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In-season indicators of run-strength and survival for northern British Columbia coho

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Abstract

In providing forecasts of run-strength and survival for the coho of northern British Columbia for 2000, Holtby et al. (2000) concluded that modest incidental catches of coho from the upper Skeena would not pose a significant risk of irreversible damage. They emphasized that forecasts for the area had not proven sufficiently reliable to proceed with modest incremental fishing without an early in-season indicator that would warn of unforeseen survival disasters such as the one that occurred in 1996 sea-entry. The purpose of this research document is to make a preliminary examination of the utility of four possible in-season indicators of run-strength and survival for northern B.C. coho.

Four fishery-performance measures were examined: the Skeena test-fishery index, which is essentially a *CPUE* of a river-mouth gill-net fishery, the wild coho *CPUE* in the SE Alaskan Tree Point gill-net fishery, the coho *CPUE* in the Alaskan boundary area troll fishery, and the upper Skeena CWT catch as a proportion of CWTs released in the SE Alaskan troll fishery. To ensure that these measures would serve as 'early-warnings', analysis was confined to data available by week 31 or roughly Aug. 1st. Forecast models for Babine and Toboggan hatchery coho and Lachmach wild coho, total stock size of the Babine Lake coho aggregate and the total stock size of the 'average-streams' of Areas 3, 4L, 4U and 6 were developed where there was a useful statistical relationship.

It is important that the early-warning schemes detect a sea-entry year like 1996 (return year 1997), which saw record low survival and escapement over much of northern B.C. (Holtby et al 1999). For upper Skeena coho marine survivals in 1992 and 1995 and 1998 were also very low and given the precarious state of upper Skeena coho returning off the 1997 brood, should be detected by any early-warning scheme. There are as yet no *LRP*s for northern B.C. coho. However, abundance values equal to 20% of carrying capacities from stock-recruitment analyses (Holtby et al. 2000) exceed levels seen in the upper Skeena in the years of poor survival. Values of 20% of the observed mean marine survivals also seem to exceed survival realized in most of the years noted above. Consequently, the models were evaluated using 'trigger' points set 20% of the long-term mean survival or 20% of the estimated carrying capacity of the stock. Where data-series are too short to establish these levels then the models were evaluated using trigger points set to approximately twice the values observed for the 1996 sea-entry year.

Of the four fishery-performance variables evaluated as early-warning forecast tools the CPUE in the Alaskan boundary area troll appears to be the most promising. Models based on this CPUE were predictive for most of the variables of concern and were able to reliably detect trigger situations while not giving more than one false trigger. The second best predictor was the proportion of CWTs recovered to week 29 in the Alaskan troll. Models based on this performance measure were able to detect trigger situations for upper and lower Skeena coho but failed outside of the Skeena and notably in Area 6. Furthermore, the models signaled spurious false triggers. The remaining two performance measures, the Skeena test-fishery index and CPUE in the Alaskan Tree Point gill-net fishery seem unsuitable as early-warning indicators.

Résumé

Après avoir présenté des prévisions de la remonte et de la survie des saumons cohos du Nord de la Colombie-Britannique pour 2000, Holtby *et al.*(2000) ont conclu que de modestes prises accessoires de cohos de la haute Skeena ne poseraient pas un risque important de dommage irréversible. Ces auteurs ont souligné que les prévisions pour cette région ne sont pas suffisamment fiables pour permettre une pêche modérée d'intensité croissante en l'absence d'un indicateur qui pourrait prévenir en début de saison de désastres imprévus pour la survie du saumon, comme celui qui est survenu lors de l'entrée en mer de 1996. Le présent document de recherche vise à présenter un examen préliminaire de l'utilité de quatre indicateurs en saison de la remonte et de la survie du saumon coho du Nord de la C.-B.

Voici les quatre mesures de performance de pêche qui ont été étudiées : l'indice de pêche expérimentale dans la Skeena (essentiellement les CPUE d'une pêche au filet maillant à l'embouchure de la rivière), les CPUE de cohos sauvages de la pêche au filet maillant dans la zone alaskienne de Tree Point, les CPUE de cohos de la pêche à la traîne dans les eaux frontalières de l'Alaska et la proportion des cohos marqués par fil codé capturés dans la haute Skeena par rapport au nombre de cohos marqués dans la pêche à la traîne du Sud-Est de l'Alaska. Pour s'assurer que ces mesures peuvent servir d'« alertes rapides », l'analyse s'est limitée aux données qui étaient disponibles la semaine 31, soit à peu près le 1er août. Lorsqu'une relation statistique utile existait, on a élaboré des modèles de prévision de la taille des stocks de cohos sauvages de la rivière Lachmach et de cohos provenant des écloseries Babine et Toboggan ainsi que de la taille totale du stock combiné du lac Babine et des « cours d'eau moyens » des zones 3, 4L, 4U et 6.

Il importe que le système d'alerte rapide puisse détecter une année d'entrée en mer comme celle de 1996 (année de remonte 1997), durant laquelle les faibles survie et échappée ont atteint des records dans une grande partie du Nord de la C.-B. (Holtby *et al.*, 1999). Tout système d'alerte rapide devrait détecter une très faible survie en mer des cohos de la haute Skeena (comme celles observées en 1992, 1995 et 1998, ainsi que celle qui devrait toucher les saumons éclos en 1997). Aucun programme de retrait de permis de pêche du saumon coho dans le Nord de la C.-B. n'a encore été mis en œuvre. Toutefois, les indices d'abondance, égalent à 20% de la capacité de charge calculée à partir des analyses stock-recrutement (Holtby et *al.2000)* surpassent les niveaux observés dans la haute Skeena lors des années de faible survie. Les valeurs de 20% de la survie en mer moyenne semblent excéder les valeurs enregistrées durant la majorité des années citées plus haut. Par conséquent, on a évalué les modèles en utilisant des points critiques établis à 20% de la survie moyenne à long terme ou de la capacité de charge estimée du stock. Dans les cas où les séries chronologiques étaient trop courtes pour déterminer ces valeurs, les modèles ont été évalués à l'aide de points critiques correspondant à environ le double des valeurs observées pour l'année d'entrée en mer 1996.

Les CPUE de la pêche à la traîne dans les eaux frontalières de l'Alaska semblent être la plus prometteuse des quatre variables de performance de pêche évaluées en tant qu'outils de prévision permettant une alerte rapide. Les modèles fondés sur ces CPUE permettaient de prédire la plupart des variables importantes et de détecter les situations critiques tout en ne donnant pas plus d'une fausse alerte. La proportion du nombre de cohos marqués par fil codé capturés au bout de 29 semaines dans la prêche à la traîne en Alaska était le deuxième meilleur indice : les modèles fondés sur cette mesure ont pu détecter les situations critiques dans la haute et la basse Skeena, mais pas ailleurs, notamment dans la zone 6. En outre, les modèles ont erronément signalé des situations critiques (fausses alertes). Les deux autres mesures de performance de pêche, soit l'indice de pêche expérimentale dans la Skeena et les CPUE de la pêche au filet maillant dans la zone alaskienne de Tree Point, ne semblent pas convenir comme indicateurs d'alerte rapide.

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1 Introduction

In providing forecasts of run-strength and survival for the coho of northern British Columbia for 2000, Holtby et al. (2000) concluded that modest incidental catches of coho from the upper Skeena would not pose a significant risk of irreversible damage. They emphasized that forecasts for the area had not proven sufficiently reliable to proceed with modest incremental fishing without an early in-season indicator that would warn of unforeseen survival disasters such as the one that occurred in 1996 sea-entry. The purpose of this research document is to make a preliminary examination of the utility of four possible in-season indicators of run-strength and survival for northern B.C. coho.

Any “early-warning” scheme has three important attributes:

1. It must provide dependable detection of the situation against which it is warning. The consequences of failing to detect an extremely poor survival year are to increase the risk of irreversible damage to the stocks where there is a conservation concern. Because we fish coho in highly mixed-stock fisheries, those risks are actually applied to *Conservation Units* as well as individual spawning populations. Consequently, this is the most important of the three attributes.

2. It must provide warning in sufficient time to act to lessen risk. The schemes considered in this research document would provide advice at the end of July or in the first week of August. This is sufficient warming to significantly reduce the impacts of troll fisheries, which are the major harvesters of upper Skeena coho.

3. It must provide no or very few false warnings. The consequences of a false warning have more to do socio-economic disruption than conservation, but are nonetheless of sufficient import that this is an important attribute.

An important consideration is devising and evaluating an early-warning scheme is deciding what it is that is to be detected. Doing so is not a simple task and this research document does not contain a defensible recommendation on this topic. One obvious approach is to consider historical events that have been considered undesirable and to test scheme over their abilities in detecting such events. Another approach is to compare forecasts against conservation benchmarks such as a *Limit Reference Point* (*LRP*).

It is important that the early-warning schemes detect a sea-entry year like 1996 (return year 1997), which saw record low survival and escapement over much of northern B.C (Holtby et al. 1999). For upper Skeena coho marine survivals in 1992 and 1995 and 1998 were also very low and given the precarious state of upper Skeena coho returning off the 1997 brood, marine survivals of comparable levels should also be detectable by any early-warning scheme. There are as yet no LRPs for northern B.C. coho. However, abundance values equal to 20% of carrying capacities from stock-recruitment analyses (Holtby et al. 2000) exceed levels seen in the upper Skeena in the years of poor survival. Values of 20% of the observed mean marine survivals also seem to exceed survival realized in most of the years noted above. Consequently, the models were evaluated using ‘trigger’ points set at 20% of the long-term mean survival or 20% of the estimated carrying capacity of the stock. Where data-series are too short to establish these levels then the models were evaluated using trigger points set to approximately twice the values observed for the 1996 sea-entry year. Although these trigger points will be re-evaluated, the approach presented here can be easily adapted to any trigger point.

2 Data Sources

Marine survival values for the Skeena and Lachmach indicator systems, total stock size for the Babine coho aggregate, and the total stock size for the 'average-streams' of Areas 3, 4L, 4U and 6 have been documented by Holtby et al. (1999, 2000). The Tyee test fishery is described in detail by Kadowaki (1988) and by Cox-Rogers and Jantz (1993). Test-fishery data were obtained from a database maintained by Fisheries Management staff in the DFO Prince Rupert office (pers. comm. L. Jantz, Operations Branch, Prince Rupert). Data on upper Skeena CWT recoveries in Alaskan troll fisheries, and coho catch and effort in boundary area troll fisheries and in the Tree Point gill-net fishery were provided by Leon Shaul of the Alaska Department of Fish and Game, Commercial Fisheries Division, Douglas, Alaska from ADFG sources.

3 In-season forecast tools

3.1 Skeena test-fishery index

The Tyee test-fishery is primarily intended for in-season management of the Skeena sockeye fisheries but because coho, chinook, steelhead and pink are also caught, it has been routinely used as an abundance index for all salmon species in Area 4. The number of all species captured in the Tyee test-fishery has been recorded daily for the period July 1st to August 25th since 1956. The test-fishery index is the cumulative catch per 1000 fathom-minutes from mid-June to a fixed termination date, which has typically been August 25th, the earliest date of fishery closure. The test-fishery has operated in the same place with the same gear since its inception.

3.1.1 In-season forecasts

The cumulative Skeena test-fishery index to July 31st for weeks 27 to 29 is correlated with some of the survival and abundance measures of interest:

	r	*P*‡	*N*
Babine stock size	0.28	NS	44
average-stream Area 4L stock size	0.33	< 0.05	44
average-stream Area 4U stock size	0.57	<0.001	44
average-stream Area 6 stock size	0.61	<0.001	44
Babine marine survival	0.53	NS	6
Toboggan marine survival	0.57	0.05	12

‡ H_0: r=0

Correlation between survivals or stock sizes and the cumulative test-fishery index to earlier dates are weaker such that July 31st is the earliest useful index date. The relationships with Area 4U and Area 6 stock-size are potentially the most useful and the following models were fit to these data series:

dependent	model†	adj. R^2	P	N	forecast Table
log Area 4U stock size	$0.608I - 5.65$	0.30	< 0.001	44	Table 1
log Area 6 stock size	$0.515I - 6.19$	0.36	< 0.001	44	Table 2

† I is the cumulative test-fishery index to July 31st.

3.1.2 As early warning of low abundance

Using the specified criterion there was only one trigger situation in the upper Skeena (1997) although abundance in 1995 was close to the trigger (Table 1). The forecast model correctly identified the 1997 trigger when the 80%CI was used and indicated a false trigger in 1995. There were no other false triggers. For the Area 6 average-stream there were three trigger situations in 1995, 1997 and 1999 and three other years when total stock size fell below 1,000 (Table 2). Using the 80%CI, the forecast model correctly identified five of those six years with no additional false triggers. The model did not identify 1999. That failure highlights the risks of using a model that relies on large-scale similarities in abundance trends. In the past two years, a divergence in the trajectories of stocks from the upper Skeena and Area 6 has become apparent (Holtby et al. 2000).

3.2 Early CPUE in SE (Area 6) Alaskan troll

The Alaskan troll fishery in southern inside Area 6-southern portion and nearby areas (sub-Districts 103-11 and 104-10) has been monitored for the past two decades. The potential utility of mean *CPUE* estimates for this fishery for forecasting marine survival and abundance of northern BC coho was examined.

Catch and *CPUE* estimates are available beginning in week 27, which is approximately the first week of July (Table 3). The most useful forecast period ends in week 29, which is approximately the third week in July. Statistics for that period are available early in August. In some weeks, catch and effort were not reported. In those strata the *CPUE* was estimated using the contingency approach of Brown (1974) and an Excel VBA macro (pers. comm. J. Blick, ADFG, Douglas AK). Estimated values are shaded in Table 3. The time series of the boundary area *CPUE* (Figure 3) shows low values in 1988, 1995, 1997 and 1998. The value in 1997 was particular poor. Poor escapement and low marine survival were seen in the Skeena coho indicators in those same years.

3.2.1 In-season forecasts

The mean boundary area coho *CPUE* for weeks 27 to 29 is strongly correlated with some of the survival and abundance measures of interest:

	r	P	N
Babine stock size	0.34	NS	19
average-stream Area 3 stock size	0.47	< 0.05	19
average-stream Area 4L stock size	0.55	< 0.05	19
average-stream Area 4U stock size	0.64	< 0.01	19
Babine marine survival	0.95	< 0.01	6
Toboggan marine survival	0.90	<< 0.001	12
Lachmach marine survival	0.53	0.07	12

Relationships between the troll *CPUE* and abundance and survival measures for Area 3 (includes Lachmach) and Babine coho are weaker than for Skeena coho. This possibly reflects differences in distribution of Babine and Area 3 coho compared to lower Skeena and Bulkley/Morice coho (Holtby et al. 1999, 2000). Forecast models for Babine and Toboggan survival and upper Skeena abundance were pursued.

3.2.2 In-season forecasts

The following Table summarizes the forecast models that were developed:

dependent	model†	adj. R^2	P	N	forecast Table
logit Babine marine survival	$0.0432C - 5.74$	0.88	< 0.01	6	Table 4
logit Toboggan marine survival	$0.0356C - 5.12$	0.80	< 0.001	12	Table 5
log Area 4U stock size	$0.0342C - 5.12$	0.42	< 0.05	19	Table 6
log Area 6 stock size	$0.0185C - 6.13$	0.20	< 0.05	19	Table 7

† C is the mean boundary area coho *CPUE* for weeks 27 to 29.

As might be surmised from the model fit, the boundary area *CPUE* provided excellent forecasts of Babine (Table 4) and Toboggan survival (Table 5). The forecast model for upper Skeena coho is weaker but potentially useful while the forecast model for Area 6 coho is marginally significant.

3.2.3 As early warning of poor survival and low abundance

Performance of the models in providing an early warning of poor survival or low abundance is summarized in Table 4 to Table 7. Both forecast models of survival successfully indicated all trigger situations using the 50%CI. The Babine forecast model did not indicate any false triggers (Table 4). The Toboggan model indicated only one false trigger, which was in 1988 when observed survival was only slightly greater than the trigger threshold (Table 5). The forecast model for upper Skeena stock size correctly detected the single trigger situation (1997; Table 6) and indicated no false triggers using the 50%CI. The forecast model for Area 6 detected only one of three trigger situations using the 50%CI and would have detected only two if the 80%CI were used (Table 7).

3.3 Early CPUE in Tree Point gill-net fishery

The Alaskan gill-net fishery at Tree Point in SE Alaska is a prolonged and intense fishery that targets a sequence of sockeye and pink stocks returning to northern BC and SE Alaska. The fishery begins in late June (statistical week 25) and continues usually to the end of September (statistical week 39) but sometimes for an additional two weeks. Peak coho catches occur in the first week of September (statistical week 36). The catch prior to statistical week 32 (earlier than approximately the second week of August) is relatively small. Records of catch and effort (boat-days) have been kept since 1969. In some years, the fishery did not begin until statistical week 26 (last week of June) so the cumulative totals of catch and effort begin in that week.

The utility of the cumulative CPUE (cCPUE) in forecasting abundance and marine survival was examined. The measures of abundance used were the total stock size (catch plus escapement) of the Babine coho aggregate and the total 'average-stream' abundance for Canadian Statistical Areas 3 (Nass), 4L (lower Skeena), 4U (upper Skeena) and 6 (Kitimat) (Holtby et al. 2000). These estimates were available for the entire period of 1969 to 1999. The measures of survival used were the estimates for Toboggan and Babine hatchery coho in the Skeena and for Lachmach wild coho at the head of Work Channel (Statistical Area 3). Abundance measures were log transformed. Survival estimates were Logit transformed.

3.3.1 In season forecasts

Total abundance was not strongly correlated with cCPUE (following Table; $r \approx 0.35$ for P=0.05) and most of the relationships were not statistically significant. This finding was not surprising since the temporal pattern of *cCPUE* (Figure 6) is dissimilar to the abundance patterns of upper Skeena coho. With no predictive value cCPUE as a forecast tool for abundance was not pursued further.

	correlation between total abundance and cCPUE (N = 31)				
statistical week	Babine	Cdn. Area 3	Cdn. Area 4L	Cdn. Area 4U	Cdn. Area 6
26	0.19	0.16	0.31	0.21	0.08
27	0.06	0.17	0.30	0.22	0.02
28	0.04	0.13	0.26	0.26	-0.01
29	0.02	0.17	0.35	0.33	0.06
30	0.04	0.14	0.31	0.34	0.07
31	0.10	0.20	0.38	0.37	0.19

Marine survival was more strongly correlated with cCPUE as the following Table shows.

	correlation between marine survival and cCPUE (N= 6 for Babine, 12 for others)		
statistical week	Babine	Toboggan	Lachmach
26	0.34	0.33	0.12
27	0.74	0.59	0.24
28	0.70	0.72	0.34
29	0.72	0.83	0.47
30	0.71	0.80	0.49
31	0.68	0.82	0.53

The relationships between *cCPUE* and survival for Lachmach and Babine coho were not statistically significant in any week and were not considered further. The strongest correlation between Toboggan survival and *cCPUE* was in week 29 and the following regression model was estimated:

$$\text{logit } s = 0.383cCPUE - 4.69 \quad (N{=}12;\ P{<}0.001;\ \text{adj. } R^2{=}0.66),$$

where s is marine survival and *cCPUE* is the cumulative coho CPUE to week 29. Comparison of the time series of forecasts and observed marine survivals (Table 9) indicates that the forecasts were generally very good. The observed value did not fall within the 50%CI in only three of 12 years.

3.3.2 As early warning of poor survival

At Toboggan, survival in four of the 12 years would be considered poor. The trigger level was set at 2%, which is approximately 20% of the survival observed in 1999 (Table 5). As an early-warning indictor *cCPUE* successfully detected all four of the trigger situations but also gave four false triggers. With a less stringent trigger value of 0.007, which is 20% of the mean observed survival (0.035) the extremely poor survival of 1996 sea-entry (1997 return) would have been detected without false triggers by using the 80%CI in week 29 (Table 9).

3.4 Early recoveries of CWT in the Alaskan troll

The fishery-specific exploitation rates in Alaskan fisheries are sufficiently large and constant that the number of upper Skeena tags caught in Alaskan troll fisheries, expressed as a proportion of tags released, should be correlated with marine survival. If the timing of upper Skeena coho through the Alaskan fisheries and the fisheries themselves are less variable than survival, then the catch before the end of July, as a proportion of the number of tags released, might provide a useful forecast of survival.

The forecast models were fit by first expressing the tags recovered in Alaskan troll fisheries as proportions of the total release the preceding year by week for Babine (Table 8), Toboggan (Table 11) and Lachmach (Table 12). These proportions were then cumulated beginning in week 27 (roughly the second week of July). The cumulative proportions caught by week were then Logit transformed. For each site, the Logit transformed proportion of tags caught was used as the independent variable in a linear regression predicting the Logit transformed marine survival by week. The result was a forecast model relating the cumulative proportion of tags caught to marine survival by week and site.

dependent	predictor† (X in model)	model	adj. R^2	P	N
Logit Babine marine survival	Babine - week 29	$0.862X + 1.43$	0.76	< 0.05	6
Logit Babine marine survival	Babine – week 30	$1.06X + 2.20$	0.88	< 0.005	6
Logit Toboggan marine survival	Toboggan – week 29	$0.527X - 0.189$	0.61	< 0.005	12

dependent	predictor† (X in model)	model	adj. R^2	P	N
Logit Toboggan marine survival	Toboggan – week 30	$0.606X + 0.085$	0.63	< 0.005	12
Logit Lachmach marine survival	Lachmach – week 29	$0.731X + 1.41$	0.38	< 0.05	11
log Area 4L stock size	Toboggan – week 29	$0.422X + 10.4$	0.60	< 0.002	12
log Area 4U stock size	Toboggan – week 29	$0.480X + 9.40$	0.39	< 0.02	12
log Area 4U stock size	Toboggan – week 30	$0.541X + 9.59$	0.38	< 0.02	12

† predictors are all Logit transformed AK troll catch to indicated week of CWTs from indicated stock as a proportion of CWTs released.

3.4.1 In-season forecasts

Generally, the models made reasonable predictions of marine survival and the forecasts improved over the course of the season (Figure 7 to Figure 11). In most years the marine survival fell within the 80%CI by week 29, and it was within the 50%CI by week 30 in many years (Table 13 to Table 15). Performance was not uniform however, and for Babine and Toboggan there was a least one year where the model forecast was poor (e.g. Babine: 1998; Toboggan: 1992, 1993). In some years (e.g. 1994, 1995) the temporal pattern of the in-season forecast was strikingly similar among the stocks. The similarities were most marked between Lachmach and Babine. Those two stocks are known to have a more northerly distribution in the Alaskan fishery (Holtby et al. 1999), suggesting that annual differences in the patterning of the forecasts are at least partially due to variability in fish distributions and the timing of their entry into the fishery. There were common patterns in forecast success between sites within certain years, due to either differences in fishing effort, some other property of the fisheries or to differences in run timing (entry into the fishery).

3.4.2 As early warning of poor survival

Interest in in-season forecasts of survival is focused on their utility in detecting years of poor survival in sufficient time to modify harvest. Although detection of extremely poor survival years like 1996 (sea-entry) would be crucial to an “early-warning” scheme, there have other years of extremely poor survival that should have triggered management actions (e.g. 1991 and 1994 sea-entry). Minimizing false triggering events is also important because of the socio-economic costs of limiting fishing unnecessarily.

Model forecasts made in weeks 29 and 30 are presented in Table 13 (Babine), Table 14 (Toboggan), and Table 15 (Lachmach). The Tables contain the information required to determine if the trigger would have been signaled in each year for each stock.

Babine   Marine survival has been measured for Babine coho in only six years (1994 to 1999 return years). Within those years a trigger situation (survival ≤ 0.01) occurred in three years and was successfully detected in week 29 by the 50%CI in the two years of poorest survival. The 1995 survival was 0.01 and was not detectable without false triggers until week 30 using the 80%CI. In descending order of preference, the forecasts would be ordered: week 30-80%CI, week 29-80%CI, week 29-50%CI and week 30-50%CI.

			trigger signaled			
			50% CI		80%CI	
return year	observed marine survival	triggering situation present	week 29	week 30	week 29	week 30
1994	0.040	N	N	N	N	N
1995	0.010	Y	N	N	Y	Y
1996	0.031	N	N	N	Y	N
1997	0.006	Y	Y	Y	Y	Y
1998	0.007	Y	Y	Y	Y	Y
1999	0.051	N	N	N	N	N

Toboggan Marine survival has been estimated in 12 years for Toboggan coho and a trigger situation (survival≤0.02) was present in four of the years. All of the trigger situations were detected in both weeks using the 50%CI. Two false triggers were signaled using the 50%CI in both weeks and an additional false trigger was signaled using the 80%CI. The observed marine survival in 1988 was close to the trigger value. In descending order of preference, the forecasts would be ordered: week 29-50%CI, week 30-50%CI, week 29-50%CI and week 30-80%CI.

			trigger signaled			
			50% CI		80%CI	
year	observed marine survival	trigger situation present	week 29	week 30	week 29	week 30
1988	0.021	N	Y	Y	Y	Y
1989	0.027	N	N	N	Y	Y
1990	0.041	N	N	N	N	Y
1991	0.060	N	N	N	N	N
1992	0.017	Y	Y	Y	Y	Y
1993	0.029	N	Y	Y	Y	Y
1994	0.060	N	N	N	N	N
1995	0.018	Y	Y	Y	Y	Y
1996	0.025	N	N	N	N	N
1997	0.005	Y	Y	Y	Y	Y
1998	0.018	Y	Y	Y	Y	Y
1999	0.104	N	N	N	N	N

Lachmach Marine survival has been estimated in 12 years in Lachmach and a trigger situation (survival≤0.02) has not been observed. A false trigger was signaled in 1988 in both weeks. This might be a statistical artifact of the very small tag release in 1987 (Table 12). Two false triggers were signaled using the 50%CI in both weeks and an additional false trigger was signaled using the 80%CI. The observed marine survival in 1988 was close to the trigger value. Examination of Figure 10 and Figure 11 suggests that forecasts from week 30 are generally closer than those made in week 29 but there is no experience to suggest which confidence interval in week 30 should be used.

			trigger signaled			
			50% CI		80%CI	
year	observed marine survival	trigger situation present	week 29	week 30	week 29	week 30
1988	0.030	N	Y	Y	Y	Y
1989	0.043	N	N	N	N	N
1990	0.132	N	N	N	N	N
1991	0.124	N	N	N	N	N
1992	0.094	N	N	N	N	N
1993	0.066	N	N	N	N	N
1994	0.188	N	N	N	N	N
1995	0.086	N	N	N	N	N
1996	0.104	N	N	N	N	N
1997	0.043	N	N	N	N	N
1998	0.095	N	N	N	N	N
1999	0.125	N	N	N	N	N

There is no clear choice among the week-CI combinations. The combination week 29-50%CI had the best aggregate performance (summed preference rank) while week 29-80% would have detected all trigger situations at the cost of some false triggers.

3.4.3 As early warning of low abundance

Toboggan and Babine tag recoveries as proportions of tags released are correlated with the stock size of the average stream in Areas 4U and 4L. The predictive model for the upper Skeena using cumulative catch to week 29 (shown above) was used to forecast for the period 1988 to 1999 (Table 16). Within this period there is one trigger event (1997) and one year that is close to being a trigger event (1988). The model detected both years with no false triggers using the 50%CI.

4 Conclusions

Four fisheries-performance measures were tested for utility in providing early warning of either poor marine survival or low abundance for northern B.C. coho. The results of those examinations are summarized in the following Table. The entries in the Table first indicate whether a particular model was not predictive (~P). If the model was predictive then the entry indicates whether trigger events were successfully detected (T: Y or N), whether spurious triggers were indicated (S: Y or N) and within what confidence interval (C: 50% or 80%).

	fishery performance measure			
variable being forecast	cumulative Skeena test-fishery index	*CPUE* Alaskan boundary area troll	*CPUE* Alaskan Tree Point gill-net fishery (week 29)	Alaskan troll recovery of upper Skeena CWTs (week 30)
marine survival: Lachmach	~P	~P	~P	T:–† S:Y C:80%
marine survival: Toboggan hatchery	~P	T:Y S:N C:80%	T:Y S:Y C:80%	T:Y S:Y C:80%
marine survival: Babine hatchery	~P	T:Y S:N C:80%	~P	T:Y S:N C:80%
total stock size average-stream Area 3 (Nass)	~P	T:Y S:N C:80%	~P	~P
total stock size average-stream Area 4L (lower Skeena)	~P	predictive but not evaluated	~P	T:–† S:N C:80%
total stock size average-stream Area 4U (upper Skeena)	T:Y S:N C:80%	T:Y S:N C:80%	~P	T:Y S:N C:80%
total stock size average-stream Area 6 (Kitimat)	T:N S:N C:80%	T:N S:N C:80%	~P	~P
total stock Babine aggregate	~P	~P	~P	~P

† no trigger events were observed for survival at Lachmach or abundance in Area 4L.

Of the four fishery-performance variables evaluated as early-warning forecast tools the *CPUE* in the Alaskan boundary area troll appears to be the most promising. Models based on this *CPUE* were predictive for most of the variables of concern and were able to reliably detect trigger situations while not giving more than one false trigger. The second best predictor was the proportion of CWTs recovered to week 29 in the Alaskan troll. Models based on this performance measure were able to detect trigger situations for upper and lower Skeena coho but failed outside of the Skeena and notably in Area 6. Furthermore, the models signaled spurious false triggers. The remaining two performance measures, the Skeena test-fishery index and *CPUE* in the Alaskan Tree Point gill-net fishery seem unsuitable as early warning indicators.

5 References

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Table 1. In-season forecasts of total stock size of the average stream in the upper Skeena (Area 4U) based on the cumulative Skeena test-fishery index on July 31. Also shown for each year are whether a trigger situation (stock size < 171) was observed and what the forecast detected at two levels of confidence.

			forecast stock size									trigger situations		
year	test-fishery index to July 31	observed total stock size	CI 99%<	CI 95%<	CI 90%<	CI 75%<	**forecast**	CI 25%<	CI 10%<	CI 5%<	CI 1%<	forecast 50%CI	forecast 80% CI	observed
1956	18.9	2290	1.0E+04	6.6E+03	5.2E+03	2.7E+03	**1.7E+03**	1.1E+03	5.5E+02	4.4E+02	2.8E+02			
1957	25.3	1100	1.3E+04	7.9E+03	6.3E+03	3.2E+03	**2.0E+03**	1.3E+03	6.5E+02	5.2E+02	3.3E+02			
1958	17.6	2200	1.1E+04	6.7E+03	5.3E+03	2.7E+03	**1.7E+03**	1.1E+03	5.6E+02	4.4E+02	2.8E+02			
1959	17.5	2100	1.0E+04	6.6E+03	5.3E+03	2.7E+03	**1.7E+03**	1.1E+03	5.5E+02	4.4E+02	2.8E+02			
1960	20.6	1720	1.2E+04	7.5E+03	6.0E+03	3.1E+03	**1.9E+03**	1.2E+03	6.2E+02	5.0E+02	3.1E+02			
1961	12.2	1780	8.2E+03	5.2E+03	4.1E+03	2.1E+03	**1.3E+03**	8.5E+02	4.4E+02	3.5E+02	2.2E+02			
1962	21.2	2310	1.1E+04	7.2E+03	5.7E+03	2.9E+03	**1.9E+03**	1.2E+03	6.0E+02	4.8E+02	3.0E+02			
1963	27.3	1980	1.4E+04	8.9E+03	7.1E+03	3.6E+03	**2.3E+03**	1.4E+03	7.3E+02	5.8E+02	3.6E+02			
1964	18.1	2110	1.1E+04	6.7E+03	5.4E+03	2.7E+03	**1.7E+03**	1.1E+03	5.6E+02	4.5E+02	2.8E+02			
1965	33.2	1430	1.8E+04	1.1E+04	9.0E+03	4.5E+03	**2.8E+03**	1.8E+03	8.9E+02	7.0E+02	4.4E+02			
1966	45.3	1400	2.1E+04	1.3E+04	1.0E+04	5.1E+03	**3.2E+03**	2.0E+03	9.9E+02	7.8E+02	4.9E+02			
1967	19.3	1010	1.2E+04	7.3E+03	5.8E+03	3.0E+03	**1.9E+03**	1.2E+03	6.0E+02	4.8E+02	3.0E+02			
1968	11.8	1330	7.9E+03	5.0E+03	4.0E+03	2.0E+03	**1.3E+03**	8.2E+02	4.2E+02	3.4E+02	2.1E+02			
1969	7.0	1260	6.4E+03	4.0E+03	3.2E+03	1.6E+03	**1.0E+03**	6.6E+02	3.3E+02	2.7E+02	1.7E+02			
1970	16.6	1660	1.1E+04	6.9E+03	5.5E+03	2.8E+03	**1.8E+03**	1.1E+03	5.8E+02	4.6E+02	2.9E+02			
1971	6.6	1750	5.7E+03	3.6E+03	2.9E+03	1.5E+03	**9.2E+02**	5.8E+02	3.0E+02	2.4E+02	1.5E+02			
1972	6.5	2880	6.8E+03	4.3E+03	3.4E+03	1.8E+03	**1.1E+03**	7.1E+02	3.6E+02	2.9E+02	1.8E+02			
1973	7.2	1700	6.2E+03	3.9E+03	3.1E+03	1.6E+03	**1.0E+03**	6.4E+02	3.3E+02	2.6E+02	1.6E+02			
1974	4.2	1650	5.4E+03	3.4E+03	2.7E+03	1.4E+03	**8.6E+02**	5.4E+02	2.8E+02	2.2E+02	1.4E+02			
1975	9.0	365	7.2E+03	4.5E+03	3.6E+03	1.8E+03	**1.2E+03**	7.4E+02	3.8E+02	3.0E+02	1.9E+02			
1976	2.7	549	4.4E+03	2.8E+03	2.2E+03	1.1E+03	**6.9E+02**	4.3E+02	2.2E+02	1.7E+02	1.1E+02			
1977	5.7	1980	6.1E+03	3.8E+03	3.1E+03	1.6E+03	**9.9E+02**	6.2E+02	3.2E+02	2.5E+02	1.6E+02			
1978	5.9	3340	6.2E+03	3.9E+03	3.1E+03	1.6E+03	**1.0E+03**	6.4E+02	3.3E+02	2.6E+02	1.6E+02			
1979	2.8	395	3.7E+03	2.3E+03	1.8E+03	9.0E+02	**5.6E+02**	3.5E+02	1.7E+02	1.4E+02	8.5E+01			

			forecast stock size									trigger situations		
year	test-fishery index to July 31	observed total stock size	CI 99%<	CI 95%<	CI 90%<	CI 75%<	**forecast**	CI 25%<	CI 10%<	CI 5%<	CI 1%<	forecast 50%CI	forecast 80% CI	observed
1980	17.2	3210	9.9E+03	6.3E+03	5.0E+03	2.6E+03	**1.6E+03**	1.0E+03	5.3E+02	4.2E+02	2.7E+02			
1981	13.5	1510	9.2E+03	5.8E+03	4.7E+03	2.4E+03	**1.5E+03**	9.6E+02	4.9E+02	3.9E+02	2.5E+02			
1982	5.9	1070	5.2E+03	3.3E+03	2.6E+03	1.3E+03	**8.4E+02**	5.3E+02	2.7E+02	2.1E+02	1.3E+02			
1983	11.1	2840	8.6E+03	5.5E+03	4.3E+03	2.2E+03	**1.4E+03**	9.0E+02	4.6E+02	3.7E+02	2.3E+02			
1984	5.9	1380	5.7E+03	3.6E+03	2.8E+03	1.4E+03	**9.1E+02**	5.8E+02	2.9E+02	2.3E+02	1.5E+02			
1985	6.2	2010	5.5E+03	3.5E+03	2.7E+03	1.4E+03	**8.8E+02**	5.6E+02	2.8E+02	2.3E+02	1.4E+02			
1986	8.4	3100	6.8E+03	4.3E+03	3.5E+03	1.8E+03	**1.1E+03**	7.1E+02	3.6E+02	2.9E+02	1.8E+02			
1987	11.0	728	7.8E+03	5.0E+03	3.9E+03	2.0E+03	**1.3E+03**	8.1E+02	4.2E+02	3.3E+02	2.1E+02			
1988	3.2	376	5.4E+03	3.4E+03	2.7E+03	1.4E+03	**8.7E+02**	5.5E+02	2.8E+02	2.2E+02	1.4E+02			
1989	8.2	716	6.9E+03	4.4E+03	3.5E+03	1.8E+03	**1.1E+03**	7.2E+02	3.7E+02	2.9E+02	1.9E+02			
1990	15.9	1000	1.0E+04	6.4E+03	5.1E+03	2.6E+03	**1.7E+03**	1.1E+03	5.4E+02	4.3E+02	2.7E+02			
1991	5.8	1170	5.5E+03	3.4E+03	2.7E+03	1.4E+03	**8.8E+02**	5.5E+02	2.8E+02	2.2E+02	1.4E+02			
1992	4.4	534	5.4E+03	3.4E+03	2.7E+03	1.4E+03	**8.6E+02**	5.5E+02	2.8E+02	2.2E+02	1.4E+02			
1993	3.5	500	4.1E+03	2.6E+03	2.0E+03	1.0E+03	**6.4E+02**	4.0E+02	2.0E+02	1.6E+02	9.8E+01			
1994	3.3	1530	3.9E+03	2.4E+03	1.9E+03	9.5E+02	**5.9E+02**	3.7E+02	1.8E+02	1.4E+02	9.0E+01			
1995	2.5	194	3.3E+03	2.1E+03	1.6E+03	8.0E+02	**4.9E+02**	3.0E+02	1.5E+02	1.2E+02	7.3E+01		Y	
1996	6.3	418	5.4E+03	3.4E+03	2.7E+03	1.4E+03	**8.7E+02**	5.5E+02	2.8E+02	2.2E+02	1.4E+02			
1997	1.8	72	3.1E+03	1.9E+03	1.5E+03	7.2E+02	**4.4E+02**	2.7E+02	1.3E+02	1.0E+02	6.4E+01		Y	Y
1998	7.3	1320	6.0E+03	3.8E+03	3.0E+03	1.5E+03	**9.7E+02**	6.2E+02	3.1E+02	2.5E+02	1.6E+02			
1999	10.6	1030	9.0E+03	5.7E+03	4.5E+03	2.3E+03	**1.5E+03**	9.3E+02	4.8E+02	3.8E+02	2.4E+02			

Table 2. In-season forecasts of total stock size of the average stream in the Kitimat (Area 6) based on the cumulative Skeena test-fishery index on July 31. Also shown for each year are whether a trigger situation (stock size < 421) was observed and what the forecast detected at two levels of confidence.

			forecast stock size									trigger situations		
year	test-fishery index to July 31	observed total stock size	CI 99%<	CI 95%<	CI 90%<	CI 75%<	**forecast**	CI 25%<	CI 10%<	CI 5%<	CI 1%<	forecast 50%CI	forecast 80% CI	observed
1956	18.9	4.4E+03	8.8E+03	6.2E+03	5.2E+03	3.1E+03	**2.2E+03**	1.6E+03	9.4E+02	7.9E+02	5.6E+02			
1957	25.3	4.1E+03	1.0E+04	7.3E+03	6.1E+03	3.7E+03	**2.6E+03**	1.8E+03	1.1E+03	9.1E+02	6.4E+02			
1958	17.6	2.1E+03	8.9E+03	6.3E+03	5.3E+03	3.2E+03	**2.2E+03**	1.6E+03	9.5E+02	8.0E+02	5.6E+02			
1959	17.5	1.8E+03	8.9E+03	6.3E+03	5.3E+03	3.2E+03	**2.2E+03**	1.6E+03	9.4E+02	7.9E+02	5.6E+02			
1960	20.6	2.1E+03	9.9E+03	7.0E+03	5.9E+03	3.5E+03	**2.5E+03**	1.7E+03	1.0E+03	8.8E+02	6.2E+02			
1961	12.2	2.1E+03	7.2E+03	5.1E+03	4.3E+03	2.6E+03	**1.8E+03**	1.3E+03	7.7E+02	6.5E+02	4.6E+02			
1962	21.2	3.1E+03	9.5E+03	6.7E+03	5.6E+03	3.4E+03	**2.4E+03**	1.7E+03	1.0E+03	8.5E+02	6.0E+02			
1963	27.3	3.4E+03	1.1E+04	8.0E+03	6.7E+03	4.0E+03	**2.8E+03**	2.0E+03	1.2E+03	1.0E+03	7.0E+02			
1964	18.1	3.1E+03	9.0E+03	6.3E+03	5.3E+03	3.2E+03	**2.3E+03**	1.6E+03	9.6E+02	8.0E+02	5.7E+02			
1965	33.2	3.8E+03	1.4E+04	9.8E+03	8.2E+03	4.9E+03	**3.4E+03**	2.4E+03	1.4E+03	1.2E+03	8.2E+02			
1966	45.3	2.6E+03	1.6E+04	1.1E+04	9.2E+03	5.4E+03	**3.8E+03**	2.6E+03	1.5E+03	1.3E+03	9.0E+02			
1967	19.3	1.6E+03	9.6E+03	6.8E+03	5.7E+03	3.4E+03	**2.4E+03**	1.7E+03	1.0E+03	8.5E+02	6.0E+02			
1968	11.8	3.8E+03	7.0E+03	4.9E+03	4.1E+03	2.5E+03	**1.8E+03**	1.2E+03	7.5E+02	6.3E+02	4.4E+02			
1969	7.0	1.2E+03	5.8E+03	4.1E+03	3.4E+03	2.1E+03	**1.5E+03**	1.0E+03	6.1E+02	5.2E+02	3.6E+02			
1970	16.6	1.6E+03	9.2E+03	6.5E+03	5.5E+03	3.3E+03	**2.3E+03**	1.6E+03	9.8E+02	8.2E+02	5.8E+02			
1971	6.6	2.0E+03	5.3E+03	3.7E+03	3.1E+03	1.9E+03	**1.3E+03**	9.3E+02	5.5E+02	4.7E+02	3.3E+02			
1972	6.5	2.9E+03	6.2E+03	4.4E+03	3.7E+03	2.2E+03	**1.6E+03**	1.1E+03	6.6E+02	5.5E+02	3.9E+02			
1973	7.2	1.2E+03	5.7E+03	4.0E+03	3.4E+03	2.0E+03	**1.4E+03**	1.0E+03	6.0E+02	5.1E+02	3.6E+02			
1974	4.2	1.5E+03	5.0E+03	3.5E+03	3.0E+03	1.8E+03	**1.2E+03**	8.8E+02	5.2E+02	4.4E+02	3.1E+02			
1975	9.0	1.6E+03	6.4E+03	4.5E+03	3.8E+03	2.3E+03	**1.6E+03**	1.1E+03	6.8E+02	5.8E+02	4.1E+02			
1976	2.7	1.3E+03	4.3E+03	3.0E+03	2.5E+03	1.5E+03	**1.0E+03**	7.2E+02	4.3E+02	3.6E+02	2.5E+02			
1977	5.7	1.3E+03	5.6E+03	3.9E+03	3.3E+03	2.0E+03	**1.4E+03**	9.9E+02	5.9E+02	5.0E+02	3.5E+02			
1978	5.9	1.7E+03	5.7E+03	4.0E+03	3.4E+03	2.0E+03	**1.4E+03**	1.0E+03	6.0E+02	5.1E+02	3.6E+02			
1979	2.8	2.3E+03	3.6E+03	2.5E+03	2.1E+03	1.2E+03	**8.7E+02**	6.0E+02	3.5E+02	2.9E+02	2.1E+02		Y	

year	test-fishery index to July 31	observed total stock size	forecast stock size									trigger situations		
			CI 99%<	CI 95%<	CI 90%<	CI 75%<	**forecast**	CI 25%<	CI 10%<	CI 5%<	CI 1%<	forecast 50%CI	forecast 80% CI	observed
1980	17.2	2.0E+03	8.5E+03	6.0E+03	5.0E+03	3.0E+03	**2.1E+03**	1.5E+03	9.1E+02	7.6E+02	5.4E+02			
1981	13.5	1.5E+03	8.0E+03	5.6E+03	4.7E+03	2.8E+03	**2.0E+03**	1.4E+03	8.5E+02	7.2E+02	5.1E+02			
1982	5.9	1.3E+03	4.9E+03	3.5E+03	2.9E+03	1.7E+03	**1.2E+03**	8.6E+02	5.1E+02	4.3E+02	3.0E+02			
1983	11.1	1.8E+03	7.5E+03	5.3E+03	4.5E+03	2.7E+03	**1.9E+03**	1.3E+03	8.0E+02	6.8E+02	4.8E+02			
1984	5.9	1.8E+03	5.3E+03	3.7E+03	3.1E+03	1.9E+03	**1.3E+03**	9.2E+02	5.5E+02	4.6E+02	3.3E+02			
1985	6.2	2.2E+03	5.1E+03	3.6E+03	3.0E+03	1.8E+03	**1.3E+03**	8.9E+02	5.3E+02	4.5E+02	3.2E+02			
1986	8.4	3.6E+03	6.2E+03	4.4E+03	3.7E+03	2.2E+03	**1.6E+03**	1.1E+03	6.6E+02	5.5E+02	3.9E+02			
1987	11.0	1.2E+03	6.9E+03	4.9E+03	4.1E+03	2.5E+03	**1.7E+03**	1.2E+03	7.4E+02	6.2E+02	4.4E+02			
1988	3.2	8.1E+02	5.0E+03	3.6E+03	3.0E+03	1.8E+03	**1.3E+03**	8.8E+02	5.3E+02	4.4E+02	3.1E+02			
1989	8.2	1.1E+03	6.3E+03	4.4E+03	3.7E+03	2.2E+03	**1.6E+03**	1.1E+03	6.7E+02	5.6E+02	4.0E+02			
1990	15.9	1.9E+03	8.6E+03	6.1E+03	5.1E+03	3.1E+03	**2.2E+03**	1.5E+03	9.2E+02	7.7E+02	5.5E+02			
1991	5.8	1.5E+03	5.1E+03	3.6E+03	3.0E+03	1.8E+03	**1.3E+03**	8.9E+02	5.3E+02	4.5E+02	3.1E+02			
1992	4.4	1.3E+03	5.0E+03	3.5E+03	3.0E+03	1.8E+03	**1.2E+03**	8.8E+02	5.2E+02	4.4E+02	3.1E+02			
1993	3.5	1.1E+03	4.0E+03	2.8E+03	2.3E+03	1.4E+03	**9.6E+02**	6.7E+02	4.0E+02	3.3E+02	2.3E+02		Y	
1994	3.3	1.0E+03	3.8E+03	2.6E+03	2.2E+03	1.3E+03	**9.0E+02**	6.3E+02	3.7E+02	3.1E+02	2.2E+02		Y	
1995	2.5	3.5E+02	3.3E+03	2.3E+03	1.9E+03	1.1E+03	**7.7E+02**	5.4E+02	3.1E+02	2.6E+02	1.8E+02		Y	Y
1996	6.3	1.1E+03	5.1E+03	3.6E+03	3.0E+03	1.8E+03	**1.3E+03**	8.8E+02	5.3E+02	4.4E+02	3.1E+02			
1997	1.8	2.2E+02	3.1E+03	2.1E+03	1.8E+03	1.0E+03	**7.1E+02**	4.9E+02	2.8E+02	2.3E+02	1.6E+02		Y	Y
1998	7.3	1.3E+03	5.5E+03	3.9E+03	3.3E+03	2.0E+03	**1.4E+03**	9.8E+02	5.8E+02	4.9E+02	3.5E+02			
1999	10.6	3.4E+02	7.8E+03	5.5E+03	4.6E+03	2.8E+03	**2.0E+03**	1.4E+03	8.3E+02	7.0E+02	4.9E+02			Y

Table 3. Total weekly troll catch in the SE Alaska boundary area for weeks 27 to 33 and the *CPUE* (catch/boar-day) for the same period. Shaded *CPUE* values were estimated (see text). The mean *CPUE* for the weeks 27 to 29 is also shown.

	weekly catch of coho in Alaskan boundary area							CPUE (catch/boat-day)							
	statistical week							statistical week							
year	27	28	29	30	31	32	33	27	28	29	30	31	32	33	average (27 to 29)
1981			1086	3115	2977	248	437	34.1	47.7	62.1	90.3	43.5	55.1	29.1	48.0
1982	1847	497	883	485	1948			35.2	55.2	34.0	26.2	29.7	29.7	23.8	41.5
1983		2133	1164	2367	4622	1699		39.4	54.0	72.8	65.8	77.0	53.1	54.3	55.4
1984	404	183	1166	595	91	747	1125	26.9	91.5	23.8	13.8	13.0	34.0	36.3	47.4
1985		1552	4011	2899	3583	138	4323	55.1	50.1	127.3	60.4	73.1	46.0	55.1	77.5
1986	176	2090	2877	511	1273	2794	2600	22.0	72.1	66.9	56.8	79.6	66.5	55.3	53.7
1987	163	1270	976	2138	1981	4138		11.9	57.7	51.4	66.8	41.3	39.6	41.0	40.3
1988		534		1441			1523	23.1	32.4	42.1	31.0	29.3	30.0	20.2	32.5
1989	1056	1479	2697	3155	4696	6121	1669	72.8	27.1	56.8	67.8	56.4	77.2	46.4	52.2
1990	3353	6105	6410	2282	1511	397	2345	65.7	70.6	58.0	43.5	45.1	23.4	59.4	64.8
1991	435	8484	16105	5509	8238	5492	6363	30.0	81.6	109.0	68.3	71.3	69.1	52.2	73.5
1992	1080	997	995	1725	1372	3425	3700	11.7	22.7	24.9	33.8	53.8	54.4	39.4	19.8
1993		3208	6415	2479	4959	6079	5957	34.8	33.8	78.2	69.8	72.4	77.9	48.4	48.9
1994		736	2127	4149	6986	7423	6929	37.8	20.4	101.3	94.3	121.5	156.3	101.9	53.2
1995	1225	223	924	685	413	1675		53.3	12.2	31.3	33.4	21.2	48.6	28.6	32.3
1996	77	3575	2195	4045	3255	4049	2223	9.1	70.8	72.0	90.9	72.3	101.2	74.1	50.6
1997		162		495	1301	4006		3.4	4.8	6.2	30.0	92.9	76.3	55.2	4.8
1998	0	2221	261	1940	4346	5316	2016	19.7	34.4	29.0	71.9	97.7	87.9	61.1	27.7
1999		2158	2292	6350	8493	11186	10682	46.7	45.9	104.2	106.7	116.0	111.9	107.4	65.6

Table 4. For Babine coho, observed marine survivals and in-season forecasts using the boundary area troll CPUE averaged over weeks 27 to 29. Associated confidence are shown. A trigger situation (survival≤0.01) was detected when the 50%CI around the forecast contained the trigger.

	marine survival					
year	1994	1995	1996	1997	1998	1999
observed	0.040	0.010	0.031	0.006	0.007	0.051
99%<	0.120	0.051	0.107	0.021	0.043	0.208
95%<	0.065	0.027	0.058	0.010	0.023	0.113
90%<	0.055	0.023	0.049	0.008	0.019	0.094
75%<	0.041	0.017	0.037	0.005	0.014	0.069
50%<	**0.031**	**0.013**	**0.028**	**0.004**	**0.011**	**0.052**
25%<	0.023	0.010	0.021	0.003	0.008	0.039
10%<	0.017	0.007	0.016	0.002	0.006	0.028
5%<	0.014	0.006	0.013	0.002	0.005	0.023
1%<	0.007	0.003	0.007	0.001	0.003	0.011

forecast performance in detecting a trigger situation						
forecast	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE
observed	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE

Table 5. For Toboggan coho, observed marine survivals and in-season forecasts using the boundary area troll CPUE averaged over weeks 27 to 29. Associated confidence are shown. A trigger situation (survival≤0.02) was detected when the 50%CI around the forecast contained the trigger.

	marine survival											
year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
observed	0.021	0.027	0.041	0.060	0.017	0.029	0.060	0.018	0.025	0.005	0.018	0.104
99%<	0.060	0.114	0.173	0.231	0.041	0.102	0.117	0.060	0.108	0.027	0.052	0.178
95%<	0.043	0.082	0.126	0.169	0.029	0.073	0.085	0.042	0.078	0.018	0.037	0.129
90%<	0.037	0.071	0.109	0.146	0.024	0.063	0.073	0.036	0.067	0.015	0.031	0.112
75%<	0.024	0.048	0.073	0.098	0.016	0.042	0.049	0.024	0.045	0.009	0.021	0.075
50%<	0.019	0.037	0.056	0.075	0.012	0.033	0.038	0.018	0.035	0.007	0.016	0.058
25%<	0.014	0.028	0.043	0.058	0.009	0.025	0.029	0.014	0.027	0.005	0.012	0.045
10%<	0.009	0.019	0.028	0.037	0.006	0.017	0.019	0.009	0.018	0.003	0.008	0.029
5%<	0.008	0.016	0.024	0.032	0.005	0.014	0.017	0.008	0.015	0.003	0.007	0.025
1%<	0.006	0.011	0.017	0.022	0.003	0.010	0.012	0.006	0.011	0.002	0.005	0.017

forecast performance in detecting a trigger situation

forecast	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE
observed	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE

Table 6. For the average stream of the upper Skeena (Area 4U) coho aggregate, observed total stock size and in-season forecasts using the boundary area troll CPUE averaged over weeks 27 to 29. Associated confidence are shown. A trigger situation (stock size ≤ 171) was detected when the 50%CI around the forecast contained the trigger.

	total stock size																		
year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
observed	1510	1070	2840	1380	2010	3100	728	376	716	1000	1170	534	500	1530	194	418	71.7	1320	1030
99%<	3975	3192	5170	3900	12221	4858	3077	2403	4619	7349	10384	1652	4112	4777	2383	4359	1112	2078	7582
95%<	3027	2430	3931	2970	9123	3696	2341	1822	3515	5558	7788	1239	3131	3635	1806	3318	817	1570	5730
90%<	2256	1810	2925	2214	6655	2752	1743	1352	2618	4111	5710	908	2333	2706	1340	2472	585	1160	4236
75%<	1416	1134	1830	1389	4036	1724	1092	842	1641	2549	3491	555	1464	1696	834	1551	345	718	2624
50%<	**863**	**691**	**1113**	**847**	**2374**	**1049**	**665**	**509**	**1000**	**1535**	**2071**	**329**	**893**	**1032**	**504**	**945**	**197**	**432**	**1578**
25%<	526	421	677	517	1396	639	405	308	609	924	1228	195	544	629	305	576	112	260	949
10%<	330	264	424	324	847	400	254	192	382	573	751	119	341	394	190	361	66	161	588
5%<	246	197	315	242	618	298	189	142	284	424	551	87	254	293	141	269	48	119	435
1%<	187	150	240	184	461	227	144	108	216	321	413	65	194	223	107	205	35	90	328

forecast performance in detecting a trigger situation

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
forecast																	Y		
observed																	Y		

Table 7. For the average stream of the Kitimat (Area 6) coho aggregate, observed total stock size and in-season forecasts using the boundary area troll CPUE averaged over weeks 27 to 29. Associated confidence are shown. A trigger situation (stock size ≤ 421) was detected when the 50%CI around the forecast contained the trigger.

	total stock size																		
year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
observed	1460	1340	1820	1830	2200	3600	1190	811	1090	1940	1470	1300	1140	1000	348	1080	223	1260	336
99%<	4333	3854	5009	4289	8248	4838	3780	3330	4705	6118	7487	2778	4414	4793	3316	4557	2332	3098	6229
95%<	3415	3036	3942	3380	6388	3809	2977	2614	3706	4792	5823	2160	3478	3774	2603	3590	1780	2425	4876
90%<	2641	2346	3044	2614	4849	2943	2300	2013	2864	3682	4439	1646	2690	2917	2004	2776	1331	1862	3744
75%<	1757	1560	2021	1740	3131	1956	1529	1331	1904	2424	2887	1070	1790	1938	1324	1846	839	1224	2463
50%<	**1140**	**1011**	**1308**	**1129**	**1969**	**1267**	**990**	**858**	**1234**	**1556**	**1829**	**677**	**1161**	**1256**	**853**	**1198**	**514**	**785**	**1579**
25%<	740	656	847	733	1238	821	642	553	800	999	1159	429	753	814	550	777	315	503	1013
10%<	492	436	562	487	799	545	426	365	532	658	754	279	501	541	363	517	198	331	666
5%<	381	337	434	377	607	421	330	281	411	505	574	212	388	418	280	399	148	254	512
1%<	300	265	342	297	470	332	260	221	324	396	447	165	305	329	220	315	113	199	400

forecast performance in detecting a trigger situation																			
forecast																	Y		
observed															Y		Y		Y

Table 8. Cumulative coho catch and cumulative CPUE (catch/boat-day) for the Alaskan Tree Point gill-net sockeye fishery. Cumulative totals began in week 26.

	cumulative catch beginning week 26						cumulative CPUE					
	statistical week						statistical week					
return year	26	27	28	29	30	31	26	27	28	29	30	31
1969	161	482	905	1,652	2,086	2,452	0.52	0.71	0.94	1.26	1.36	1.49
1970	439	835	2,137	2,816	3,382	4,390	1.32	1.24	1.86	1.65	1.61	1.79
1971	57	173	342	890	2,031	11,959	0.20	0.27	0.34	0.63	1.26	6.98
1972	750	2,339	4,568	7,657	12,727	14,974	1.69	2.49	3.10	3.81	4.73	4.68
1973	1,072	2,340	3,164	4,400	5,335	6,146	1.68	1.78	1.79	1.99	1.91	1.95
1974	708	1,676	1,676	2,461	3,111	3,716	1.56	1.94	1.94	2.27	2.22	2.18
1975	891	1,955	2,691	3,462	4,736	6,272	1.81	2.05	2.11	2.36	3.22	4.27
1976	530	2,779	6,193	8,072	8,907	8,907	1.24	2.89	4.15	3.98	3.92	3.92
1977	79	388	698	1,289	1,651	2,545	0.17	0.43	0.49	0.64	0.76	0.95
1978	4,842	8,739	12,850	16,003	22,803	27,312	6.65	6.48	6.77	7.33	8.60	8.20
1979	290	774	1,987	3,438	4,954	5,403	0.47	0.61	1.13	1.74	2.26	2.28
1980	944	2,255	3,476	4,501	4,962	5,267	1.90	2.52	2.47	2.33	2.27	2.33
1981	377	543	1,300	1,553	2,470	3,354	0.71	0.59	0.99	1.01	1.41	1.77
1982	589	1,749	2,585	5,047	7,308	8,597	1.42	2.02	2.22	3.04	3.30	3.49
1983	650	2,643	3,821	5,626	8,287	11,583	1.69	2.98	3.45	4.14	4.37	4.57
1984	821	1,885	2,731	3,877	4,775	6,109	2.12	2.67	2.62	2.49	2.34	2.37
1985	216	893	2,835	4,932	7,386	9,719	0.44	1.07	2.77	3.29	3.70	3.78
1986	428	1,135	2,051	5,885	9,223	12,701	1.39	2.78	2.88	4.18	4.43	4.96
1987	580	1,155	1,436	2,327	3,908	4,463	1.33	1.40	1.32	1.85	2.32	2.40
1988	105	1,353	1,852	3,530	4,212	4,421	0.23	1.33	1.39	1.80	1.90	1.81
1989	1,400	2,615	3,294	4,643	5,924	8,584	3.86	3.62	3.54	3.09	2.88	3.22
1990	883	1,673	2,347	3,256	4,471	6,390	3.71	3.65	3.67	4.02	3.76	4.29
1991	303	616	1,523	3,454	5,089	7,982	1.06	1.25	2.25	3.73	3.68	4.33
1992	512	1,629	2,231	2,670	3,443	4,946	1.58	2.31	2.14	1.89	1.93	2.20
1993	846	2,430	3,005	3,299	3,949	6,049	2.20	2.74	2.44	2.20	2.14	2.59
1994	425	1,327	1,961	3,629	5,156	5,822	0.92	1.61	1.78	2.66	3.05	3.05
1995	901	1,721	2,039	2,257	2,859	3,487	2.27	2.23	1.87	1.81	1.82	1.82

	cumulative catch beginning week 26						cumulative CPUE					
	statistical week						statistical week					
return year	26	27	28	29	30	31	26	27	28	29	30	31
1996	383	2,200	3,415	4,688	6,883	8,585	0.82	2.57	2.74	2.71	3.33	3.45
1997	76	243	443	734	1,125	1,835	0.22	0.38	0.48	0.64	0.70	0.88
1998	393	1,052	2,126	3,466	5,796	8,459	1.06	1.38	1.80	2.44	3.22	3.72
1999	793	3,024	6,692	9,420	14,420	16,768	2.23	4.72	7.16	7.68	8.63	8.08

Table 9. For Toboggan coho, observed marine survivals and in-season forecasts using the Tree Point cumulative CPUE. Associated confidence are shown. A trigger situation (survival≤0.02) was detected when the 50%CI around the forecast contained the trigger.

	In-season forecast of Toboggan marine survival from Tree Point cumulative CPUE											
year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
observed	0.021	0.027	0.041	0.060	0.017	0.029	0.060	0.018	0.025	0.005	0.018	0.104
99%<	0.113	0.170	0.231	0.209	0.117	0.128	0.148	0.114	0.150	0.083	0.138	0.658
95%<	0.050	0.078	0.110	0.099	0.051	0.057	0.067	0.050	0.069	0.034	0.062	0.390
90%<	0.039	0.062	0.088	0.079	0.041	0.045	0.053	0.040	0.054	0.027	0.049	0.320
75%<	0.027	0.043	0.060	0.054	0.027	0.031	0.036	0.027	0.037	0.018	0.034	0.222
50%<	**0.018**	**0.030**	**0.042**	**0.038**	**0.019**	**0.021**	**0.025**	**0.018**	**0.026**	**0.012**	**0.023**	**0.151**
25%<	0.013	0.021	0.029	0.026	0.013	0.015	0.018	0.013	0.018	0.008	0.016	0.100
10%<	0.008	0.014	0.019	0.018	0.009	0.010	0.012	0.008	0.012	0.005	0.011	0.063
5%<	0.007	0.011	0.015	0.014	0.007	0.008	0.009	0.007	0.009	0.004	0.009	0.047
1%<	0.003	0.005	0.006	0.006	0.003	0.003	0.004	0.003	0.004	0.002	0.004	0.016

forecast performance in detecting trigger situation												
ideal					Y			Y		Y	Y	
50%CI	Y				Y	Y	Y	Y	Y	Y	Y	

Table 10. Number of Babine coho CWTs (expanded for catch samples) caught in Alaskan troll fisheries by week and year. The number of CWTs released in the preceding year and, where available, the estimated marine survival are also tabulated.

	Cumulative Tags Starting in Week 27														
year	27	28	29	30	31	32	33	34	35	36	37	38	39	tags released	survival
1987	56	83	147	191	240	266	266	276	276	276	276	276	276	29808	
1988	1	13	23	39	46	46	66	70	70	72	72	72	72	31019	
1989	67	128	178	245	300	332	348	355	366	366	366	366	366	29004	
1990	43	89	125	165	189	221	236	243	261	261	261	261	261	31139	
1991	46	75	138	179	232	269	304	304	316	321	324	324	324	30362	
1992	3	10	42	70	90	116	139	139	176	238	242	242	242	31497	
1993	0	30	51	116	133	163	186	186	201	214	214	214	214	30979	
1994	0	37	81	132	193	240	299	362	428	448	452	452	452	30753	0.040
1995	16	34	67	79	97	133	136	137	146	150	150	150	150	32934	0.010
1996	6	33	71	119	161	191	208	242	252	262	262	262	262	29255	0.031
1997	0	11	11	21	21	26	26	30	34	53	56	56	56	29694	0.006
1998	2	35	49	83	99	120	129	131	155	155	155	155	155	59891	0.007
1999	152	270	420	509	614	767	841	957	1031	1076	1105	1105	1105	59965	0.051

Table 11. Number of Toboggan coho CWTs (expanded for catch samples) caught in Alaskan troll fisheries by week and year. The number of CWTs released in the preceding year and, where available, the estimated marine survival are also tabulated.

	Cumulative Tags Starting in Week 27														
year	27	28	29	30	31	32	33	34	35	36	37	38	39	tags released	survival
1987															
1988	0	0	5	12	14	14	20	26	26	26	26	26	26	31794	0.021
1989	45	52	77	111	133	135	135	135	135	135	135	135	135	30354	0.027
1990	44	102	121	138	167	180	189	197	197	197	197	197	197	31300	0.041
1991	16	118	276	340	406	422	459	459	487	487	487	487	487	30954	0.060
1992	0	8	38	56	67	128	130	130	152	152	152	152	152	31290	0.017
1993	2	38	94	109	138	155	161	161	173	202	202	202	202	60542	0.029
1994	11	57	154	227	279	344	384	421	441	451	456	456	456	32600	0.060
1995	2	10	30	37	45	65	67	67	67	67	67	67	67	33533	0.018
1996	19	85	114	163	216	238	243	284	284	284	284	284	284	33609	0.025
1997	0	0	9	19	23	30	30	40	40	44	44	44	44	32368	0.005
1998	4	14	23	35	43	56	58	58	59	59	59	59	59	33255	0.018
1999	42	107	196	288	342	413	442	482	494	502	509	509	509	33935	0.104

Table 12. Number of Lachmach coho CWTs (expanded for catch samples) caught in Alaskan troll fisheries by week and year. The number of CWTs released in the preceding year and, where available, the estimated marine survival are also tabulated.

	Cumulative Tags Starting in Week 27														
year	27	28	29	30	31	32	33	34	35	36	37	38	39	tags released	survival
1987															
1988	0	0	0	1	1	1	4	6	6	6	6	6	6	1169	0.030
1989	8	18	40	61	77	85	88	88	92	92	92	92	92	9481	0.043
1990	17	65	162	262	349	415	474	487	506	510	513	515	515	17210	0.132
1991	34	76	226	349	484	572	636	636	668	693	700	707	707	24408	0.124
1992	0	3	52	147	174	243	307	307	324	362	375	380	380	13186	0.094
1993	11	36	72	146	182	206	260	262	289	313	342	353	359	19921	0.066
1994	0	29	110	208	353	484	587	712	781	804	813	820	820	14055	0.188
1995	0	12	29	43	48	76	80	82	105	105	108	108	108	6276	0.086
1996	2	22	32	60	87	101	107	107	116	116	116	116	116	3629	0.104
1997	7	14	26	48	60	73	73	75	79	85	93	93	93	5234	0.043
1998	0	15	38	74	100	148	153	160	179	187	187	187	187	7645	0.095
1999	24	86	176	260	322	346	368	387	421	446	459	462	462	11722	0.125

Table 13. For Babine coho in-season forecasts of marine survival made in weeks 29 and 30 with associated confidence intervals for 1994 to 1999.

year	1994	1995	1996	1997	1998	1999
observed marine survival	0.040	0.010	0.031	0.006	0.007	0.051
week 29						
99%<	0.156	0.126	0.145	0.044	0.066	0.359
95%<	0.068	0.055	0.064	0.015	0.027	0.165
90%<	0.054	0.043	0.050	0.011	0.021	0.128
75%<	0.036	0.029	0.033	0.007	0.013	0.084
50%<	**0.024**	**0.020**	**0.023**	**0.004**	**0.009**	**0.055**
25%<	0.017	0.013	0.015	0.003	0.006	0.036
10%<	0.011	0.009	0.010	0.002	0.004	0.023
5%<	0.008	0.007	0.008	0.001	0.003	0.017
1%<	0.003	0.003	0.003	0.000	0.001	0.006
week 30						
99%<	0.110	0.060	0.103	0.022	0.037	0.229
95%<	0.059	0.032	0.056	0.010	0.019	0.124
90%<	0.050	0.027	0.047	0.008	0.016	0.103
75%<	0.037	0.020	0.035	0.006	0.012	0.076
50%<	**0.028**	**0.015**	**0.027**	**0.004**	**0.009**	**0.056**
25%<	0.021	0.012	0.020	0.003	0.006	0.042
10%<	0.016	0.009	0.015	0.002	0.005	0.030
5%<	0.013	0.007	0.012	0.002	0.004	0.025
1%<	0.007	0.004	0.006	0.001	0.002	0.012

Table 14. For Toboggan coho in-season forecasts of marine survival made in weeks 29 and 30 with associated confidence intervals for 1988 to 1999.

year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
observed marine survival	0.021	0.027	0.041	0.060	0.017	0.029	0.060	0.018	0.025	0.005	0.018	0.104
week 29												
99%<	0.040	0.134	0.166	0.255	0.093	0.105	0.184	0.081	0.155	0.048	0.072	0.204
95%<	0.023	0.085	0.106	0.165	0.058	0.066	0.118	0.051	0.099	0.029	0.045	0.131
90%<	0.018	0.069	0.085	0.133	0.047	0.053	0.095	0.041	0.080	0.023	0.036	0.106
75%<	0.014	0.054	0.067	0.103	0.037	0.042	0.074	0.032	0.062	0.017	0.028	0.082
50%<	**0.008**	**0.034**	**0.042**	**0.065**	**0.023**	**0.027**	**0.047**	**0.020**	**0.040**	**0.011**	**0.018**	**0.052**
25%<	0.005	0.022	0.027	0.040	0.015	0.017	0.029	0.013	0.025	0.007	0.011	0.033
10%<	0.004	0.017	0.021	0.030	0.012	0.013	0.023	0.010	0.019	0.005	0.009	0.025
5%<	0.003	0.013	0.016	0.024	0.009	0.010	0.018	0.008	0.015	0.004	0.007	0.020
1%<	0.002	0.008	0.010	0.014	0.006	0.006	0.011	0.005	0.009	0.002	0.004	0.012
week 30												
99%<	0.043	0.132	0.146	0.247	0.089	0.089	0.190	0.069	0.154	0.052	0.068	0.213
95%<	0.025	0.085	0.094	0.162	0.057	0.057	0.124	0.043	0.100	0.031	0.042	0.139
90%<	0.020	0.069	0.077	0.132	0.046	0.046	0.101	0.035	0.081	0.025	0.034	0.113
75%<	0.015	0.054	0.060	0.104	0.036	0.036	0.079	0.027	0.064	0.019	0.026	0.089
50%<	**0.009**	**0.035**	**0.039**	**0.066**	**0.023**	**0.023**	**0.051**	**0.017**	**0.041**	**0.012**	**0.017**	**0.057**
25%<	0.006	0.023	0.025	0.042	0.015	0.015	0.033	0.011	0.027	0.007	0.011	0.036
10%<	0.004	0.018	0.020	0.032	0.012	0.012	0.025	0.008	0.021	0.006	0.008	0.028
5%<	0.003	0.014	0.016	0.025	0.009	0.009	0.020	0.007	0.016	0.004	0.006	0.022
1%<	0.002	0.009	0.010	0.015	0.006	0.006	0.012	0.004	0.010	0.003	0.004	0.013

Table 15. For Lachmach coho in-season forecasts of marine survival made in weeks 29 and 30 with associated confidence intervals for 1988 to 1999.

year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
observed marine survival	0.030	0.043	0.132	0.124	0.094	0.066	0.188	0.086	0.104	0.043	0.095	0.125
week 29												
99%<		0.199	0.310	0.306	0.194	0.187	0.276	0.209	0.296	0.214	0.216	0.421
95%<		0.141	0.229	0.227	0.137	0.131	0.203	0.150	0.219	0.154	0.156	0.315
90%<		0.120	0.198	0.195	0.116	0.110	0.175	0.128	0.188	0.132	0.133	0.271
75%<		0.099	0.166	0.164	0.095	0.091	0.147	0.106	0.158	0.110	0.111	0.227
50%<		**0.070**	**0.120**	**0.119**	**0.067**	**0.063**	**0.106**	**0.076**	**0.114**	**0.078**	**0.079**	**0.161**
25%<		0.049	0.085	0.085	0.047	0.044	0.076	0.053	0.082	0.055	0.056	0.112
10%<		0.040	0.070	0.070	0.038	0.035	0.063	0.044	0.067	0.045	0.046	0.091
5%<		0.033	0.059	0.058	0.032	0.029	0.053	0.037	0.056	0.038	0.039	0.075
1%<		0.022	0.040	0.040	0.021	0.019	0.036	0.025	0.038	0.026	0.026	0.049
week 30												
99%<	0.088	0.176	0.269	0.260	0.230	0.188	0.265	0.182	0.279	0.208	0.215	0.325
95%<	0.057	0.129	0.202	0.195	0.172	0.138	0.199	0.134	0.210	0.154	0.160	0.247
90%<	0.046	0.111	0.176	0.170	0.149	0.119	0.173	0.115	0.183	0.133	0.138	0.215
75%<	0.037	0.093	0.150	0.145	0.126	0.100	0.147	0.097	0.156	0.113	0.117	0.184
50%<	**0.024**	**0.068**	**0.111**	**0.107**	**0.094**	**0.074**	**0.109**	**0.071**	**0.116**	**0.083**	**0.087**	**0.136**
25%<	0.016	0.049	0.081	0.079	0.068	0.054	0.080	0.052	0.085	0.061	0.063	0.100
10%<	0.012	0.041	0.068	0.066	0.057	0.045	0.067	0.043	0.071	0.051	0.053	0.083
5%<	0.010	0.035	0.058	0.056	0.049	0.038	0.057	0.037	0.060	0.043	0.045	0.070
1%<	0.006	0.024	0.041	0.039	0.034	0.027	0.040	0.026	0.042	0.030	0.032	0.049

Table 16. For the average stream of the upper Skeena (Area 4U) coho aggregate, observed total stock size and in-season forecasts using the cumulative number of Toboggan CWTs caught in Alaskan troll fisheries to week 29 as a proportion of CWTs released. Associated confidence are shown. A trigger situation (stock size ≤ 171) was detected when the 50%CI around the forecast contained the trigger.

	In-season forecast of total stock size Area 4U (upper Skeena) average-stream											
year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
observed	376	716	1000	1170	534	500	1530	194	418	72	1320	1030
99%<	2593	7119	9010	15329	4956	5565	10147	4382	8370	2914	3984	11522
95%<	1201	3604	4516	7398	2513	2826	5051	2210	4211	1394	1997	5688
90%<	594	1933	2401	3799	1350	1521	2669	1182	2246	710	1061	2981
75%<	343	1190	1468	2260	832	938	1623	726	1377	420	649	1803
50%<	**193**	**717**	**877**	**1314**	**502**	**567**	**966**	**436**	**825**	**243**	**388**	**1066**
25%<	109	432	525	764	302	342	574	262	495	140	232	630
10%<	63	266	321	454	186	211	349	161	303	83	142	381
5%<	31	143	170	233	100	114	185	86	162	42	75	200
1%<	14	72	85	113	51	58	92	43	81	20	38	99

forecast performance in detecting trigger situation

forecast 50%CI	Y									Y		
observed										Y		

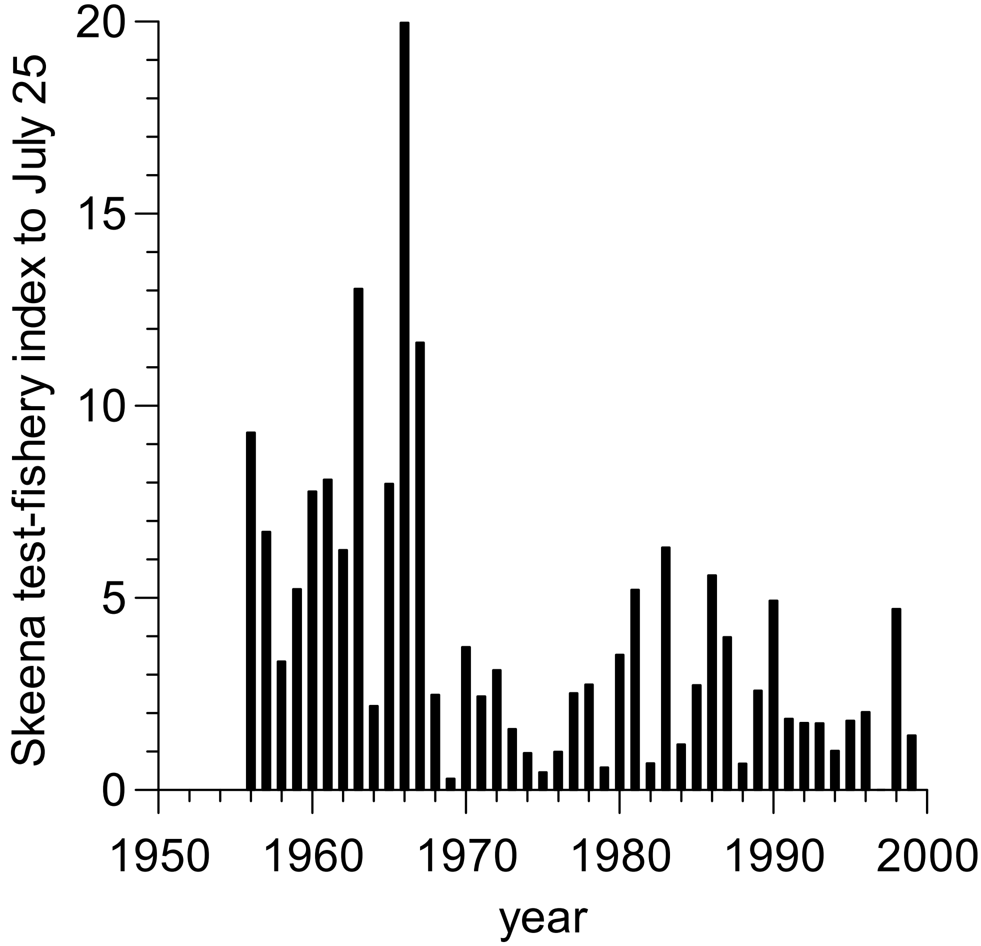

Figure 1. The Skeena test-fishery coho index to July 25.

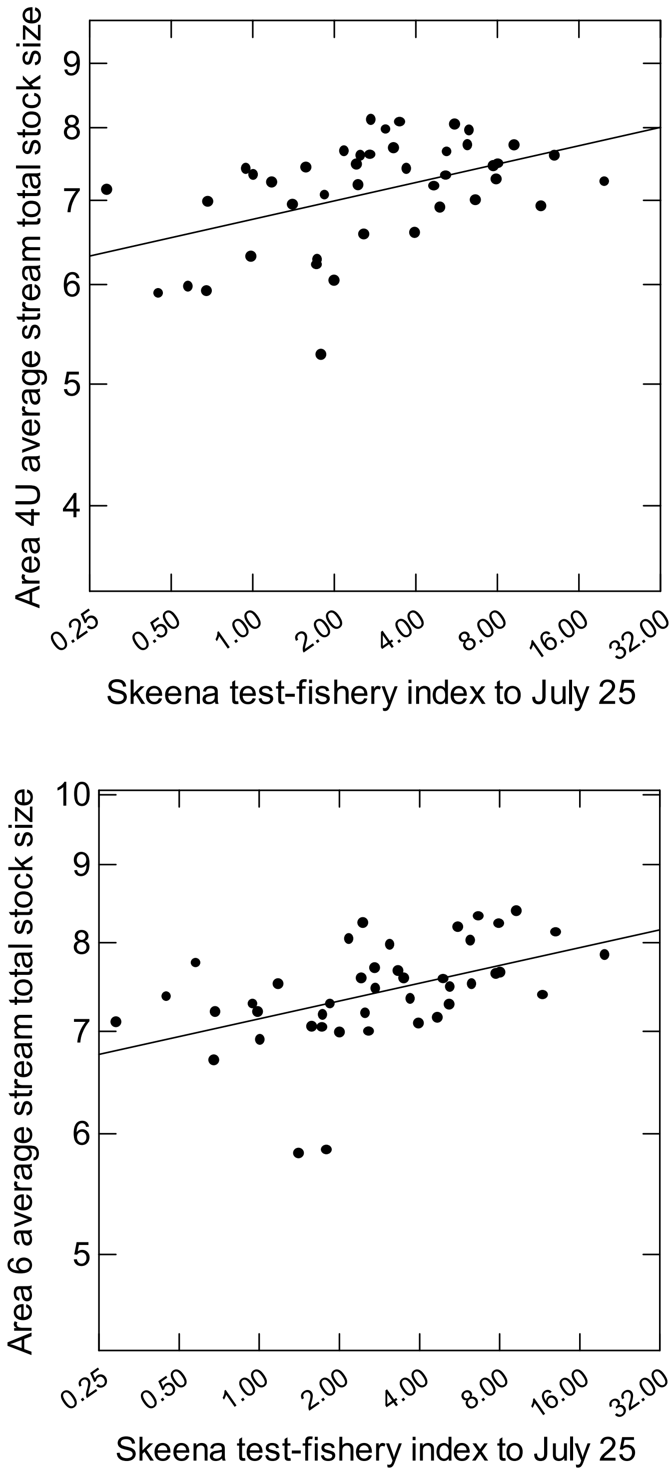

Figure 2. Relationships between the average-stream stock sizes in Area 4U (upper Skeena, top panel) and Area 6 (Kitimat, lower panel) and the Skeena test-fishery index to July 25.

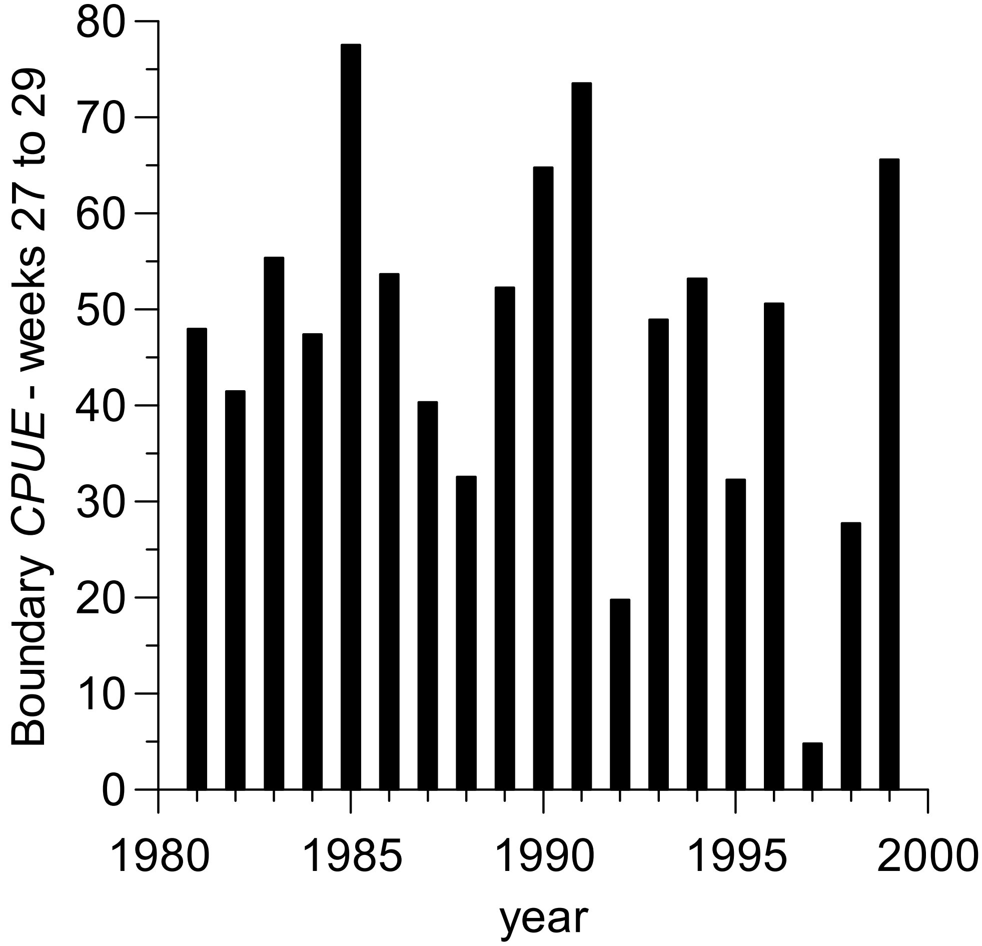

Figure 3. Mean *CPUE* in the Alaskan troll fishery in the SE Boundary area for week 27 to week 29.

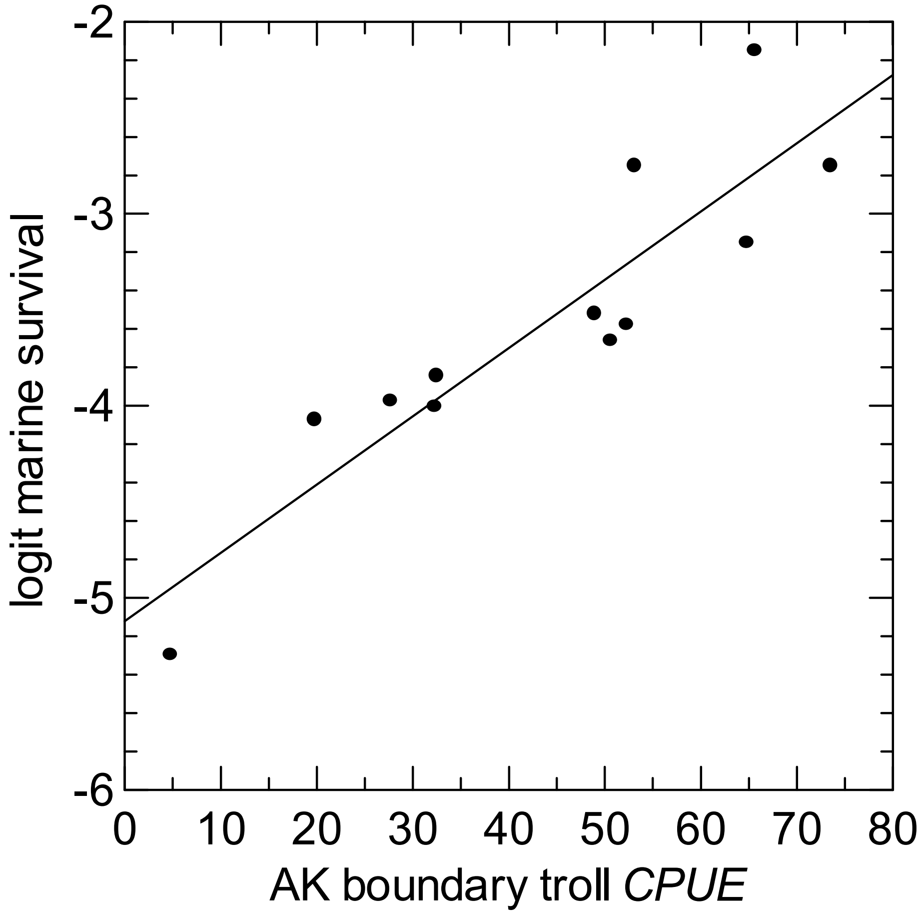

Figure 4. Logit transformed marine survival of Toboggan coho vs. mean *CPUE* for weeks 27 to 29 in the SE Alaskan boundary troll fishery.

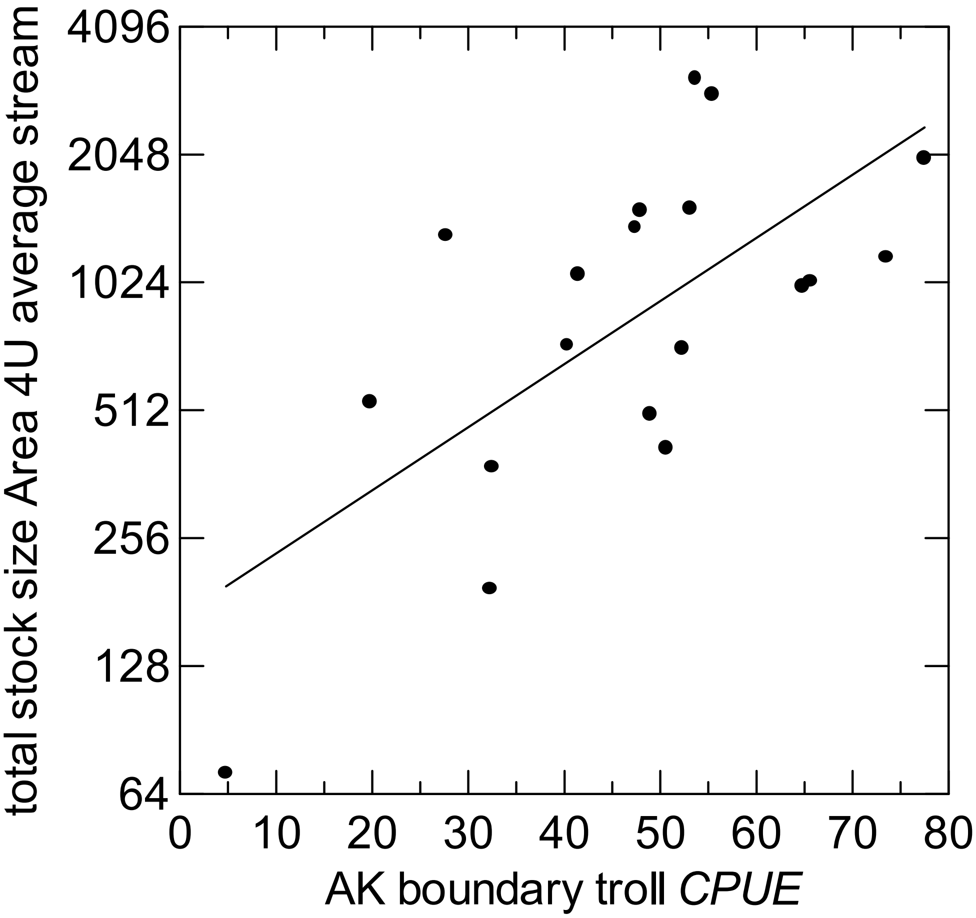

Figure 5. Total stock size of the upper Skeena 'average stream' (Area 4U) vs. the mean *CPUE* in the SE Alaskan boundary troll for weeks 27 to 29.

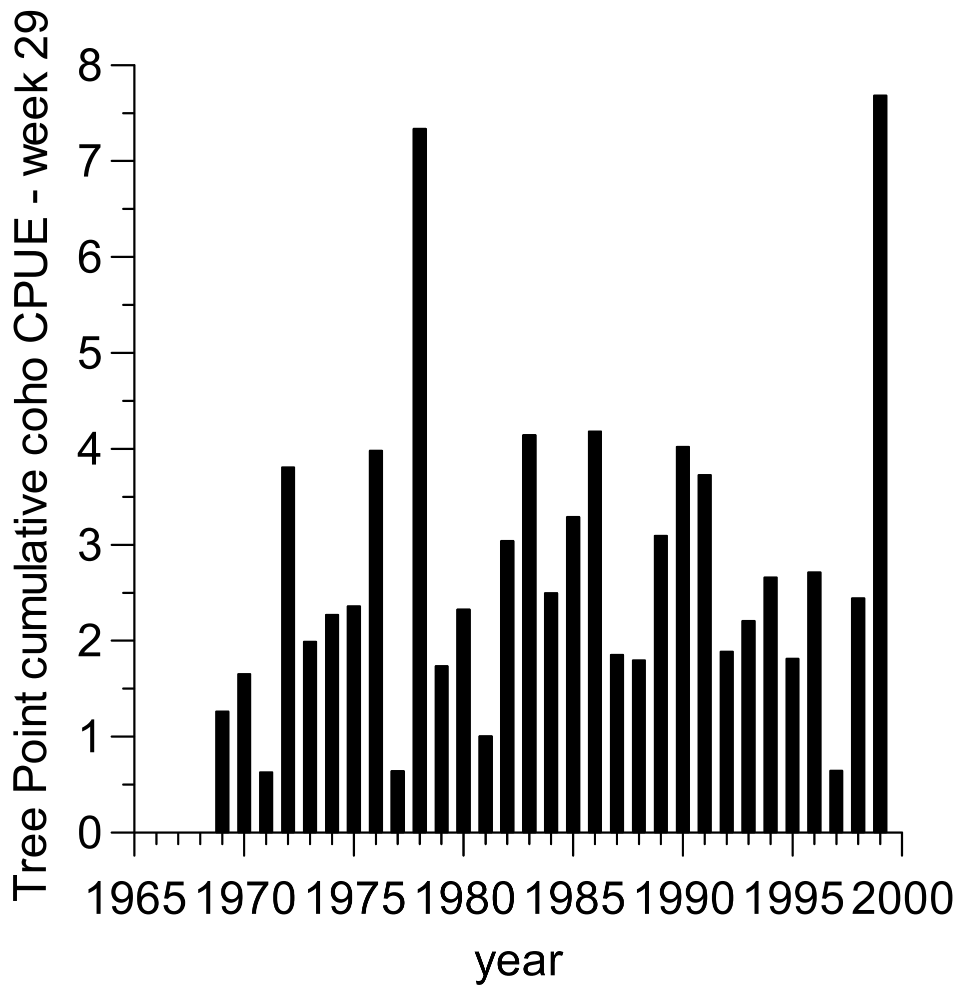

Figure 6. Cumulative coho CPUE (cumulative number per boat-day) to statistical week 29 for wild coho in the Alaskan Tree Point gill-net fishery .

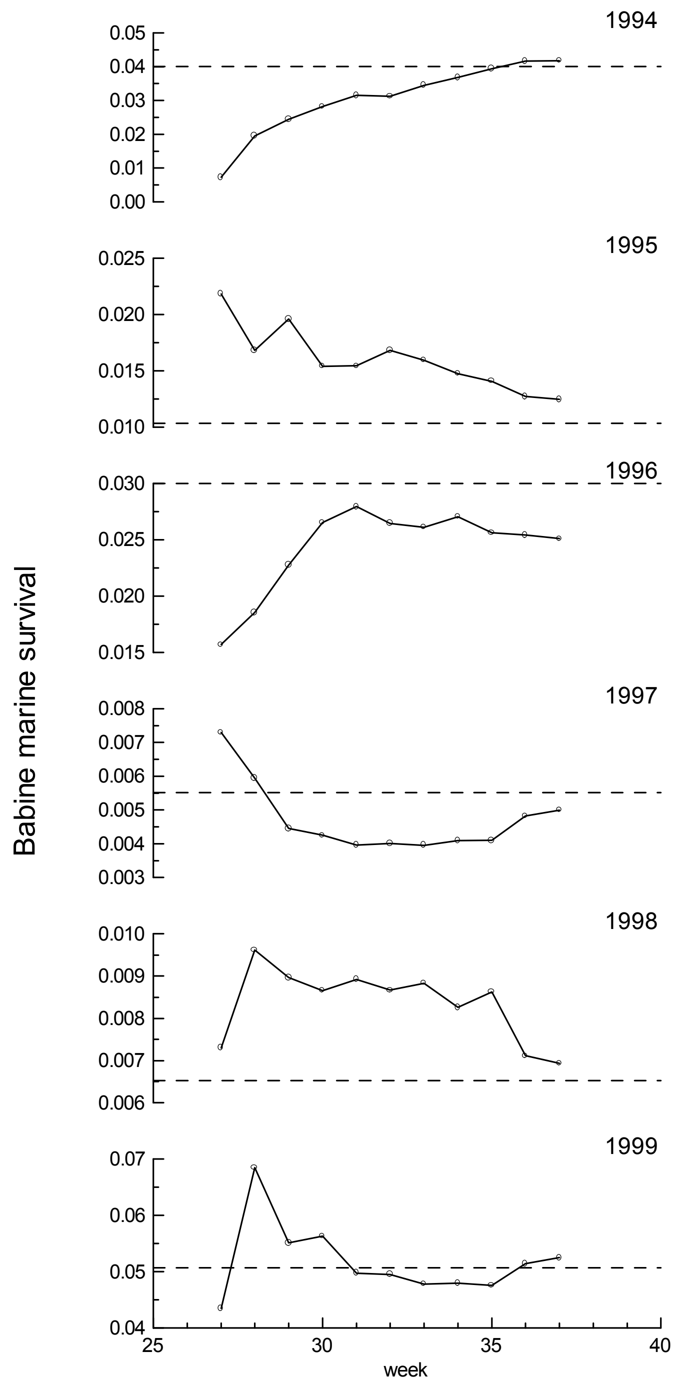

Figure 7. For Babine coho, in-season forecasts of marine survival by year and week. The horizontal dashed line is the post-season estimate of marine survival.

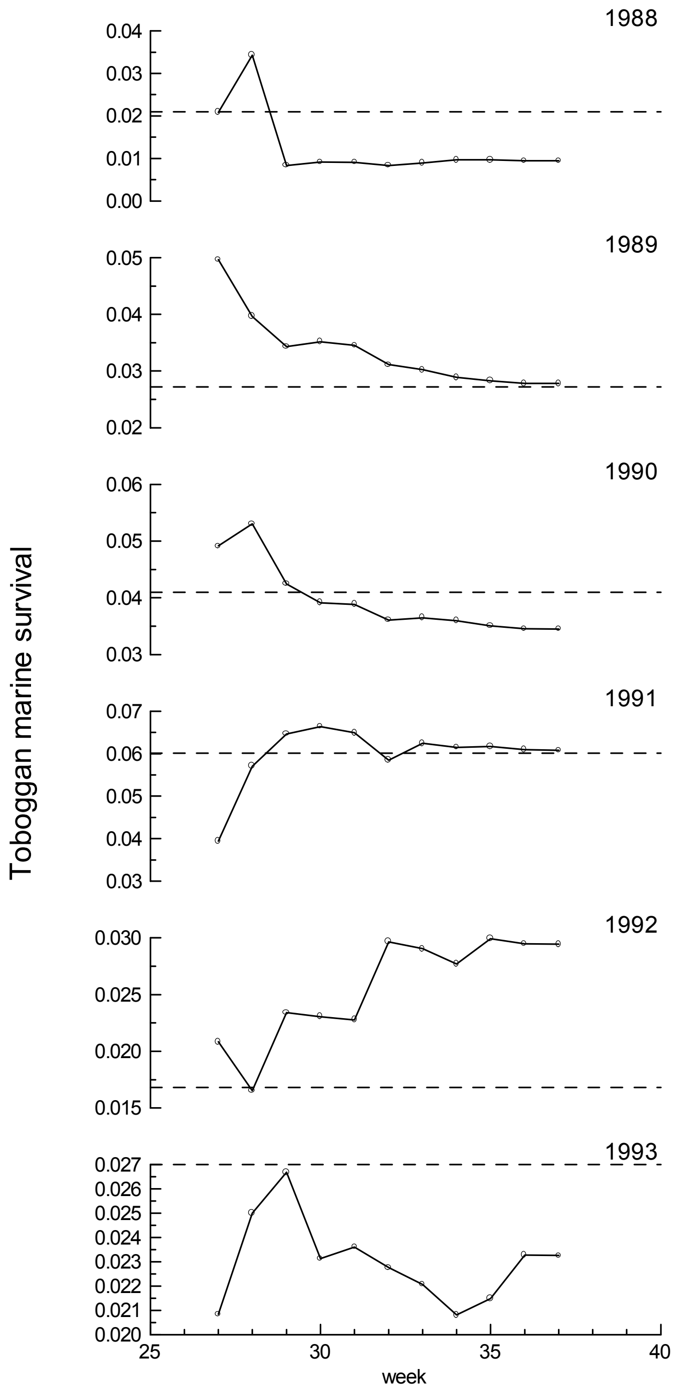

Figure 8. For Toboggan coho, in-season forecasts of marine survival by year (1988 to 1993) and week. The horizontal dashed line is the post-season estimate of marine survival.

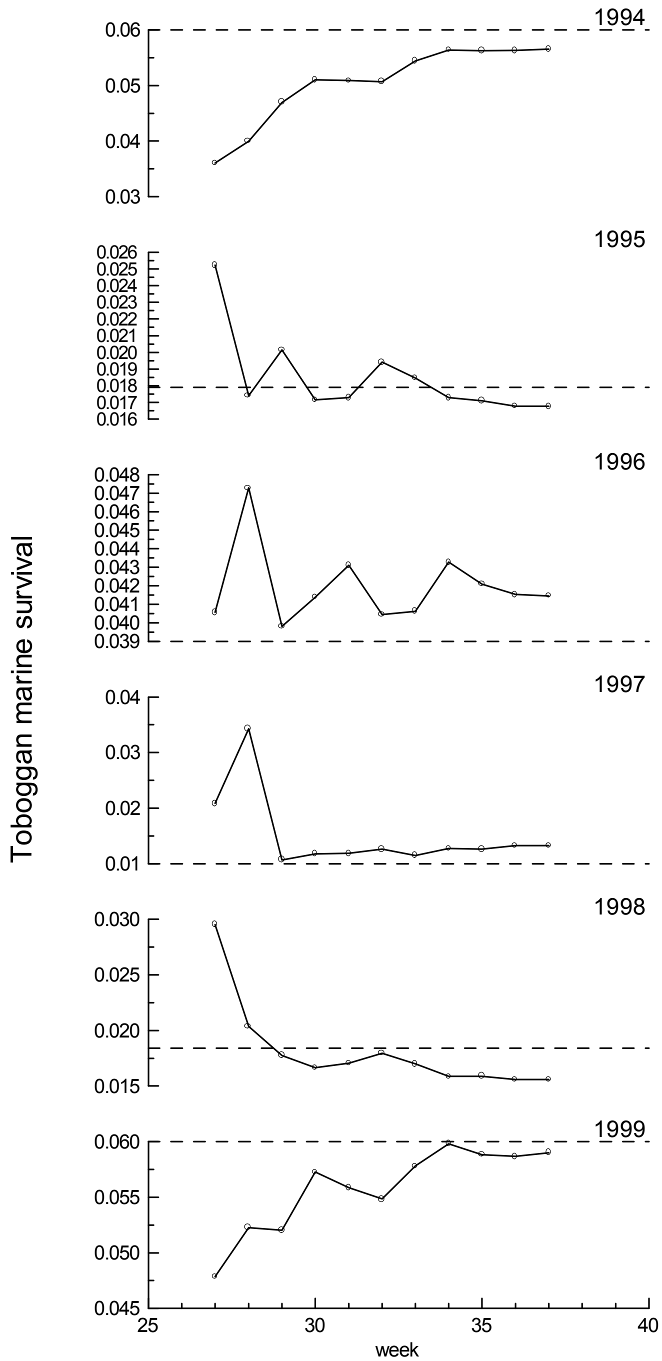

Figure 9. For Toboggan coho, in-season forecasts of marine survival by year (1994 to 1999) and week. The horizontal dashed line is the post-season estimate of marine survival.

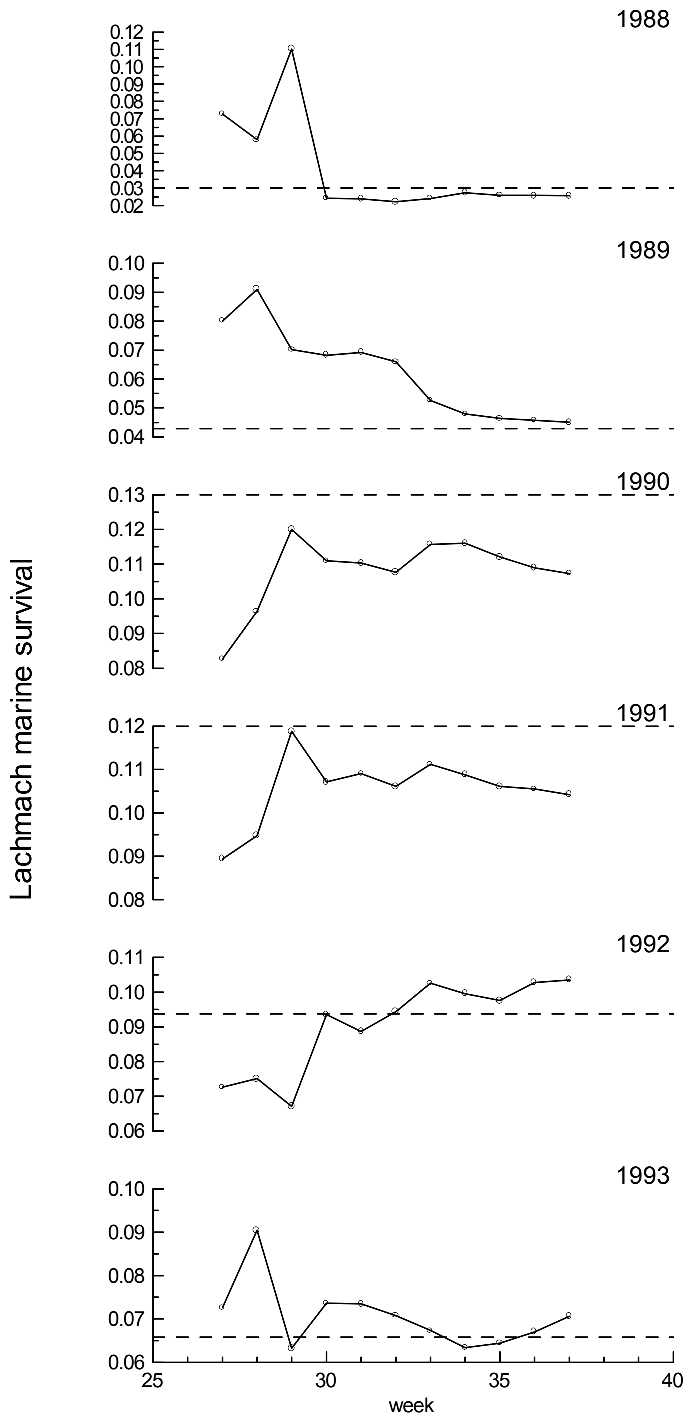

Figure 10. For Lachmach coho, in-season forecasts of marine survival by year (1988 to 1993) and week. The horizontal dashed line is the post-season estimate of marine survival.

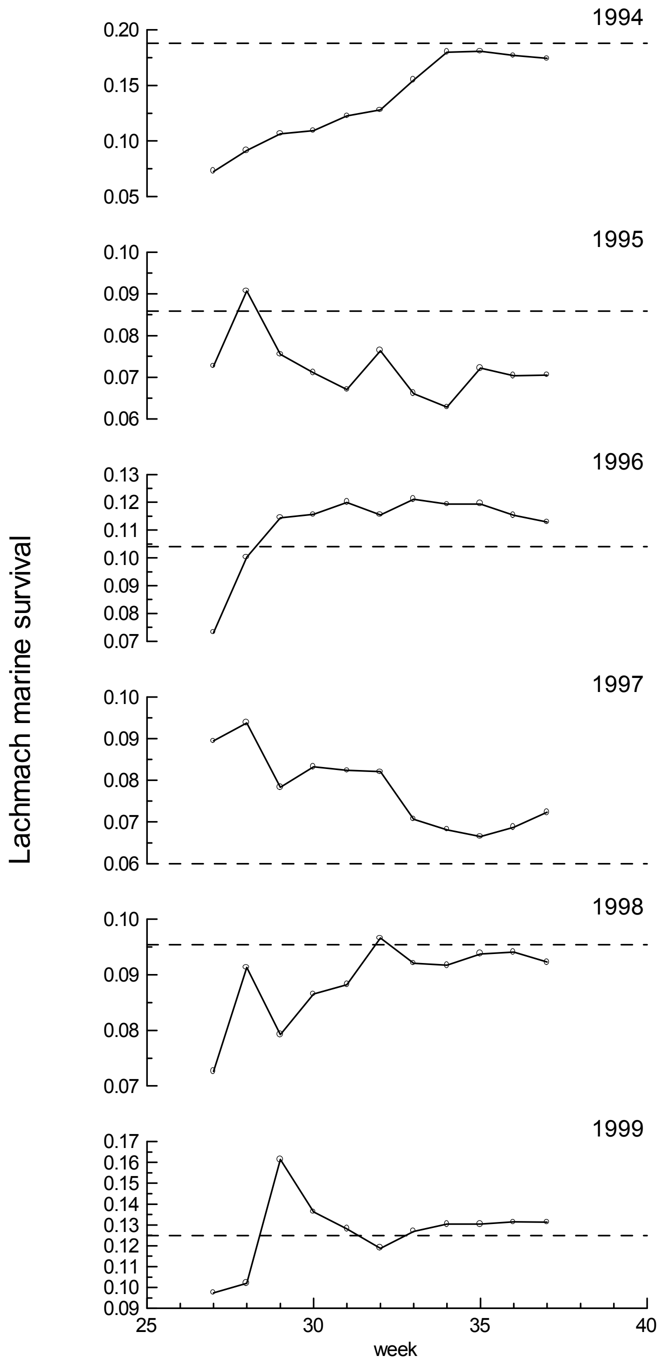

Figure 11. For Lachmach coho, in-season forecasts of marine survival by year (1994 to 1999) and week. The horizontal dashed line is the post-season estimate of marine survival.