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Recent Trends in the Catchability of Sockeye Salmon in the Skeena River Gillnet Test Fishery and Impacts on Escapement Estimation

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ABSTRACT

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In recent years, large negative biases (under-estimates) in annual Skeena River gillnet test fishery estimates of sockeye escapement have occurred. Preliminary analysis suggests that bias in the test fishery is related to variation in catchability (q) among years. Although catch per effort (C/f) in the test fishery is assumed proportional to passing abundance (N) for all species, (eg. C/f=qN), this is only true if q remains constant. Analysis of test fishery data from 1970-1992 reveals that annual sockeye catchability in the test fishery is actually variable, and has declined over time coincident with increasing returns of both sockeye and pink salmon. Because catchability varies in the test fishery, predicting appropriate values of q, for in-season use, has been very difficult. For sockeye, three factors appear to be influencing catchability in the test fishery: gear saturation, size selectivity, and the access of fish to the net. Although data are lacking, these factors may also be affecting the test fishery indices of abundance for other species.

RESUME

Cox-Rogers, S., and L. Jantz. 1993. Recent trends in the catchability of sockeye salmon in the Skeena River gillnet test fishery, and impacts on escapement estimation. Can. Manuscr. Rep. Fish. Aquat. Sci. 2219: iii+ 19 p.

Ces derniѐe res années, on a observé des biais négatifs importants (sous-estimations) dans les estimations des échappées de saumon rouge obtenues à la pêche expérimentale au filet maillant menée chaque année dans la rivière Skeena. L'analyse préliminaire indique que ce biais serait lié à la variation de la capturabilité (q) d'une année à l'autre. On pose que les captures en fonction de l'effort (C/f) dans la pêche expérimentale sont proportionnelles à l'abondance du passage pour totes les espèces (p.ex. C/f=qN), mais cela est vrai seulement si q reste constant. L'analyse des données recueillies à la pêche expérimentale entre 1970 et 1992 révèle que la capturabilité annuelle du saumon rouge dans la pêche expérimentale est réellement variable, et a baissé avec le temps tandis qu'augmentaient les remontes de saumon rouge et de saumon rose. Étant donné que la capturabilité varie dans la pêche expérimentale, il est très difficile de prévoir les valeurs précises de q, pour les utiliser pendant la saison de pêche. En ce qui concerne le saumon rouge, trois facteurs semblent influer sur la capturabilité dans la pêche expérimentale: saturation des engins, sélectivité selon la taille et accès des poissons aux filets. Bien que les données soient insuffisantes, ces facteurs peuvent aussi influer sur les indices d'abondance fournis par la pêche expérimentale pour d'autres espèces.

INTRODUCTION

The Skeena River Salmon Management Committee established the Skeena River gillnet test fishery in 1955. The test fishery is used to monitor sockeye and pink salmon escapement during the management season (June-September). As a secondary function, the test fishery is also used to monitor the relative abundance of chinook, coho, chum, and steelhead passing into the Skeena River. Large negative bias (under-estimates) in test fishery estimates of sockeye escapement has occurred in recent years. This has raised concern about the reliability and accuracy of the test fishery as an index of abundance for all species.

The reason for inability of the test fishery to accurately index escapement is not well understood. The only reliable escapement data for assessing the performance of the test fishery are for sockeye salmon counted at the Babine River counting fence and for sockeye salmon estimated to spawn in non-Babine Lake tributaries. For sockeye, the accuracy of test fishery escapement estimates has declined over time, coincident with large returns of both sockeye and pink salmon. This has created uncertainty in the management of the Area 4 sockeye fishery, and has made the interpretation of test fishery indices for other species very uncertain.

Since its inception, various methods have been used to try and improve the sockeye escapement estimates obtained from test fishery indices of abundance. During the early years of the test fishery, an average escapement per test index value was used to convert test fishery catch per effort into estimates of daily escapement. In later years, a regression relating lagged weekly escapement at the Babine River fence to weekly catch per effort at the test fishing site was used to estimate weekly escapement. During the late 1970's and early 1980's, the lagged regression method began to produce substantial underestimates of sockeye escapement. This resulted in further analysis, and by the mid-1980's, the size of sockeye caught in the test fishery was being used estimate expansion factors for converting test fishery catch per effort into estimates of daily escapement (Kadowaki 1985). The new method worked well until large underestimates of sockeye escapement again occurred in the late 1980's and early 1990's. Most recently, daily catch, instead of catch per effort, has been applied to the size-based expansion factors for estimating daily escapement. Despite these most recent changes, sockeye escapement was still underestimated by approximately 33% in 1992.

The most likely reason for bias in the test fishery is error in the assumed functional relationship between test fishery catch per effort (C/f) and passing abundance (N). Although catch per effort (mean catch per hour) in the test fishery is assumed proportional to passing abundance:

(1) $C/f = qN$

this is only true if catchability (q) remains constant. Catchability is the fraction of a fish stock caught by a defined unit of fishing effort (Ricker 1975). Various studies have shown that catchability in gillnets is often variable, and can be influenced by several factors affecting the availability of fish to the gear (Hamely 1975). Gulland (1964), for example, considers variation in catchability with fish abundance to be the most significant factor influencing the relationship between C/f and N, as variation in q "will change the whole shape of the relationship between stock abundance and catch per effort from a proportional one to some type of curve".

This report examines recent trends in the catchability of sockeye salmon in the Skeena River gillnet test fishery. Evidence for factors influencing catchability in the test fishery is presented. Although sockeye are specifically examined in this report, the application of results to other species is discussed. Recommendations for further work are also presented.

Description of the Skeena River Gillnet Test Fishery

The Skeena River gillnet test fishery is located at Tyee on the lower Skeena River (see Jantz et al 1990). Test fishing is conducted by a single gillnet vessel from mid-June through mid-September. Sets are made two to three times each day during periods of low and high slack water. The net used in the test fishery is undyed, fibrous nylon, 366 metres in length and 6 metres deep. The net consists of ten equal length panels of mesh sizes 8.9 cm to 20.3 cm, hung in a 2:1 ratio (webbing : finished net length).

The net is allowed to drift with the river flow for one hour during each set. All sets are conducted parallel to the northern shore. The low and high tide sets are not conducted at exactly the same location due to channel dynamics and current patterns. Depths under the boat vary from 5 metres to 10 metres depending upon the tide.

Catch per effort, expressed as standardized catch per hour, is the measure used to index passing abundance in the test fishery. Total effort (f) in minutes for each set is calculated as the sum of one half the setting time (S), the total fishing time (F), and one half the picking time (P):

(2) $f = (0.5*S)+(F)+(0.5*P)$

The results of all daily sets are averaged to produce a mean catch per hour value for each species (eg. the "daily test index"). Mean daily catch per hour is assumed proportional to daily abundance. Annual test indices for each species are calculated as the cumulative totals of the daily mean catch per hour values.

The mean daily catch per hour values for sockeye, pink, coho, and steelhead are expanded to estimates of daily escapement using pre-season estimates of expected catchability for each species:

(3) $(C/f)/q = N$

As previously noted, the only escapement data available for actually calculating q in the test fishery are for sockeye salmon. Accurate spawning ground data are not available for other species, and so currently reported values of q for steelhead ($1/q=245$), pinks ($1/q=1000$), and coho ($1/q=543$) are of questionable validity.

METHODS

An analysis of the test fishery data base was conducted to establish recent trends in sockeye catchability. Catchability in the test fishery was estimated on an annual basis:

(4) $q = (C/f)/N$

where C/f was the annual test index for each year, and N was the actual escapement for each year. Catchabilities were estimated on an annual basis due to the lack of accurate short-term (eg. daily, weekly, etc) escapement data. Correlation and regression analysis was used to assess the relationships between annual C/f, N , and q in the test fishery.

The following factors may be influencing q in the test fishery:

Availability of fish to the gear

Catchability in the test fishery may be influenced by the availability of fish to the gear. Availability is the degree to which fish are available to capture (Cushing 1981). The factors influencing availability in the test fishery are a) those controlling vulnerability, such as gear saturation and size selectivity, and b) those controlling accessibility, such as river hydrology, net design, fish behaviour, drift topography, and the presence or absence of predators.

Calibration Accuracy

The calculation of catchability in the test fishery is dependent upon accurate escapement data. Ninety percent or more of all sockeye passing the test fishing site are bound for the Babine Lake system (Sprout and Kadowaki 1987). Native food fisheries in the mainstem Skeena River remove a fraction of all sockeye passing the test fishery. This fraction must be estimated and added to the escapement estimates for the Babine Lake component (known from fence counts) and the non-Babine Lake component (estimated from stream surveys). Sources of calibration error include the various methods used for stream surveys of non-Babine Lake sockeye stocks, and the estimates of native food fishery removals. Reliable and complete escapement data for other species are not available. No specific analyses were conducted to assess the affects of calibration accuracy on catchability in the test fishery.

Data Sources

Data were obtained from files maintained by the North Coast Division of the Department of Fisheries and Oceans in Prince Rupert. Examination of test fishery and escapement data was conducted for the years 1970 through 1992. The set-specific analyses conducted in this report were restricted to the years from 1987 through 1992. Annual sockeye escapement past the test fishery represents the combination of the Babine River fence counts, estimates of native food harvests above Tyee, and estimates of escapement to non-Babine Lake tributaries.

RESULTS

Table 1 summarizes data for the analyses presented in this report. Table 2 outlines the correlation matrix for the variables listed in Table 1. Figure 1 shows the degree of bias in test fishery estimates of sockeye escapement for the time period examined. Strong negative bias in test fishery estimates of sockeye escapement is apparent for the most recent years.

Figure 2 shows the relationship between annual sockeye C/f in the test fishery and actual sockeye escapement, N. If C/f in the test fishery is reflective of actual sockeye escapement, then the correlation between C/f and N should be strong. The relationship is actually weak ($r=0.62$), and is primarily dependent upon the 1985 data point. Without the 1985 data point, it is difficult to establish a relationship between test fishery C/f and N. Note that for annual test fishery C/f values of 1200 or so, the range of actual sockeye escapement has varied between 500,000 and 1,500,000 fish.

Two data clusters are apparent in Figure 2; a lower cluster representing C/f data primarily from the 1980's and 1990's, and an upper cluster representing C/f data primarily from the 1970's. Both clusters may be related to the influence that pink abundance might have on sockeye C/f, as years of high pink escapement (the 1980's, Table 1) tend to be associated with years of lower sockeye C/f in the test fishery. Further analysis is required to quantify the affect of pink abundance on sockeye C/f in the test fishery.

Figure 3 shows the relationship between annual sockeye q in the test fishery and actual sockeye escapement, N. Contrary to the assumption that catchability in the test fishery remains constant, q has actually varied over time, and is negatively correlated with N ($r=-0.69$).

Availability of fish to the gear

Gear Saturation

One mechanism causing q to vary in the test fishery may be gear saturation. Gear saturation refers to the decline in net efficiency as fish accumulate in it (Hamely 1975). Evidence for gear saturation would be non-linearity in the relationship between set-specific C/f and set-specific N. Unfortunately, independent estimates of passing abundance by set are not available for the test fishery. Daily escapements at the Babine fence are too far removed (320 km) to be compared to the test fishery on a set-specific basis, and other independent estimates, such as echo sounding above the test site, are lacking.

A surrogate for passing abundance may be the test fishery catch itself. Assuming that catch increases with abundance, the plot of set-specific C/f against set-specific catch (all species) should be linear if catchability remains constant. Figure 4 shows the relationship between set-specific C/f and set-specific catch for test fishery sets made during the 1987-1992 time period. The relationship is actually curvilinear, with an inflexion beginning with catches of about fifty fish. Net efficiency does appear to decline as catches accumulate. Up to 100,000 sockeye or more can pass the test fishing site during periods of large daily migration. During such periods, gear saturation is likely.

The saturation response shown in figure 4 could also be due to the effect that picking time may have on the calculation of effort, since the handling time of test fishery gillnets typically increases with catch (Jim Cave, Pacific Salmon Commission, pers. comm.). Large catches, which take longer to haul, will tend to over estimate effort in equation (2), thus causing non-linearity in the relationship between catch per effort and abundance. The Pacific salmon Commission corrects for this effect by establishing a linear relationship between C/f and catch using only those data below the inflexion point. The rest of the catch data are then scaled according to the slope of the low-end linear relationship. A similar correction procedure applied to the test fishery data considered in this report gave inconclusive results, as the best way to construct the correction line was unclear. Additional analysis is required to see if a correction procedure has application to the Skeena River test fishery.

Size Selectivity

Another mechanism causing q to vary in the test fishery may be size selectivity. Size selectivity is any differential probability of capture based on size. Although the test fishery net is multi-panelled, size selectivity in the test fishery is possible because a) large meshes have broader selectivity curves than small meshes, and b) large fish tangle in small meshes while small fish pass through large meshes (Hamely 1975).

Evidence for size selectivity in the test fishery would be differences in relative length frequency between sockeye caught by the test fishery, and those sampled at the Babine fence. Figures 5 through 7 compare the relative length frequencies of sockeye sampled by the test fishery, and at the Babine fence, for the 1987-1992 time period. Assuming that samples collected at the Babine fence are representative of the escapement passing Tyee, then relative selection for larger sockeye occurred in 1990, 1991, and 1992. Kadowaki (1985 unpubl. MS) reviewed similar distributions for the 1970-1985 time period, and concluded that the test fishery was generally selective for larger fish. Its likely that size-selection by the test fishery is related to the sizing and placement of the gillnet panels. Unfortunately, data are lacking for a quantitive evaluation of panel-specific selectivity curves.

Figure 8 shows the relationship between annual sockeye q and mean post-orbital length for sockeye sampled in the test fishery for the 1970-1992 time period. The relationship is positively correlated ($r=0.66$), indicating that q increases as the size of sockeye caught in the test fishery (and supposedly passing) increases. Kadowaki (1985 unpubl. MS) suggested regressing annual q on size to predict values of q in-season. Unfortunately, variability about the derived relationship is quite high ($r^2=0.43$), and escapements generated using this technique result in a mean error of 24.7% for the 1988-1992 time period (Table 1). This compares to a mean error of 6.7% for the same time period simply using previous five year average values of q to estimate escapement (Table 1).

Accessibility

Another mechanism causing q to vary in the test fishery may be differential accessibility of fish to the gear. Accessibility refers to those factors affecting the probability of capture in the horizontal and vertical dimensions (Cushing 1981). Evidence of variable accessibility in the test fishery would be changes in q attributable to river hydrology, net design, fish behaviour, drift topography, and seal predation. While data were lacking for quantitive analysis of these factors, the following observations are noted:

-tidal differences at the mouth of the Skeena River are the largest on the Pacific coast of North America. Residual currents, back eddies, tide rips, and undertows can make the setting and fishing of the net, even at slack tide, quite difficult.

-the numbers and location of fish caught in the test fishery net can change as river flows, tidal heights, river temperatures, and the presence or absence of seals varies.

-the test fishery net samples varying portions of the total water column during high and low tide sets. In four of five years sampled (1971-1975) significant differences ($p<0.05$) were found between mean catches on high and low tide sets.

-Vroom (1971) documents that sockeye prefer the north shore as a migration route. The low tide set, which is made closer to the north shore, is likely to catch larger numbers of fish.

-rain tends to drive fish deeper in the test fishery net, clear skies and prevailing westerly winds tend to drive fish nearer to the surface.

-the colour of the net (off white) changes to brown the longer it is used, which may affect visibility.

-since the inception of the test fishery, changes to the topography of the river channel have no doubt occurred.

-seals destroyed 75% of all fish caught in the test fishery net during early July in 1992. Seal strikes have increased markedly since the mid-1980's.

Calibration accuracy

The final mechanism causing q to vary in the test fishery may be calibration accuracy. No specific analysis was conducted to assess the accuracy of sockeye escapement figures used to calibrate the test fishery. Counts at the Babine fence from 1970-1992 were conducted using standard procedures, and error is thought to be small. While estimates of native food harvests may be more variable, native harvesting usually accounts for less than 10% of the escapement passing Tyee in any given year. The non-Babine Lake sockeye escapement is assumed to be very small.

DISCUSSION

The purpose of this report was to examine recent trends in sockeye catchability (q) in the Skeena River gillnet test fishery. Contrary to current assumptions, annual sockeye catchability in the test fishery actually varies over time, and is inversely related to sockeye escapement (N). Three factors appear to be influencing catchability in the test fishery: gear saturation, size selectivity, and accessibility. Although direct evidence is lacking, these factors may also be affecting the test fishery indices of abundance for other species.

Because sockeye catchability varies in the test fishery, predicting appropriate values of q, for in-season use, will continue to be difficult. While the effects of gear saturation on sockeye catchability can theoretically be removed by linearizing the response between C/f and total catch, the most appropriate way to do so is not clear. As well, the best way to account for size selectivity in the test fishery is unclear. While catchabilities can be estimated in-season using the relationship between sockeye catchability (q) and mean length in the test fishery, the relationship shows considerable variability, and will produce estimates that are imprecise. Further study is required to clarify the impacts and magnitude of gear saturation and size selectivity in the test fishery.

The factor with the greatest potential to influence catchability in the test fishery may be accessibility. River hydrology, net design, fish behaviour, and seal predation are all likely affecting q in the test fishery. Unfortunately, these factors are not easily controlled. If the intention is to maintain the existing test fishery on the Skeena River, then studies to examine the influence of these factors on catchability are required.

The accuracy of the escapement estimates used to calibrate the test fishery is also important. For sockeye, this should not be a major problem, as most sockeye passing the test fishery are counted at the Babine River counting fence. For species other than sockeye, calibration accuracy is of concern. Until reliable estimates of escapement for other species are obtained, expanding daily test indices into estimates of escapement is very uncertain. The only recourse is to apply estimates of catchability for sockeye to all species. This may or may not be appropriate.

In general, the Skeena River gillnet test fishery provides relatively inaccurate estimates of sockeye escapement into the Skeena River. For other species, accuracy is unknown. No simple way of "fixing" the test fishery is apparent, as improving accuracy basically means improving the way that catchability is assessed and estimated in-season. While it is possible to improve accuracy somewhat using the methods discussed in this report, sockeye escapement estimates will still be biased. For future years, it might be best to simply use recent average trends in test fishery catchability for estimating escapements in-season. This approach needs further study, because the test fishery still has utility if bias can be reduced. It might also be useful to examine other techniques for assessing escapements into the Skeena River. One technique is echo sounding. Echo sounding has proven to be a reliable method for estimating escapements on the Fraser River (Jim Cave, Pacific Salmon Commission, pers. comm.).

RECOMMENDATIONS

1. A working group should be established to further review the potential factors affecting the Skeena River gillnet test fishery, to examine and analyze the available data, and to provide recommendations to the Department on the feasibility of improving the existing test fishery. The working group could consist of DFO staff and external consultants.

2. The working group could provide the immediate management problem of developing a better estimate of catchability by including factors such as run timing, species composition, the commercial fishery data, etc.

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Table 1. Summary data for sockeye sampled in the Skeena River gillnet test fishery from 1970 1992.

Year	Annual Test Fishery C/f	Estimated Sockeye Escape.	Actual Sockeye Escape.	Diff.	Abs. %Diff	Annual q	Actual Pink (1) Escape.	Test Fishery POH (mm)	Length Est. q	Length Estimated Escape.	Diff.	Abs. %Diff	5 year Avg q Estimated Escape.	Diff.	Abs. %Diff
1970	1039.39	641328	715744	-74416	10.4%	0.00145	942879	475.8	0.00122	846099	130355	18.2%	-	-	-
1971	1265.03	805911	871985	-66074	7.6%	0.00145	1079961	481.8	0.00132	952311	80326	9.2%	-	-	-
1972	1148.51	739387	731897	7490	1.0%	0.00157	1670017	n/a	n/a	n/a	n/a	n/a	-	-	-
1973	1844.65	1207408	872544	334864	38.4%	0.00211	1252478	492.3	0.00150	1227103	354559	40.6%	-	-	-
1974	1600.10	970068	784688	185380	23.6%	0.00204	315073	512.1	0.00183	872928	88240	11.2%	-	-	-
1975	1529.99	901681	893588	8093	0.9%	0.00171	1723862	479.0	0.00128	1193677	300089	33.6%	-	-	-
1976	1142.44	681526	636448	45078	7.1%	0.00180	598110	503.3	0.00168	677418	40970	6.4%	656679	20231	3.2%
1977	1637.59	961836	1039148	-77312	7.4%	0.00158	961529	505.7	0.00172	948539	-90609	8.7%	897993	-141155	13.6%
1978	1117.61	663753	528595	135158	25.6%	0.00211	699625	521.7	0.00199	560792	32197	6.1%	612253	83658	15.8%
1979	1798.70	1061371	1289286	-227915	17.7%	0.00140	512462	475.3	0.00122	1474197	184911	14.3%	985354	-303932	23.6%
1980	1539.74	919704	655223	264481	40.4%	0.00235	688318	507.6	0.00175	875809	220586	33.7%	913207	257984	39.4%
1981	1823.62	1062944	1511409	-448465	29.7%	0.00121	1187389	463.6	0.00102	1778694	267285	17.7%	1023763	-487646	32.3%
1982	1988.62	1158454	1302821	-144367	11.1%	0.00153	705231	518.5	0.00193	1025264	-277557	21.3%	1224454	-78367	6.0%
1983	1295.18	803086	1012099	-209013	20.7%	0.00128	2647959	477.1	0.00125	1036061	23962	2.4%	802813	-209286	20.7%
1984	1343.43	845434	1219265	-373831	30.7%	0.00110	1015833	457.8	0.00092	1446634	227369	18.6%	915601	-303664	24.9%
1985	2634.84	2060701	2352806	-292105	12.4%	0.00112	1998023	466.8	0.00107	2442937	90131	3.8%	1896287	-456519	19.4%
1986	1135.42	710547	837682	-127135	15.2%	0.00136	2146691	495.2	0.00155	731794	-105888	12.6%	923302	85620	10.2%
1987	1142.57	824938	1432724	-607786	42.4%	0.00080	3095121	489.4	0.00145	785295	-647429	45.2%	908316	-524408	36.6%
1988	1670.00	1255936	1527289	-271353	17.8%	0.00109	842291	477.8	0.00126	1323549	-203740	13.3%	1527613	324	0.0%
1989	1280.46	926831	1260374	-333543	26.5%	0.00102	4462697	483.0	0.00134	949639	-310735	24.7%	1205374	-55000	4.4%
1990	1139.21	756160	1109193	-353033	31.8%	0.00103	2504885	487.2	0.00141	803685	-305508	27.5%	1089891	-19302	1.7%
1991	1238.32	874566	1353821	-479255	35.4%	0.00091	4710956	476.5	0.00124	998559	-355262	26.2%	1204695	-149126	11.0%
1992	1201.54	1011499	1500000	-488501	32.6%	0.00080	900000	473.5	0.00119	1009577	-490423	32.7%	1254343	-245657	16.4%
70-75 Avg	1404.61	877631	811741	65890	8.1%	0.00172	1164045	488.20	0.00143	1018424	206683	25.5%	-	-	-
76-81 Avg	1509.95	891856	943352	-51496	5.5%	0.00174	774572	496.20	0.00157	1052575	109223	11.6%	848208	-95143	21.3%
82-87 Avg	1590.01	1067193	1359566	-292373	21.5%	0.00120	1934810	484.13	0.00137	1244664	-114902	8.5%	1111796	-247771	19.6%
88-92 Avg	1305.91	964998	1350135	-385137	28.5%	0.00097	2684166	479.59	0.00129	1017002	-333134	24.7%	1256383	-93752	6.7%

(1) accuracy unknown

Table 2. Pearson correlation coefficients (r) for variables measured in the Skeena River gillnet test fishery from 1970-1992 (n=22).

	A	B	C	D	E	F	G
A	1.000						
B	-0.015	1.000					
C	0.600	0.622	1.000				
D	-0.711	0.096	-0.690	1.000			
E	-0.271	-0.102	-0.555	0.660	1.000		
F	0.664	-0.274	0.347	-0.656	-0.341	1.000	
G	0.746	-0.055	0.589	-0.765	-0.454	0.962	1.000

A= Year
B= Annual sockeye test index (C/f)
C= Annual sockeye escapement (N)
D= Annual sockeye catchability (q)
E= Mean sockeye POH length in test fishery
F= Annual pink escapement
G= Annual sockeye+pink escapement

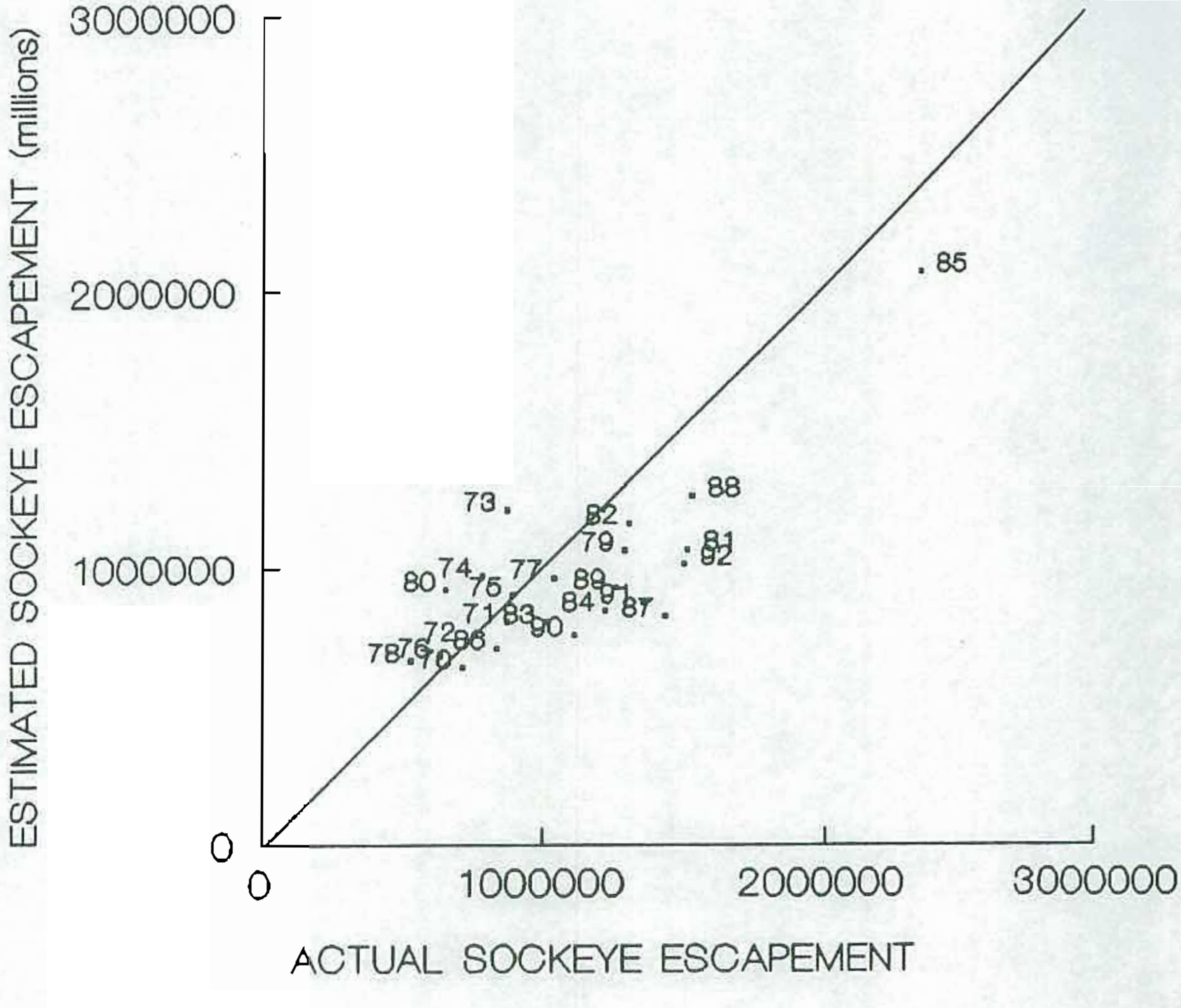


Figure 1. The relationship between estimated sockeye escapement and actual sockeye escapement for the Skeena River test fishery from 1970-1992. The solid line is the proportional relationship.

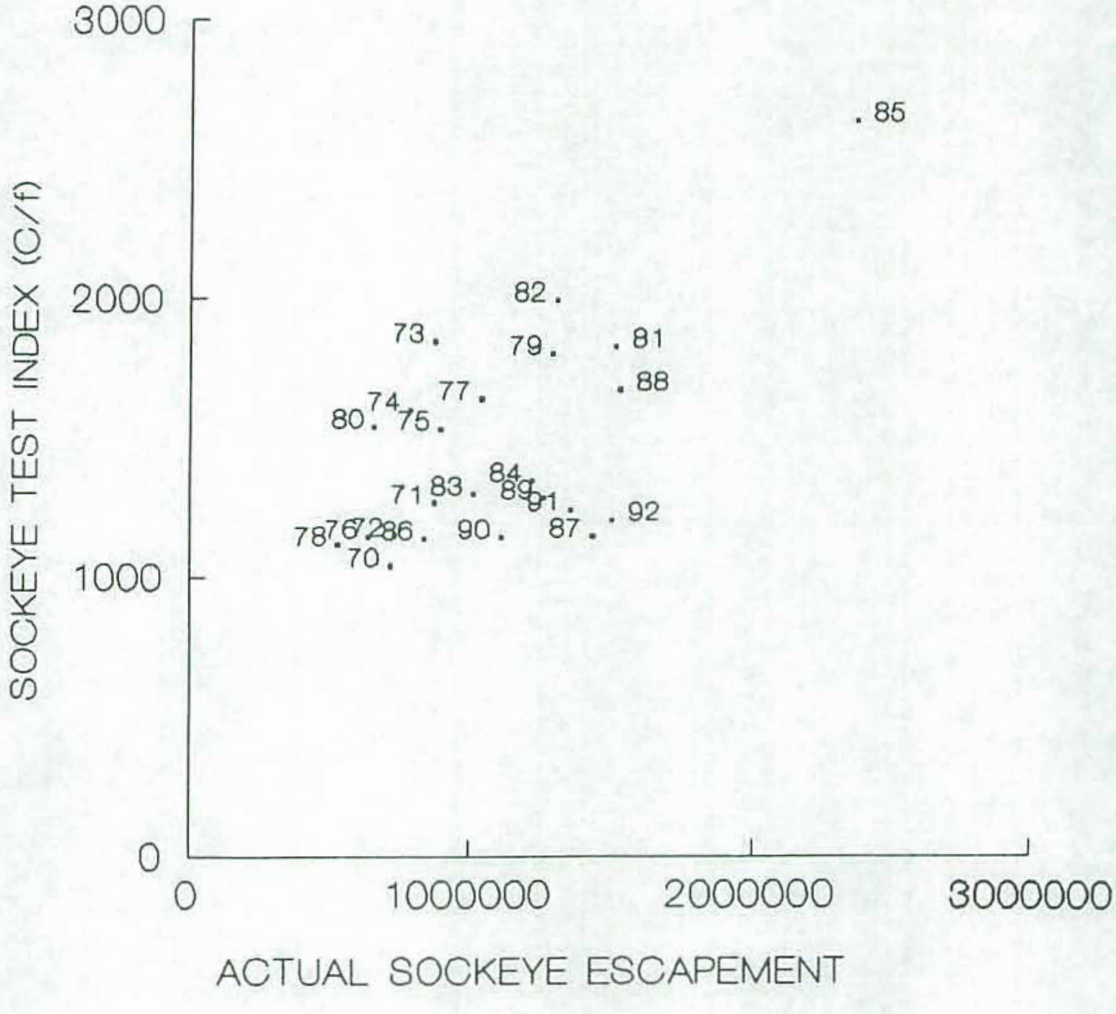


Figure 2. The relationship between annual sockeye catch per effort (C/f) and actual sockeye escapement (N) for sockeye sampled in the Skeena River gillnet test fishery from 1970-1992. (r=0.62).

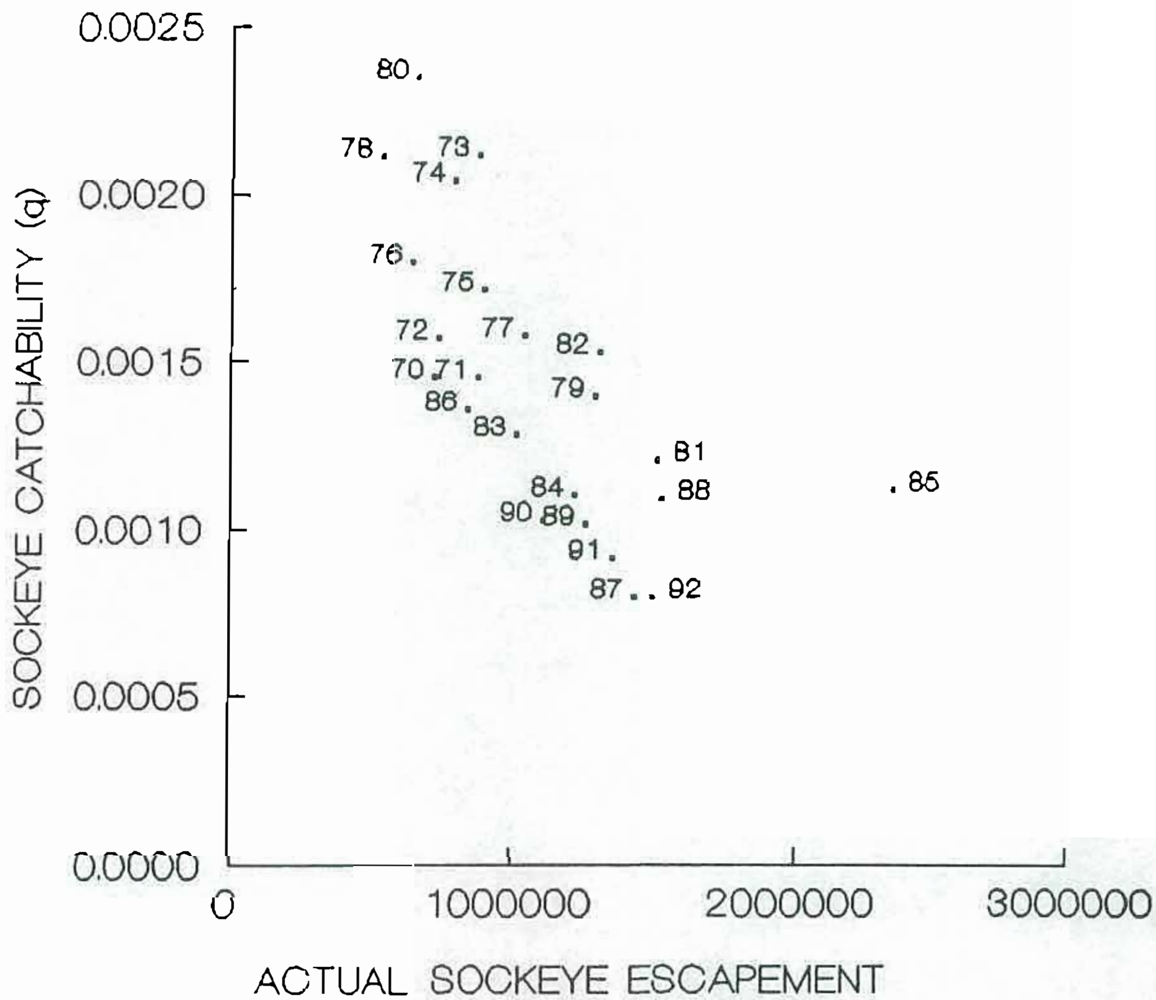


Figure 3. The relationship between annual sockeye catchability (q) and actual sockeye escapement (N) for sockeye sampled in the Skeena River gillnet test fishery from 1970-1992 (r=-0.69).

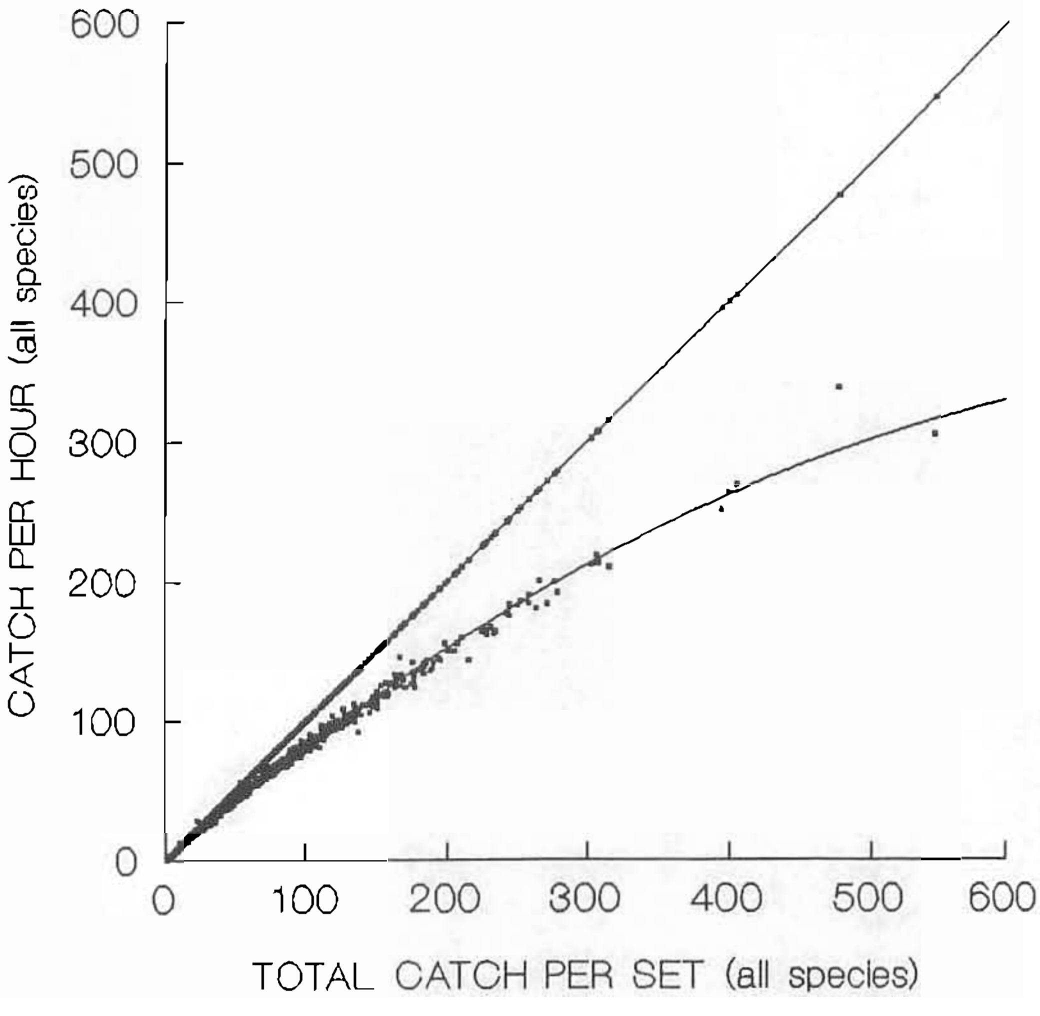


Figure 4. The relationship between catch per hour (C/f) and total catch per set, for all species sampled in the Skeena River gillnet test fishery from 1987-1992. The solid line represents the proportional relationship.

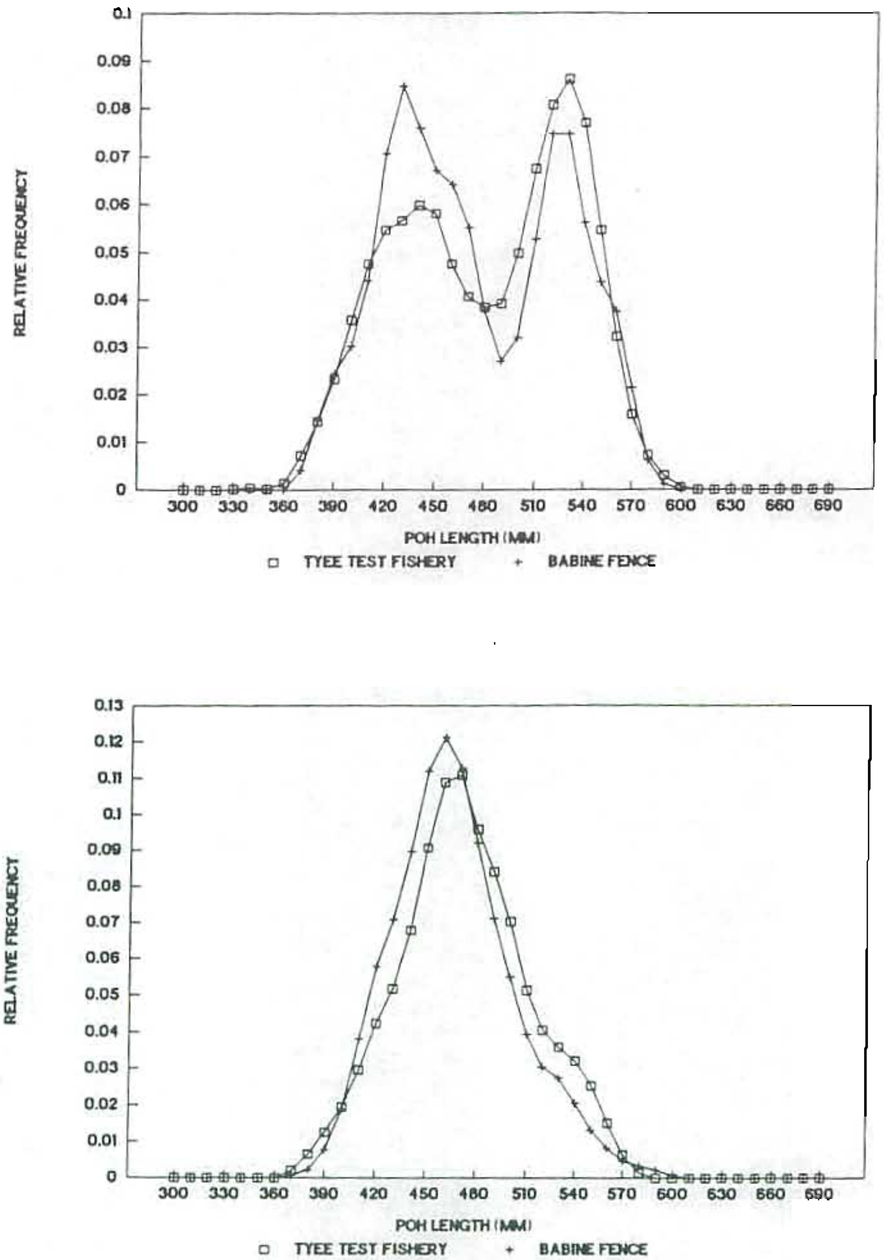
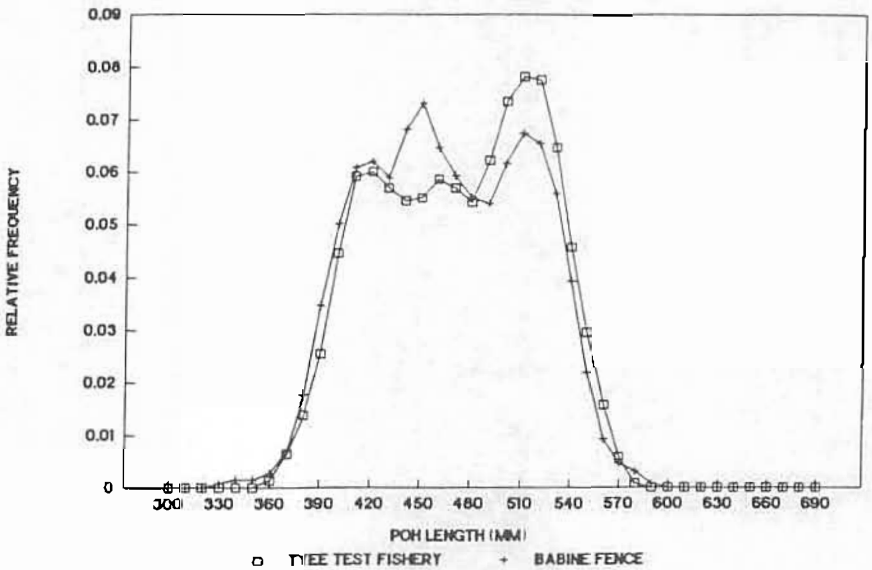
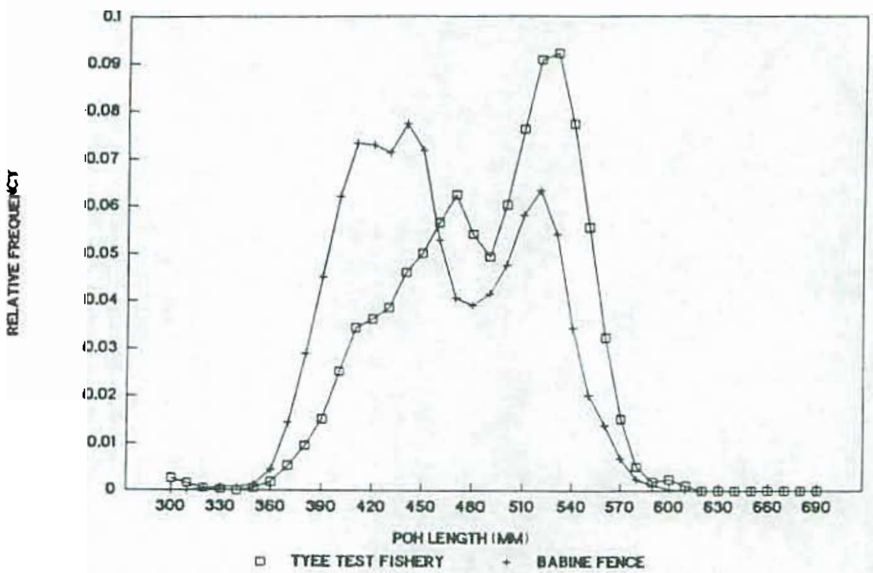


Figure 5. Relative length frequencies for sockeye sampled in the Skeena River gillnet test fishery, and at the Babine fence, for 1987 and 1988.





test

Figure 6. Relative length frequencies for sockeye sampled in the Skeena River gillnet test fishery, and at the Babine fence, for 1989 and 1990.

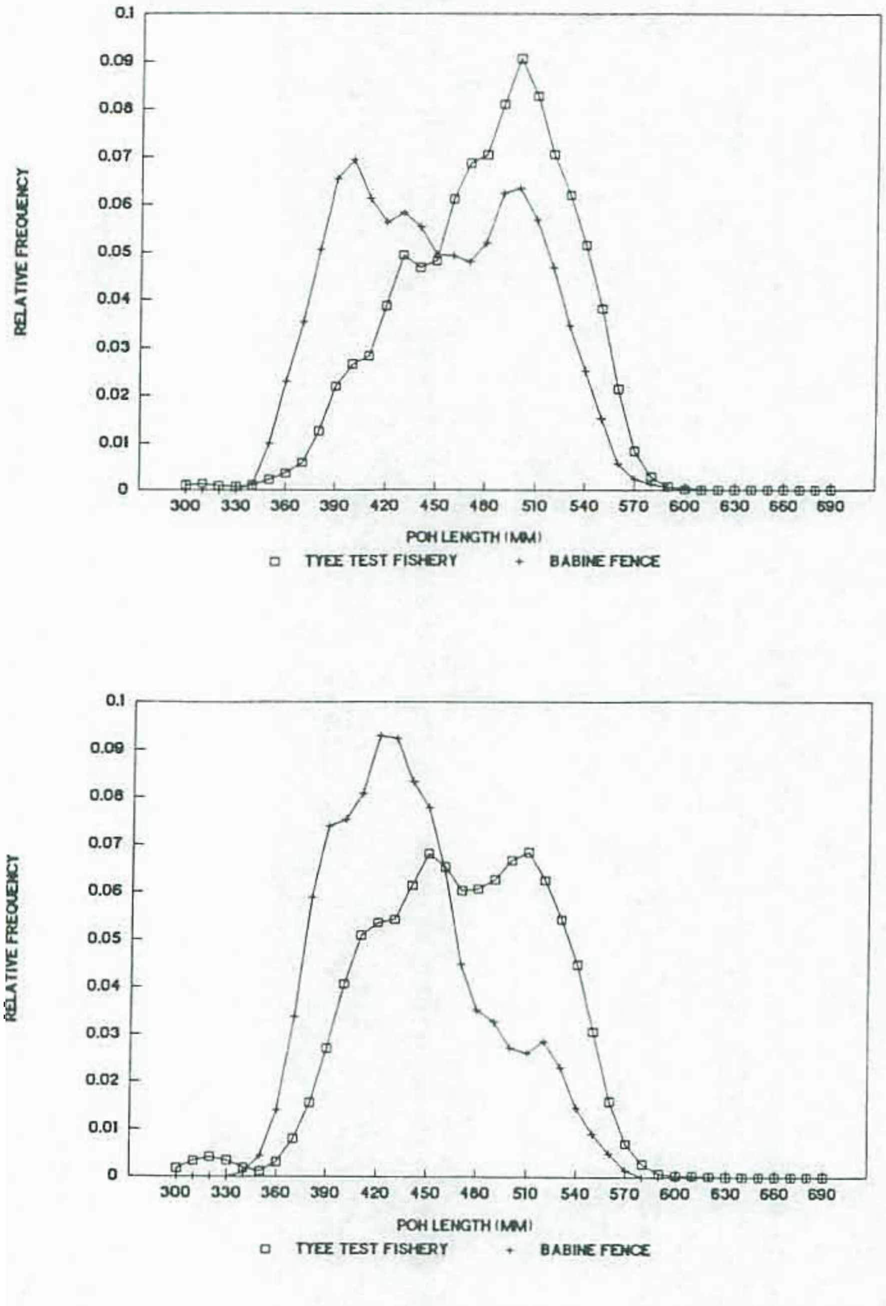
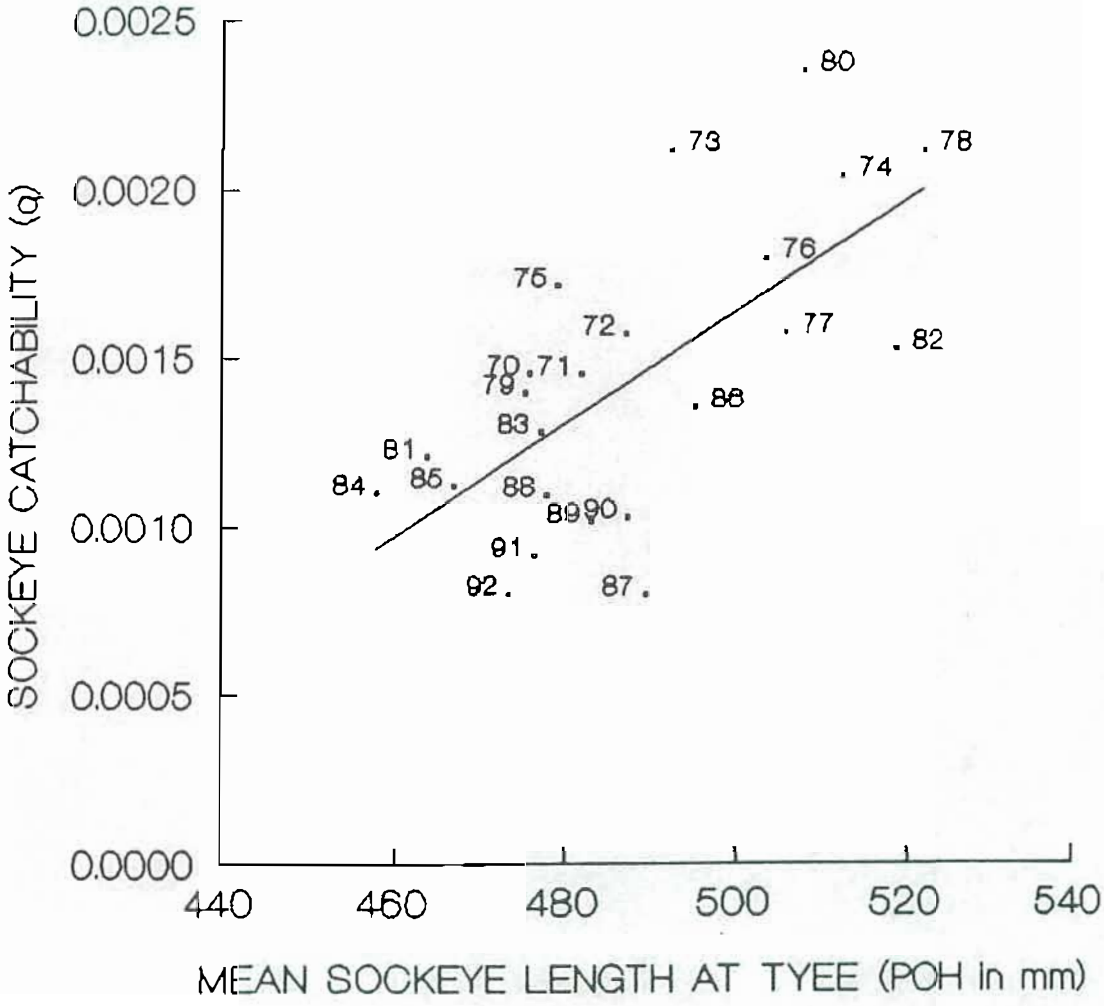


Figure 7. Relative length frequencies for sockeye sampled in the Skeena River gillnet test fishery, and at the Babine fence, for 1991 and 1992.



test

Figure 8. The relationship between annual sockeye catchability (q) and mean postorbital-hypural length (mm) for sockeye sampled in the Skeena River gillnet test fishery from 1970-1992. ($y= 1.66E\text{-}10(x)+6.69E\text{-}04$, $r=0.66$, $r^2=0.43$).