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Research Document 2005/077

Document de recherche 2005/077

Using an Eulachon Indicator Framework to Provide Advice on Fraser River Harvest Opportunities for 2006

Utilisation d'un cadre d'indicateurs de l'eulakane pour donner des avis sur les possibilités de pêche dans le Fraser pour 2006

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ISSN 1499-3848 (Printed / Imprimé)

Abstract

The Fraser River eulachon fishery has an important cultural significance, especially to local First Nations. These small anadromous smelt return annually to the Fraser River to spawn and are targeted by First Nation, recreational and commercial fishermen at this time. Although eulachon populations have declined gradually coastwide since the mid-1960s, a sudden and synchronous population decline occurred around 1993-94 among several major eulachon-bearing rivers. Continued low returning biomass in the Fraser River prompted a review of research and management considerations with a traffic light approach for making management decisions adopted in 2003. This approach considered four independent measures of stock status: 1) spawning stock biomass (SSB) based on the Fraser River egg and larval survey; 2) an offshore biomass index derived from the shrimp research survey off the south-west coast of Vancouver Island; 3) Columbia (and Fraser) River catch; and 4) the Fraser River test fishery catch. After compiling and interpreting each of these indicators, we recommend no harvest of Fraser River eulachon in 2006. Each of the four indicators suggests conservation concerns are warranted, especially the SSB estimate that has been below a response point of 150 tonnes in each of the past two years. In fact, the 2005 SSB estimate was only 16 tonnes. After considering these results in conjunction with record low catches in the test fishery (less than 900 cumulative pieces), negligible commercial catch in the Columbia or Fraser Rivers in 2005 due to low abundance, and continued low abundance in offshore waters, we recommend that all eulachon returning to the Fraser River in 2006 be allowed to spawn. Also, in light of these extremely low indicators, we suggest that careful consideration be given to any potential harvest opportunities in 2007 as stock rebuilding should be a priority of fisheries managers.

Résumé

La pêche de l’eulakane du fleuve Fraser a une importance culturelle notable, surtout pour les Premières nations locales. Ces petits éperlans anadromes remontent annuellement le fleuve Fraser pour frayer et sont alors la cible des pêcheurs récréatifs, commerciaux et des Premières nations. Bien qu’on ait assisté au déclin graduel des populations d’eulakane sur toute la côte depuis le milieu des années 1960, une baisse soudaine et synchrone des populations s’est produite vers 1993-1994 dans plusieurs des principales rivières où vivent des eulakanes. Les remontées continuellement faibles de la biomasse dans le Fraser ont suscité la tenue d’un examen des facteurs de recherche et de gestion, et une technique des feux de circulation a été adoptée en 2003 pour la prise des décisions de gestion. Dans le cadre de cette approche, quatre mesures indépendantes de l’état des stocks ont été examinées : 1) la biomasse du stock reproducteur d’après le relevé des oeufs et des larves du Fraser; 2) un indice de la biomasse hauturière provenant du relevé de recherche sur les crevettes au large de la côte sud-ouest de l’île de Vancouver; 3) les prises dans le fleuve Columbia (et le Fraser); 4) les prises des pêches expérimentales dans le Fraser. Après compilation et interprétation de chacun de ces indicateurs, nous recommandons d’éviter la récolte de l’eulakane du fleuve Fraser en 2006. Chacun des quatre indicateurs suggèrent que les inquiétudes à l’égard de la conservation sont justifiées, tout particulièrement l’estimation de la biomasse du stock reproducteur qui a été inférieure à un point d’intervention de 150 tonnes au cours de chacune des deux années antérieures. En fait, l’estimation de la biomasse génitrice de 2005 était de seulement 16 tonnes. Après examen de ces résultats conjointement avec les prises les plus basses jamais enregistrées au cours de la pêche expérimentale (moins de 900 captures cumulatives), les prises commerciales négligeables dans les fleuves Columbia ou Fraser en 2005 à cause de la faible abondance, et une abondance continuellement faible en mer, nous recommandons de laisser frayer tous les eulakanes qui remontent dans le Fraser en 2006. De plus, à la lumière de ces indicateurs extrêmement faibles, nous proposons d’examiner avec soin toute possibilité de récolte éventuelle en 2007, car le rétablissement des stocks devrait être une priorité des gestionnaires des pêches.

Introduction

Eulachon (*Thaleichthys pacificus*) belong to the Family Osmeridae (smelts) and are distributed from northern California to the southern Bering Sea, although populations south of the Columbia River appear to be extirpated (Hay and McCarter 2000). Inhabiting predominately spring freshet rivers, most eulachon spawning occurs during March and April but two of the largest eulachon runs occur either earlier (January for the Columbia River) or later (into May for the Fraser River) (Hay *et al*. 2002). Eulachon are semelparous fish that generally spawn at age-3 in British Columbia (BC) and are available to targeted fisheries at this time. Younger age classes of eulachon are captured as bycatch in other fisheries, especially the shrimp trawl fishery operating off the west coast of Vancouver Island and in central and northern BC waters (Hay *et al*. 1997). In the late 1990s eulachon bycatch "action levels" and catch reduction measures were implemented to reduce excessive offshore eulachon catches. Once action levels are reached, directed shrimp fisheries are to be curtailed even if the action level is reached mid-season (Rutherford *et al*. 2005). Further, the shrimp trawl fleet now are required to use bycatch reduction devices (BRDs) to limit the number of eulachon caught. However, the efficacy of BRDs remains a contentious issue as quantitative documentation of reduced bycatch rates for eulachon (or other species) remains unknown.

The two largest eulachon runs (apart from the Nass River in northern BC) support both commercial, recreational, and First Nation or aboriginal fisheries in BC and Washington State. However, diminished eulachon returns during the 1990s raised concerns about the status of stocks in both countries and the possibility for continued fishing opportunities. Based on these conservation concerns, fishing restrictions were implemented both in BC and Washington State. In Canada, the Department of Fisheries and Oceans (DFO) Science Branch initiated an egg and larval survey in 1995 to estimate spawning stock biomass in the Fraser River for stock assessment purposes. In the same year, DFO Fisheries Management initiated an in-season test fishery program to provide information on the number of eulachon returning to spawn in the Fraser River. Although not a preseason indicator, Hay *et al*. (2003) suggested this indicator could be useful when other indicators are "mixed" to make in-season management decisions. In addition to these more recent initiatives, two additional indicators have been proposed to make recommendations concerning Fraser River eulachon. These include the offshore biomass index derived from the annual shrimp trawl survey conducted on the west coast of Vancouver Island and the Columbia River catch data (Hay *et al*. 2002; Hay *et al*. 2005). In order to make harvest recommendations for 2006 we have compiled and analyzed these four proposed indicators following the framework provided by Hay *et al.* (2003; 2005) on eulachon abundance and population trends. Each indicator is considered in the current context of the eulachon assessment framework for decision making.

Indicator 1: Egg and Larval Survey

In 2005 ichthyoplankton surveys were conducted at three sampling sites in the lower Fraser River (a site near New Westminster, a site 2 miles down river on the North Arm and a site at Deas Island on the South Arm) over a seven week period from mid-April to early June. Fixed depth (0m, 5m and 10m) and oblique (0m to 10 m) tows were made using small bongo nets equipped with a flow meter at three locations across the river (north, centre and south) at each sampling site. Both field sampling and laboratory processing followed those documented by McCarter and Hay (2003) for sampling eulachon in the Fraser River. In the laboratory, embryonic eulachon eggs and larvae are detected and enumerated by visual examination under a dissecting microscope. Based on the density of eulachon (eggs and larvae) and volume (daily river discharge) it is possible to estimate eulachon production. This egg and larval production can then be used to estimate spawning stock biomass (SSB) when combined with previously determined estimates of relative fecundity and sex ratio (Hay *et al*. 1997; Hay *et al*. 2002; Hay *et al*. 2005). During the development of the egg and larval survey design, biomass estimates were calculated for more than a dozen different locations along the lower Fraser River. Following a multi-year distributional analysis, Hay *et al*. (2002) argued the most cost effective design consisted of two sampling locations representing the cumulative discharge of the north and south arms of the Fraser River. These two sites represent the total eulachon return to the river and are consistent with an assessment of the entire Fraser River eulachon stock (Table 1).

Following a peak in 1996, SSB has decreased substantially with 2005 representing the lowest SSB and 2004 representing the second lowest SSB observed over the time series (Figure 1; Table 1). Prior to the sharp decline in SSB in 2004, 1997 was the previous record low year with a SSB estimate of approximately 75 tonnes. Minor population rebounds were observed in 1999 and 2001 but these were short-lived and did not contribute to increased standing stock size. Consistent with previous findings, most of the Fraser River SSB was detected in the south arm (~ 85%) rather than the north arm (~15%) (Figure 1; Table 1).

The Fraser River eulachon stock continues to hover at precariously low levels. The relatively strong recruitment in 1996 resulted in “better than average” recruitments in 1999 and 2002 but the relationship dissolved in 2005 as this was the weakest recruitment to date (Figure 1). The two other cohorts that make up this stock (assuming a three year life cycle) have been weak and variable. Recruitment was very low in 1997 and 2000 with some evidence of a minor increase in 2003 but it is unclear if this trend would continue in 2006 (Figure 1). For example, the 1998 spawning cohort increased in 2001 but this trend did not continue in 2004, the second lowest observed SSB (Figure 1). Based on this relatively short time series, forecasts have not been possible.

Hay *et al*. (2003) and Hay *et al*. (2005) provide guidelines on how this indicator could be interpreted for management purposes. They suggested that a low SSB (<150 tonnes) for one year is cause for concern and a restriction on removals should be activated. Further, they suggested that a low SSB for two (or more) consecutive years is more cause for alarm and should signal a halt to all removals.

Given that the past two years represent extremely low SSB estimates, especially 2005 where SSB is almost an order of magnitude less than the suggested response point of 150 tonnes, our recommendation based on this indicator is not to allow any removals in 2006. Furthermore, the extremely low biomass estimate derived for the 2005 Fraser River eulachon run suggests future productivity from this system could be dramatically diminished in the near future.

Indicator 2: Offshore Biomass Index from the Shrimp Survey

Eulachon are a common bycatch species in the annual shrimp trawl research survey conducted on the west coast of Vancouver Island and Queen Charlotte Sound. On the west coast of Vancouver Island, Shrimp Management Areas 124Off and 125Off have been surveyed almost annually since 1973. In 1996 the shrimp survey area was expanded to cover parts of Area 121Off and 123Off and in 1999 was expanded further to include Shrimp Management Area 23In. Due to the shorter time series associated with surveys in areas 121Off, 123Off and 23In and the unknown relationship between Fraser River or Columbia River eulachon, these data are excluded from the present analyses but might prove useful in the future. The survey design consists of systematic trawling of known shrimp grounds allowing application of spatial analyses to estimate biomass (Boutillier *et al*. 1997). This methodology has been extended to eulachon to provide an index of offshore eulachon biomass (Hay *et al*. 1997). It is generally accepted that eulachon caught in Shrimp Management Areas 124Off and 125Off represent combined Fraser River and Columbia River fish with more fish returning to the Columbia River than the Fraser River for spawning. This assumption is supported by recent genetic analyses that show the ratio of Columbia River to Fraser River eulachon is about 60:40 in these offshore waters (Beacham *et al*. 2005).

The offshore eulachon biomass index has been highly variable between 1973 and 2005 for both 124Off and 125Off (Figure 2). In some years changes in biomass are mirrored between areas 124Off and 125Off while in others they are not. Although the biomass in areas 124Off and 125Off were very low in 2004 and 2005, this index was lower in the mid- to late-1990s.

Hay *et al*. (2003) and Hay *et al*. (2005) suggested a management alert (i.e., “yellow” signal in their traffic light approach) when the offshore index decreased below 500 tonnes and 1000 tonnes, respectively. In fact, both areas in each of 2004 and 2005 had an offshore biomass index less than 500 tonnes. In 2005, the biomass index for 124Off was 323 tonnes while the biomass index for 125Off was 336 tonnes. Thus, based on the suggested response points, reduced fishing opportunities should be provided in 2006. Hay *et al*. (2005) stop short of suggesting what an appropriate indicator level might be to signal no Fraser River harvest during the upcoming season using this indicator alone (i.e., a “red” signal in their traffic light approach). It is possible that this indicator might be refined with additional analyses. For example, starting in 1999 age composition data were collected based on length frequency distributions (Rutherford *et al*. 2002). This age composition data might be useful in refining the eulachon biomass expected to return to spawn the following year as it is expected that very few of the younger age class will spawn the preceding year. Thus, an index of the age-2+ biomass encountered in the offshore survey in May might provide a good indication of expected age-3 eulachon spawning in the Fraser River (or Columbia River) the following winter. However, the utility of this indicator will continue to be confounded by the “mixed stock” encountered by this survey.

Indicator 3: Columbia River Catch

Commercial fisheries have operated in both the Columbia and Fraser Rivers since the early 1900s with Columbia River catches generally an order of magnitude greater than Fraser River catches (Figure 3A). Hay *et al*. (2003) and Hay *et al*. (2005) outline some of the difficulties in using commercial catch data to detect changes in abundance over time but suggest the Columbia River catch data is more representative of abundance trends than the Fraser River catch data. In addition to changes in abundance, changes in catch can represent incomplete or inaccurate catch reporting, changes in market conditions that influence the supply and demand relationship, changes in spawning locations or time that result in changes in effort, etc. and these authors believe the impact of these ancillary factors are greater in the Fraser River than the Columbia River. Since we have no method to evaluate these assumptions, we report both Columbia River and Fraser River catches since 1941 (Figure 3A). However, since indicator response points were based on the Columbia River catch, we will do the same. It should be noted that the commercial eulachon catch in both rivers was at or near historical lows. In 2005, the Columbia River commercial eulachon fishery landed a total of 94 kg (G. Bargmann pers. comm..) and since 2000 total annual catches have been less than 500 tonnes. It should be noted that based on commercial eulachon catch data from the Fraser and Columbia Rivers there is no relationship between catches in these two eulachon systems (Figure 3B). Although a variety of socio-economic factors might be responsible for this observation (e.g., market demand, product value, etc.) it is probable that the Fraser River eulachon stock fluctuates independently from the Columbia River eulachon stock and that extreme caution should be exercised when extrapolating population dynamics observed in offshore waters. The general utility of this indicator lies in the longer term population trends noted for these two important eulachon producing systems and should be considered in the context of general stock health. Based on the long term decline in abundance (inferred from the catch data), especially for the Fraser River, emphasis should be placed on stock rebuilding rather than fishing opportunities. It is likely this scenario will persist and the priority on stock rebuilding could last several years.

Previously, Hay *et al*. (2003) and Hay *et al*. (2005) have suggested that a "poor" fishery in the Columbia River would have reported catches of less than 500 tonnes, a situation that has occurred since 1993 when eulachon stocks collapsed coastwide. Thus, our recommendation based on this indicator is to exercise caution in 2006 when considering harvest opportunities for Fraser River eulachon.

Indicator 4: Fraser River Test Fishery

With the exception of 1999, an eulachon test fishery has operated on the Fraser River at New Westminster daily during the spawning run since 1995. During 2005 this test fishery operated from April 1 to May 7. In this test fishery, a standardized gillnet is deployed for 15 minutes during low slack tide and the total eulachon catch is enumerated. This indicator was developed as an in-season fishery management tool and has no forecasting capability. However, this data could suggest general population patterns in the past which might prove informative when considered in conjunction with the other indicators previously presented.

The largest test fishery catch was landed in 1996 with more than 40,000 pieces landed that year (Figure 4A). In contrast, 2005 had the fewest pieces landed, under 900 pieces, less than half of the landings in the previous lowest year, 1998 (Figure 4A). Interestingly, the test fishing program does not provide any early indication of a strong or weak run, only that the run timing can be variable among years. When the number of pieces landed by day is plotted for each of the test fishing years, by early April (around day 100) strong and weak runs are not different (Figure 4B). It is only after the fact that a strong run shows different than a weak one (e.g., 1996 vs. 1997) (Figure 4B).

As an in-season tool, Hay *et al*. (2003) and Hay *et al*. (2005) suggested a conservation concern was warranted if the test fishery landed fewer than 5000 pieces. They also suggested that if the test fishery landed more than 10,000 pieces that a fishery opening might be considered. In fact, in previous years, Fisheries Management has used these response points to prioritize harvest opportunities for Fraser River eulachon. However, it is important to note that this approach has not always produced successful Fraser River eulachon fisheries. For example, in 2004 the test fishery landed more than 10,000 pieces but the commercial fishery was deemed a failure with extremely low catches. With the exception of 1996, no test fishery conducted on the Fraser River has landed more than 15,000 pieces and in four of the ten years, the test fishery has landed less than 8,000 pieces with landings less than 900 pieces in 2005 (Figure 4).

The test fishery tends to overestimate the SSB based on the egg and larval survey (Figure 5). In most years there is good correspondence between the test fishery landings and the escapement from the egg and larval survey. However, in years where the two diverge, especially 2000 and 2004, the test fishery catch is greater than the SSB estimate from the egg and larval survey (Figure 5). It is likely this divergence is an artefact associated with the test fishing program due to differences in catchability during periods of contrasting abundance. The limited (daily) and unreplicated (one time) sampling method employed by the test fishery is vulnerable to overestimating run size, as eulachon can be highly schooled (but not necessarily abundant) during the 15 minute fishing window. Also, the test fishery could underestimate run size if persistent avoidance behaviour occurs at the New Westminster test fishery site (e.g., recent river bottom dredging or other periodic environmental or river influences). In contrast, the egg and larval survey is not susceptible to these impacts, at least not to the same degree. Eulachon progeny (eggs and larvae) move passively down river and are sampled with replicate plankton net tows at various times, depths and locations alleviating potential impacts of capture avoidance or fish schooling behaviours.

Overall Recommendation

We recommend no directed eulachon fisheries on the Fraser River in 2006 including, First Nation, recreational or commercial. Furthermore, incidental mortality should be minimized in other fisheries where Fraser River eulachon are caught as bycatch. Each of the indicators has signalled that conservation concerns are warranted, especially an estimated SSB of less than 150 tonnes in each of the previous two years based on the egg and larval survey. Further, this key indicator (SSB) is at an all time low suggesting that not only are concerns about stock status in 2006 justified but the status of the stock in the near future also is of concern. Given the short life cycle of this species, consecutive years of poor returns suggest longer term fishery closures might be necessary to allow stock rebuilding.

Indicator Performance

Currently, there are no forecasts of eulachon returns to the Fraser River. Thus, in order to provide science-based advice for Fisheries Managers, a multi-indicator framework was developed (Hay *et al*. 2003; 2005). These four indicators (three preseason and one in-season) vary greatly in potential usefulness and have not been evaluated with respect to longer term performance. Thus, we conducted a retrospective analysis to judge indicator performance between 1995 and 2006. It should be noted that this period represents the time following the coastwide collapse of eulachon populations that occurred around 1993-94 without subsequent population increases. We used the same response points developed in Hay *et al*. (2003) and refined in Hay *et al*. (2005) for each indicator using their traffic light framework. This framework can be used as a tool to provide advice on potential harvest opportunities for Fraser River eulachon preseason. However, as noted previously, not all indicators are able to signal when a potential conservation concern exits (i.e., a “red” light). In fact, only the egg and larval survey with a response point below 150 tonnes for two consecutive years can trigger this signal. Over the 11 year period of the egg and larval surveys in the Fraser River, a conservation concern or “red signal” has occurred twice, once in 1999 and again in 2006 (Table 2). Following the coastwide collapse of eulachon populations, the commercial eulachon catches from the Columbia River have remained below the 500 tonne response point and have triggered a “yellow” or caution signal during the entire retrospective period (Table 2). Again, the utility of this indicator is questionable given the increased socio-economic influences (e.g., fisheries management policy) during this period.

The retrospective analysis suggests the key indicator should be the SSB estimated from the egg and larval survey. This indicator can trigger any signal (red, yellow or green) and shows the most variability over the retrospective period suggesting it is more informative than the other indicators presented when tracking Fraser River eulachon population changes. It is probable that since this indicator is measured in-river, it is not confounded by the mixed stock influences inherent in the offshore biomass index or potential differences between Fraser and Columbia River eulachon as measured in Columbia River eulachon catches.

Additional Considerations

The value of the third indicator (Columbia River catch) has clearly diminished in recent years. A predictive relationship between Columbia River eulachon catch and Fraser River eulachon catch has not been statistically demonstrated (Hay *et al*. 2003; Hay *et al*. 2005; Figure 3B) such that this indicator has no preseason utility. Inclusion of this indicator did provide limited information on another eulachon river with respect to general population trends inferred from the catch data but with direct management of eulachon in both the Columbia and Fraser Rivers, this indicator no longer reflects changes in population abundance. For example, having a small catch because of fishing or other restrictions (low demand, poor price, etc.) does not provide any information on eulachon abundance. The retrospective analysis on indicator performance also shows that this indicator was relatively uninformative as a preseason tool (Table 2). Thus, we recommend this indicator no longer be considered in future analyses for stock assessment purposes. However, since this indicator does provide information on general population trends prior to fisheries management interjection, this indicator should be considered when conservation concerns are identified. Under these circumstances it is important to consider what the population might have looked like historically and whether the current situation is desirable.

We believe the egg and larval survey provides the best quality data on eulachon abundance (SSB) in the Fraser River (and should be continued). Further, we hope that additional confidence can be gained in the test fishery catches as a measure of abundance. Although no relationship between offshore eulachon biomass index and Fraser River SSB has been determined (Hay *et al*. 2003; Hay *et al*. 2005) we suggest that this indicator be included until it is conclusively determined this index does not provide information on Fraser River eulachon. Separating the offshore eulachon index into age classes should be reconsidered. Also, recent genetic analyses suggest about 60% eulachon landed in the shrimp survey offshore on the west coast of Vancouver Island are Columbia River fish compared to 40% Fraser River fish (Beacham *et al*. 2005). It would be useful to know how variable these proportions are over time. If the proportions are variable over time then the usefulness of this indicator for Fraser River eulachon decreases substantially but if it is relatively constant then some exploratory analyses might resolve the relationship between the offshore index and Fraser River eulachon abundance. Based on the relationship between Fraser and Columbia River eulachon catches (Figure 3B) it appears these two populations are behaving asynchronously such that mixing proportions and age class proportions between stocks fluctuates annually.

Given the extremely low escapement (based on observed SSB) from the Fraser River over the past two years and the “caution” signal of the other indicators examined, a conservation concern appears justified. Under the precautionary approach for fisheries management used by DFO, emphasis should be placed on stock rebuilding rather than providing fishing opportunities (c.f., Richards and Schnute 2000). Further, this policy suggests in addition to no directed fisheries that other sources of mortality be minimized (i.e., bycatch in other fisheries, direct or indirect habitat impacts, etc.). Coastwide, eulachon populations have been in decline with many eulachon producing rivers experiencing dramatic declines around 1993-94 (Hay *et al*. 2000). Although some rivers have seen eulachon return, most have not. Thus, to preserve the Fraser River eulachon stock, all sources of mortality should be as close to zero as possible. This will provide the stock with the greatest probability of stock rebuilding. Admittedly, other natural factors will contribute to eulachon mortality (e.g., climate change, predation, competition, etc.) but these are beyond the control of human-intervention.

Conclusions

The stoplight analogy developed by Hay *et al*. (2003) and refined in Hay *et al*. (2005) describes three different potential management options depending on the indicators. When indicators are not mixed, either all positive or all negative, the management options are straightforward: if all positive then proceed with a fishery and if all negative then no fishery should occur. The difficulty, however, is when the indicators are mixed and partial fisheries are considered. Various scenarios have been explored in previous studies (Hay *et al*. 2003; 2005) but since indicators examined and prioritized in the current assessment were not mixed in 2005 (all were negative) no partial fisheries should be considered in 2006.

Acknowledgments

D. Rutherford provided the offshore biomass data used as the second indicator in this paper. Many people have participated in data collection and processing over the years. In 2005, N. Venables collected the egg and larval data aboard the FV BoJangles and the FV Miss Cheryl conducted the New Westminster test fishing program. Funding for the 2005 egg and larval field collections was provided under the DFO Aboriginal Fisheries Strategy.

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Table 1: Eulachon spawning stock biomass estimates for the south and north arms of the lower Fraser River as determined by egg and larval surveys.

		Biomass (mt)		South Arm 95% Confidence Interval		North Arm 95% Confidence Intervals	
Year	South Arm	North Arm	Combined	Upper CI	Lower CI	Upper CI	Lower CI
1995	257	45	302	331.85	182.15	59.94	30.06
1996	1588	328	1916	1777.65	1398.35	403.32	252.68
1997	57	17	74	69.11	44.89	22.15	11.85
1998	106	28	134	129.68	82.32	33.40	22.60
1999	395	25	420	512.54	277.46	31.77	18.23
2000	72	55	127	90.16	53.84	68.19	41.81
2001	422	187	609	477.47	366.53	210.56	163.44
2002	352	140	492	401.39	302.61	168.66	111.34
2003	201	66	267	239.36	162.64	75.43	56.57
2004	24	9	33	28.75	19.25	13.86	4.14
2005	14	2	16	16.45	11.55	2.45	1.55

Table 2: Preseason summary of indicator status (G=Green; Y=Yellow; R=Red) for forecast years 1995 to 2006 using the three preseason indicators (the egg and larval survey, offshore biomass index and Columbia River commercial catch). The Fraser River commercial eulachon catch also is shown.

Forecast Year	Egg and Larval Survey	Offshore Biomass Index 124Off	Offshore Biomass Index 125Off	Columbia River Catch	Fraser River Catch
1995	--	Y	Y	Y	15.1
1996	G	Y	Y	Y	63.2
1997	G	Y	Y	Y	0
1998	Y	Y	Y	Y	0
1999	**R**	Y	Y	Y	0
2000	G	Y	Y	Y	0
2001	Y	G	Y	Y	0
2002	G	G	Y	Y	5.76
2003	G	G	G	Y	0
2004	G	G	G	Y	0.44
2005	Y	Y	Y	Y	0
2006	**R**	Y	Y	Y	??

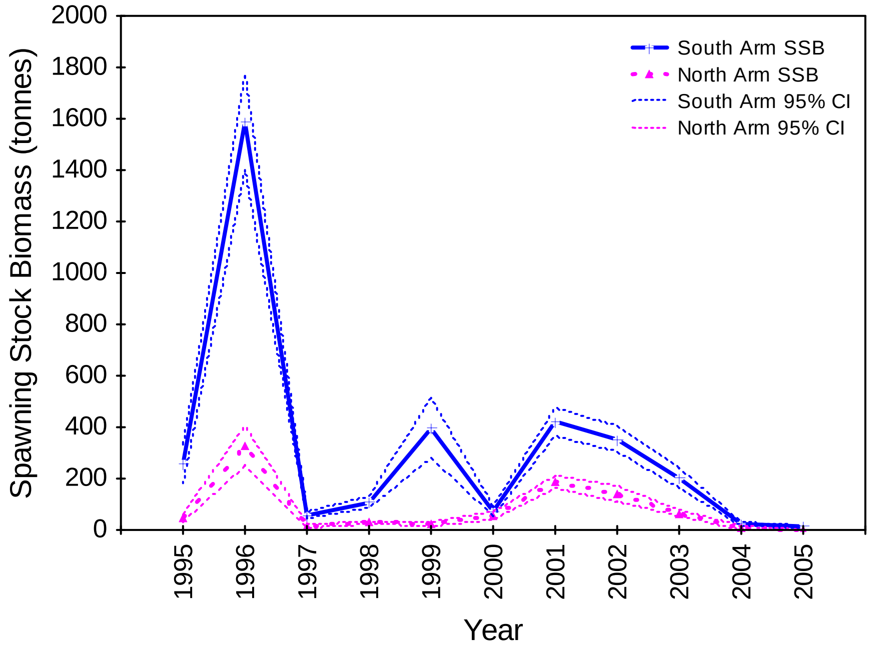


Figure 1: Fraser River eulachon spawning stock biomass (SSB) estimated from the egg and larval survey for both South Arm and North Arm sampling stations between 1995 and 2005. 95% confidence intervals are shown for both South Arm and North Arm estimates of SSB.

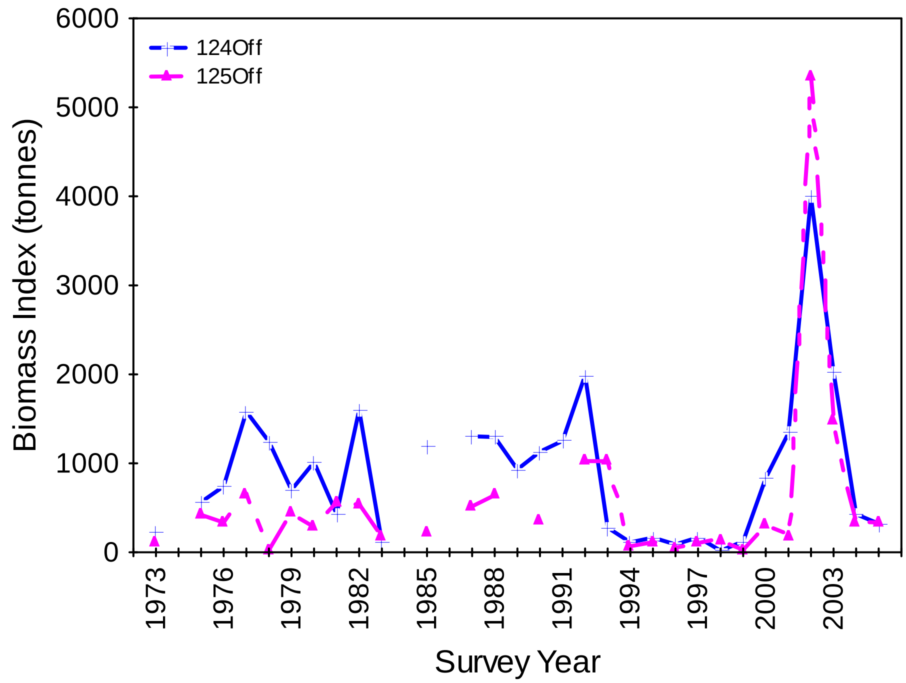
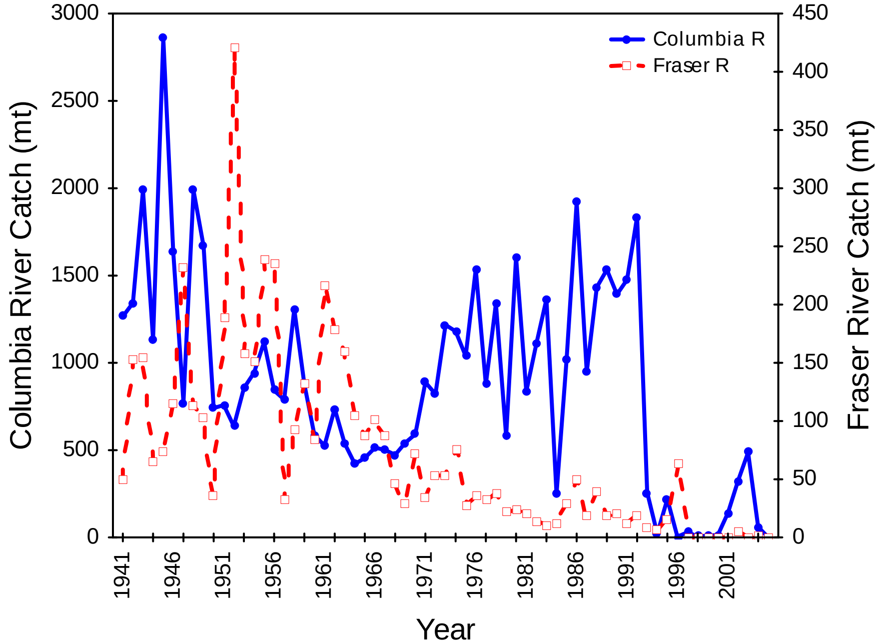


Figure 2: Biomass index for eulachon captured in the annual shrimp research survey off the west coast of Vancouver Island between 1973 and 2005 for Shrimp Management Areas 124Off and 125Off.

A



B

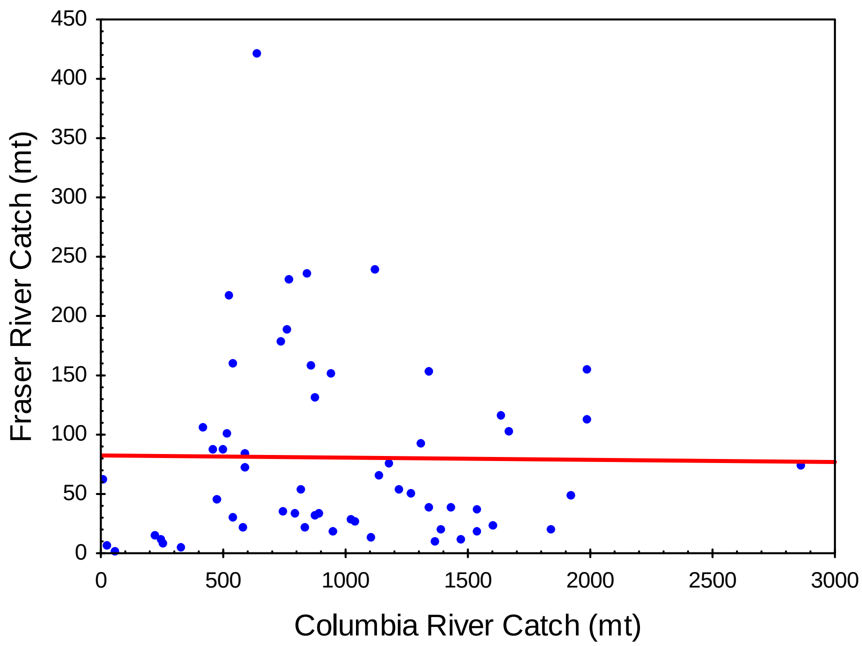


Figure 3 A) Commercial eulachon catches from both the Columbia River (left y-axis) and Fraser River (right y-axis) between 1941 and 2005. Note the different scales on the two y-axes. Recent catches reflect fishery closures and harvest restrictions. B) Relationship between commercial eulachon catches from the Fraser and Columbia Rivers.

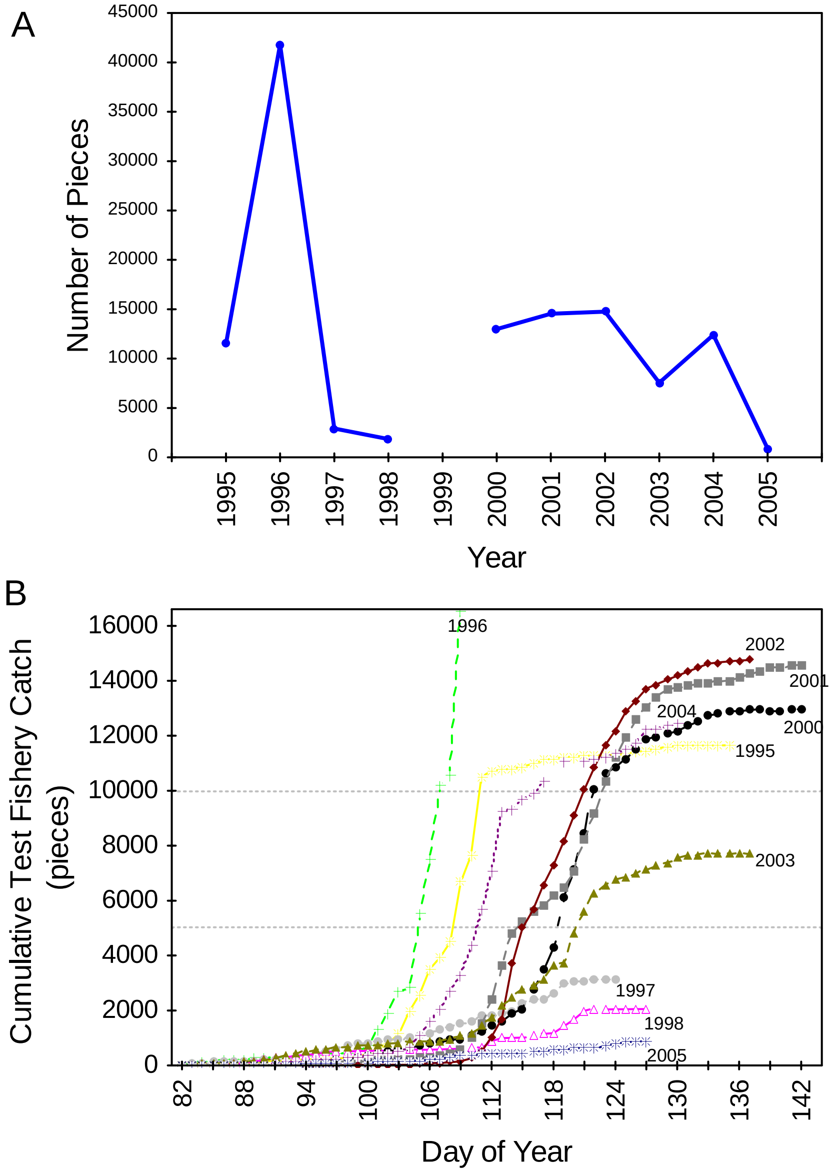


Figure 4: A) The total number of pieces landed in the New Westminster eulachon test fishery between 1995 and 2005 with no test fishery in 1999. B) Cumulative test fishery catches by day of the year for each test fishery year. Dashed lines indicate the 5000 and 10,000 piece reference points.

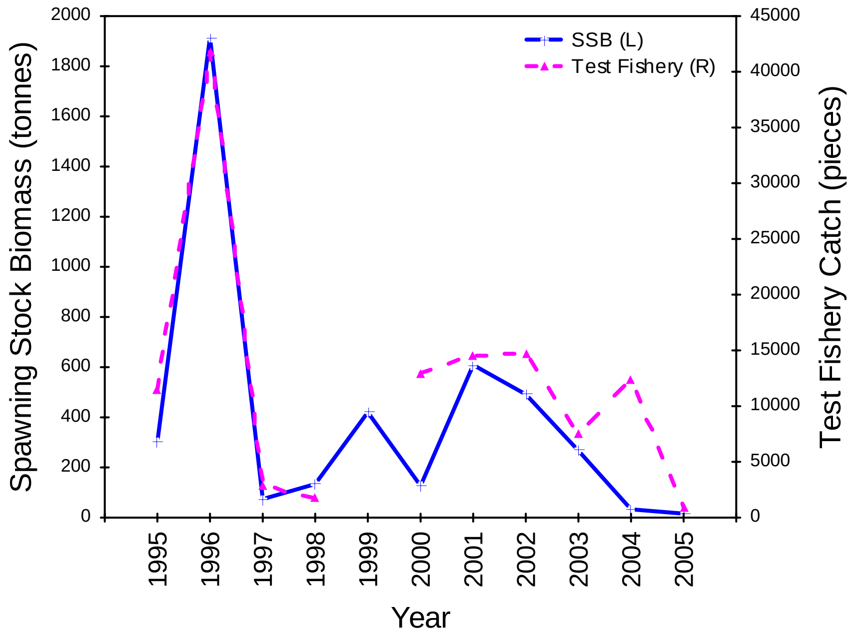


Figure 5: Comparison of spawning stock biomass (SSB) based on the egg and larval survey and the total test fishery catch between 1995 and 2005. Note there was no test fishery in 1999.