in the South Peninsula June purse seine and drift gillnet fishery, 1984-93.