Spawning biology of eulachons, longfins and some other smelt species

Sacramento, November 15 2007

Doug Hay, Scientist emeritus
Pacific Biological Station
Nanaimo, B.C., Canada V9R 5K6
hayd@pbs.dfo.ca

Adjunct Professor
Fisheries Centre,
University of BC,
Vancouver BC

Nearshore Research

2510 Holyrood Drive

Nanaimo BC V9S4K9

250 758 4568

hay.doug@shaw.ca

I will try to focus on the 'spawning' biology but there may be some other aspects of eulachon and longfin biology of relevance to the delta smelt and longfins in Sacramento.

If I digress too much, please interrupt.

Eulachons-biological review
February 19 2007

Doug Hay, Scientist emeritus
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hayd@pbs.dfo.ca

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hay.doug@shaw.ca

Recent

Georgia Basin Puget Sound Research Conference
March 26-29, 2007
Vancouver, British Columbia

Regional variation in IUCN Redbook listings of marine fish species:

overzealous listing activity in the Atlantic or too little in the Pacific?

Recent

Doug Hay – *emeritus* - Pacific biological Station, Nanaimo, BC

Nearshore Research, Nanaimo, BC

IUCN 2004. *2004 IUCN Red List of Threatened Species*. WWW.IUCNREDLIST.ORG

Biological Overview – February 19, 2007 (Doug Hay)

Part 1 - Introduction and brief historical Review of eulachons

• significance to First Nations
• role in the European exploration of western North America (Mackenzie in 1793 in Canada and Lewis and Clark in the USA (- a connection to Napoleonic wars and the Louisiana purchase?)

Part 2 - Review of eulachon distribution – mainly an update from the 2000 status report.

• global distribution of eulachons (updated with recent Alaskan information)
• brief discussion of how eulachons fit in the smelt family (Osmeridae)
• brief discussion of eulachons/Osmerids antiquity (as factors pertinent to COSEWIC issues)
• distribution in Canadian and US rivers
• the glacier/snow-pack factor – is it real? Or why do they select some rivers and not others?

Part 3 - Eulachon life history and ecology – mainly an update from the 2000 status report

• life history – egg, larval, juvenile stages – distributions, durations
• spawning biology – maturation, sex differences, spawning sites
• what they eat - what eats them
• age and growth – brief review of information gained since the 2000 status report
• predation in the ocean and climate change
• role of eulachons in coastal ecosystems

Part 4- Stock assessments methods and results: mainly an update from the PSARC reports (1999-2004)

• assessment methods in rivers - strength and limitations
• assessment in estuaries
• offshore assessment

Part 4 – continued - Focus on the Fraser River

- historical catch data
- 1995 – recognition of a concern and problem
- management actions on the Fraser
- research activities on the Fraser
- results and implications of the 2006 assessment

Part 5 - Eulachon population structure

- population structure – updated on the 2000 status report with new information based on nuclear DNA analysis
- probable population structure – Loose ends and synthesis of genetics, spawning/larval distribution
- relationships between offshore eulachon concentrations and spawning rivers
- summary: population structure: what we know, what we do not know, what we need to know

Part 6 – NOT INCLUDED - Anthropogenic factors affecting eulachons

- spawning river habitat issues – pollution, logging, dredging, flood/erosion control
- fishing (and over-fishing) of spawning eulachon
- offshore bycatch, issues of collateral mortality

Part 7 - Summary: consideration of the question: how resilient are eulachons – over geological time?

- Is this a species that can withstand or adapt to climate change?
- Does the present situation represent short-term variation or an unprecedented change?
- Are eulachon populations at risk? If so, where? In individual rivers? In BC? Everywhere?

Eulachons-review
January 13 2005

Doug Hay
Pacific Biological Station
Nanaimo, B.C., Canada
V9R 5K6

hayd@pbs.dfo.ca
250 756-7201 - voice
250 756 7053 - FAX

Recent

Pacific Biological Station

Nanaimo

Today - a selective review - aspects potentially relevant to the Sacramento system

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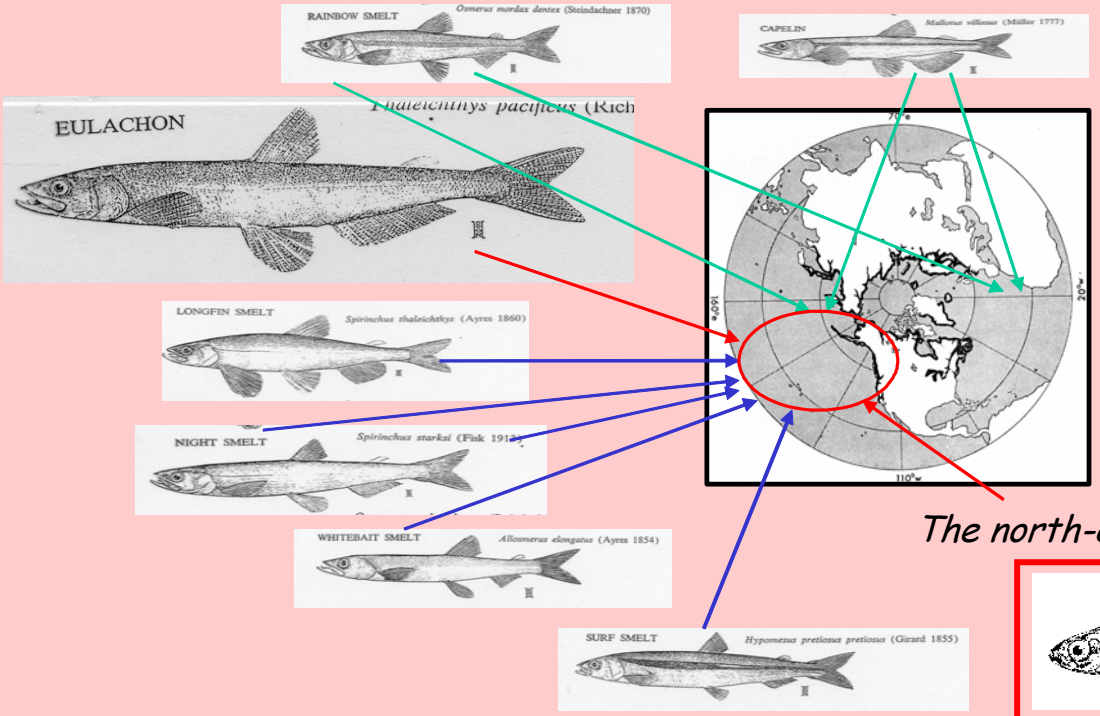
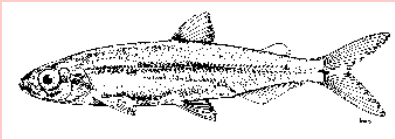
Osmerid distribution – empahsis on eulachon



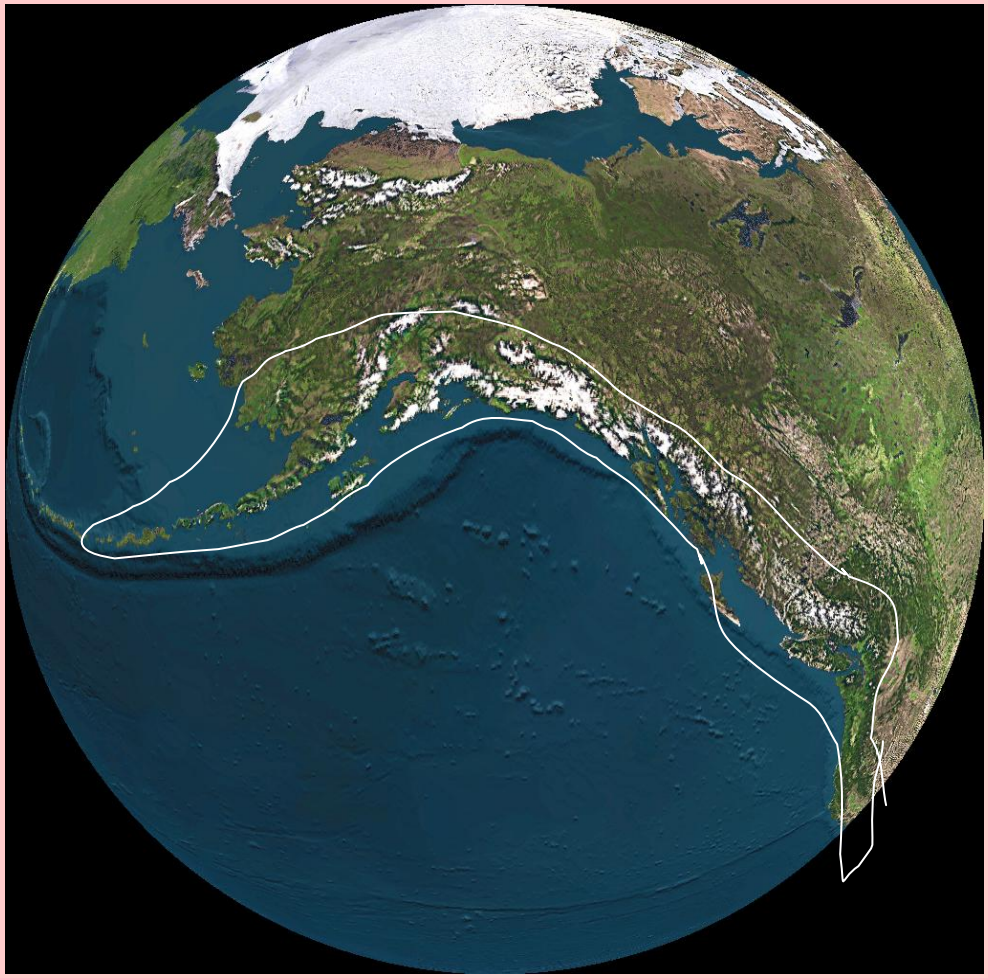
The north-east Pacific



DELTA SMELT *Hypomesus transpacificus*

In BC (and elsewhere) eulachons seem to spawn in only a relatively few rivers (15-20). In the world, maybe <100 different runs?

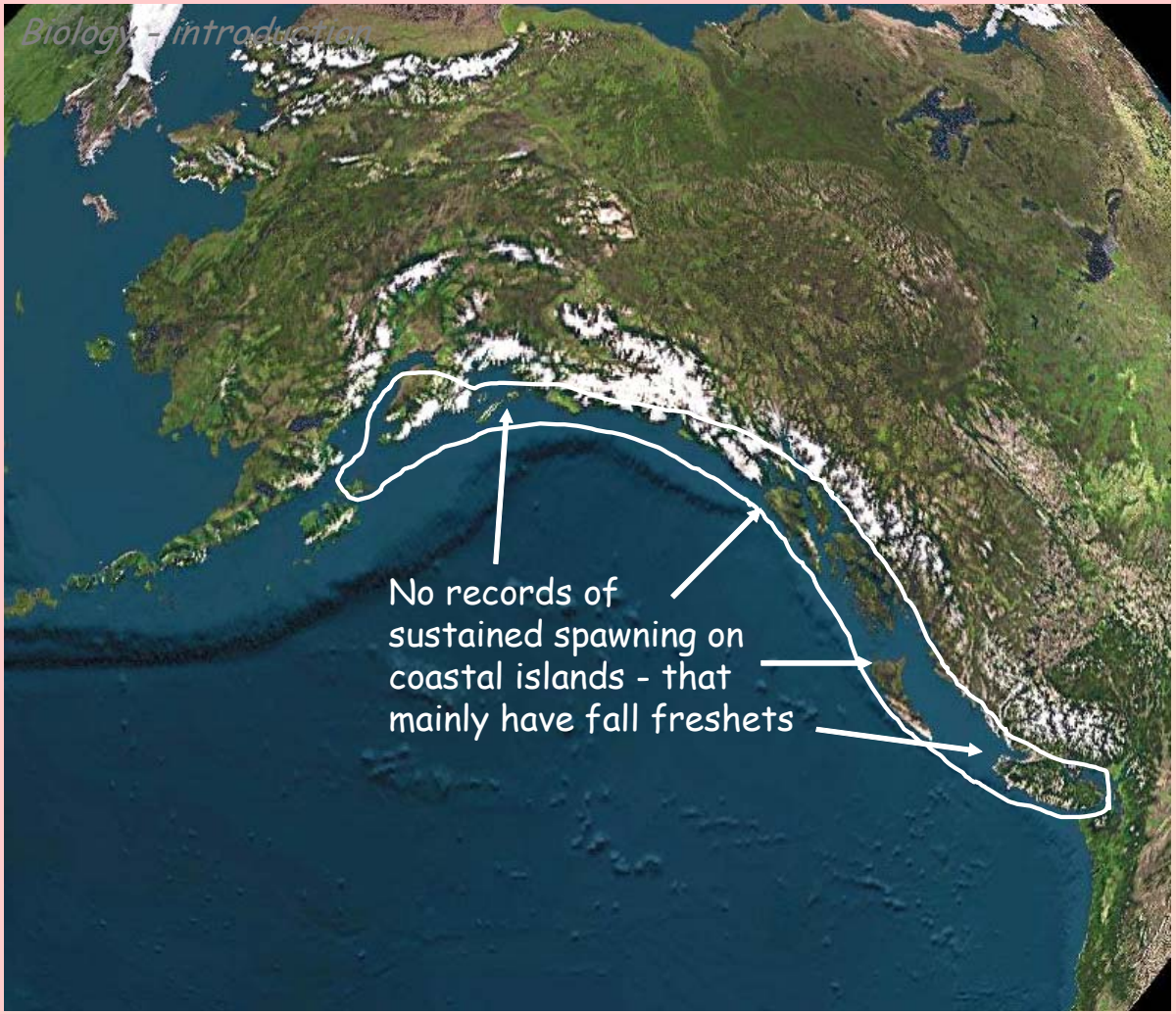
Columbia River - probably largest, followed by Fraser, then Nass or or maybe 1 or 2 Alaskan Rivers (Copper?).
Most other runs probably are much smaller.

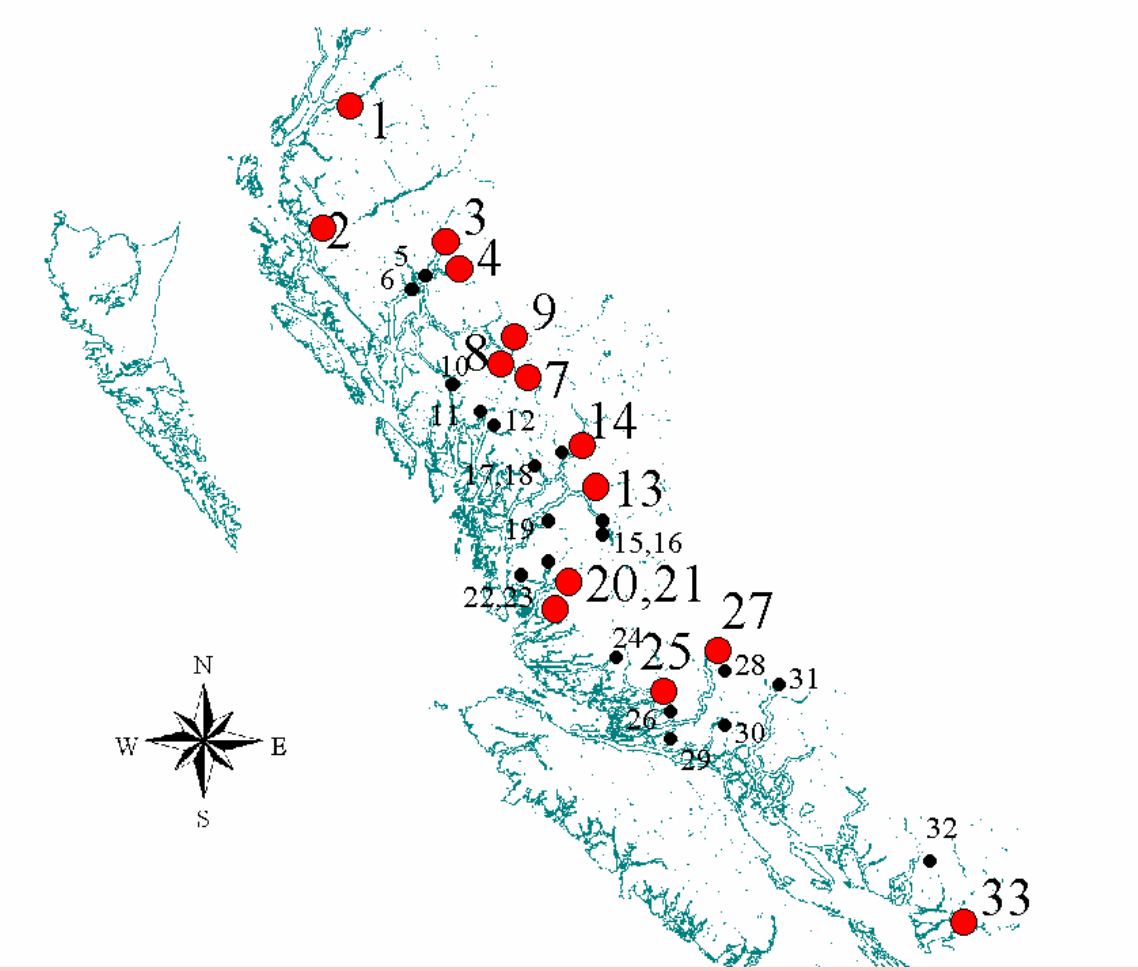


Approximate range

-northern edge (southern Bering Sea?) is uncertain

There are no records of consistent spawning in rivers that drain coastal islands (like Vancouver Island, or Queen Charlotte Island or Kodiak Island - all of which have 'fall freshets'. Eulachons spawn in rivers with 'spring freshets' that drain snowpacks





Known eulachon spawning rivers in BC. The small circles represent every known spawning river . Many of these rivers, however, do not have regular inter-annual spawning. Those that are believed to be regular are indicated with large symbols and numbers, others are shown with small symbols and numbers.

Note that there are about 33 rivers with records of eulachons and only about 13 with 'consistent' annual runs. In contrast, there are thousands of salmon runs in the same area.

Every population the world…how many?? << 100

Figure 1. -- Eulachon spawning sites west of Cape Suckling in Alaska. Sites marked with an asterisk (*) have more than one stream that supported a eulachon run. See text.

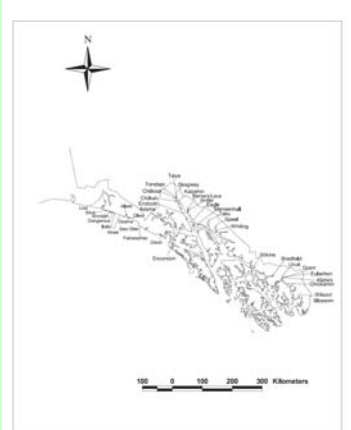
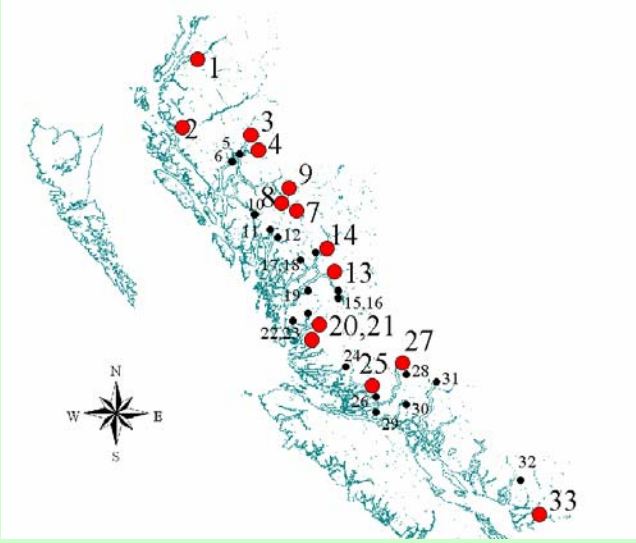
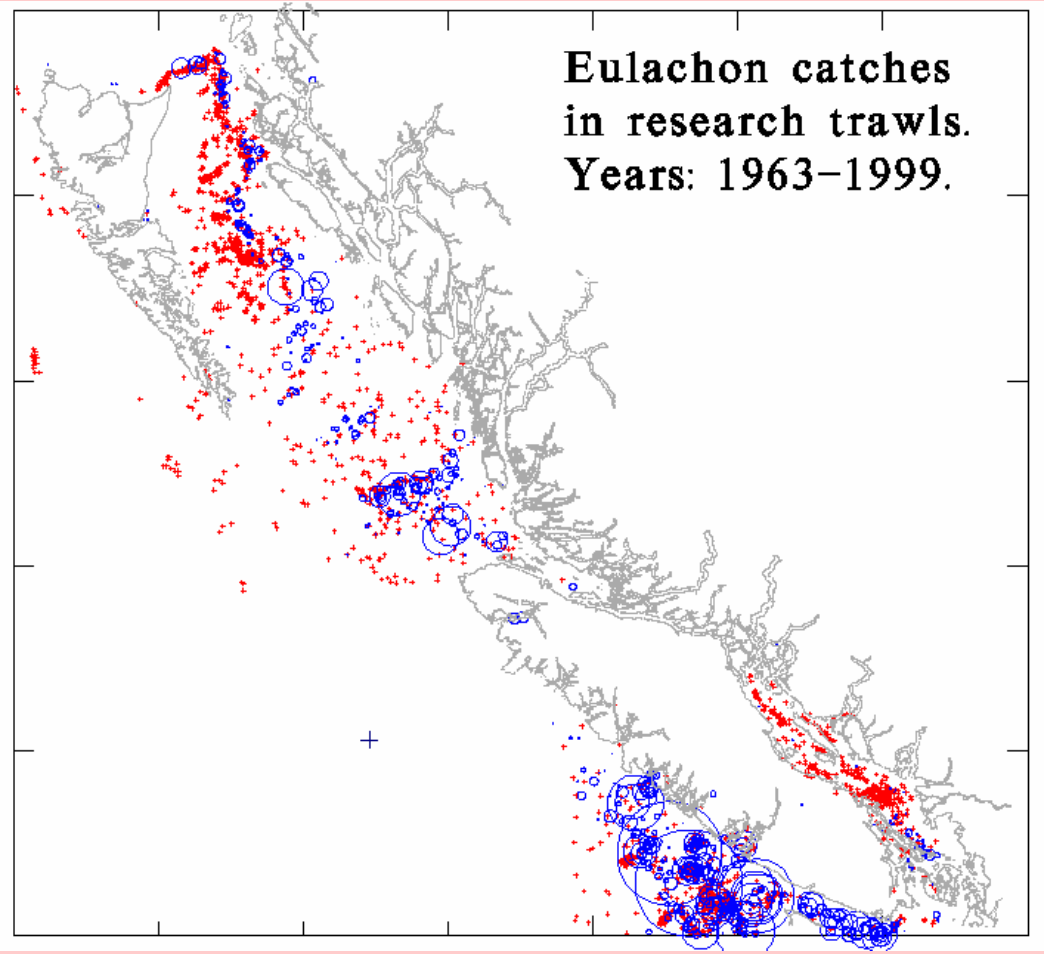


Figure 2. -- Eulachon spawning sites in Southeast Alaska (compiled by J. N. Womble).

Figure 4. -- Eulachon spawning sites in Washington, Oregon, and California. Sites marked with an asterisk (*) have more than one stream that supported a eulachon run. See text.



Offshore - distribution updates



Catch with eulachons

Catch without eulachons

Offshore distribution of eulachons from research surveys.
Circle size proportional to catch size (max. = 2700 kg/hr).

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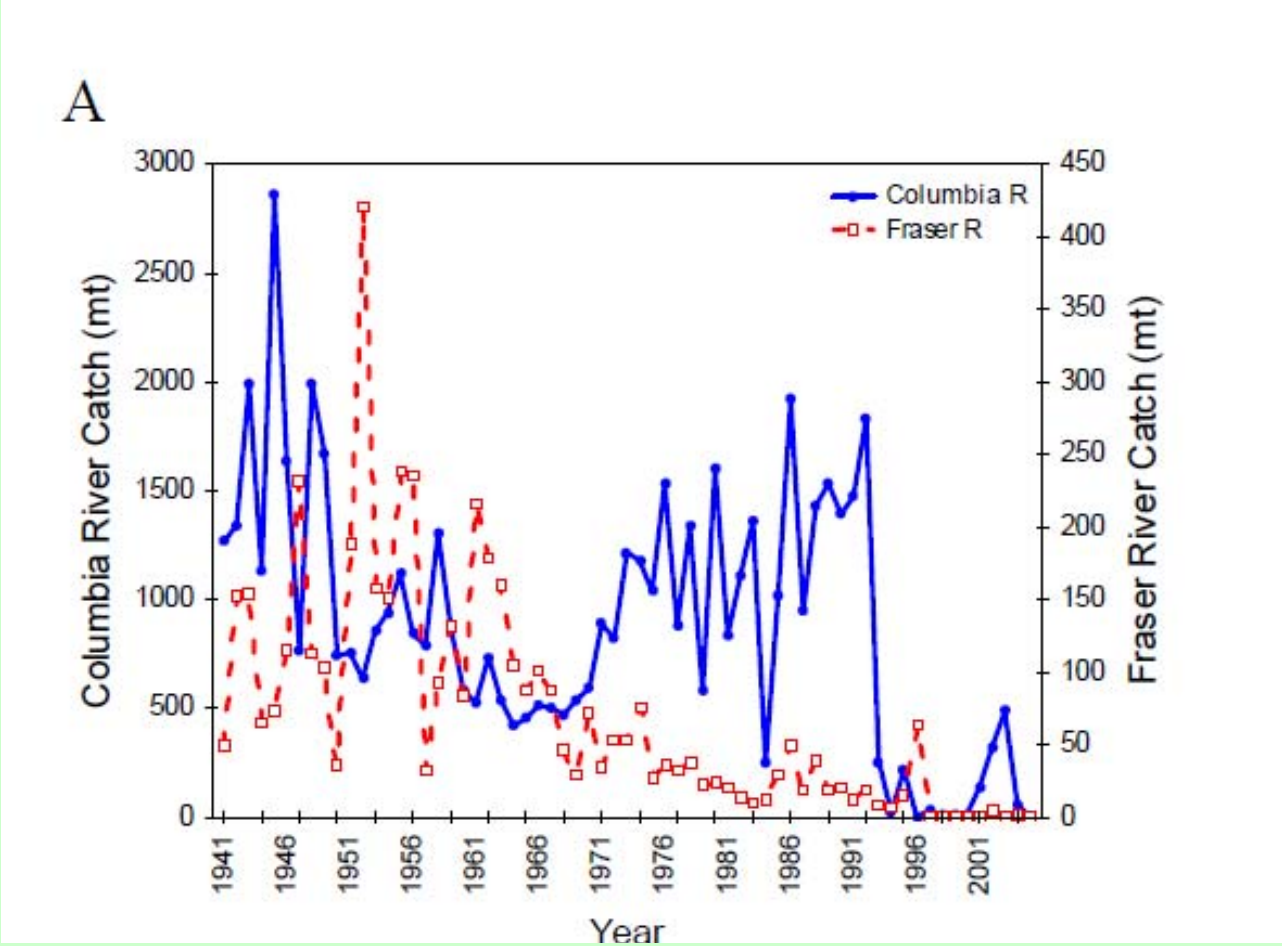
A
Columbia R
Fraser R
Columbia River Catch (mt)
Fraser River Catch (mt)
Year
0
500
1000
1500
2000
2500
3000
0
50
100
150
200
250
300
350
400
450
1941
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001

Surf smelt - *Hypomesus pretiosus*

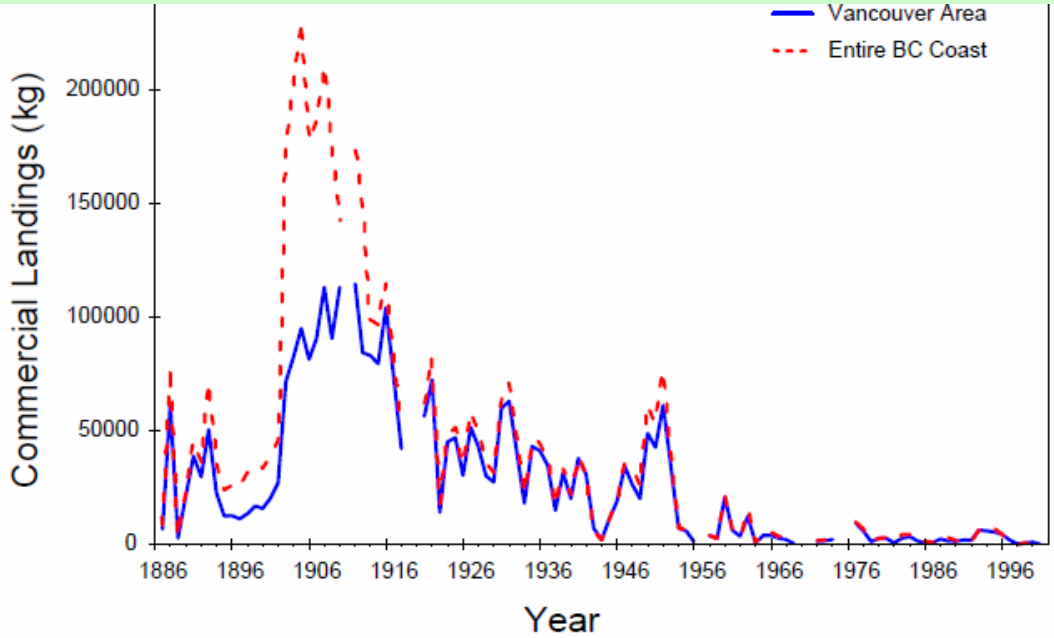

Figure 2: Reported surf smelt catches for Statistical Areas 28 and 29 (Vancouver Area) and for the entire British Columbia coast between 1886 and 2000.

http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2002/RES2002_115e.pdf

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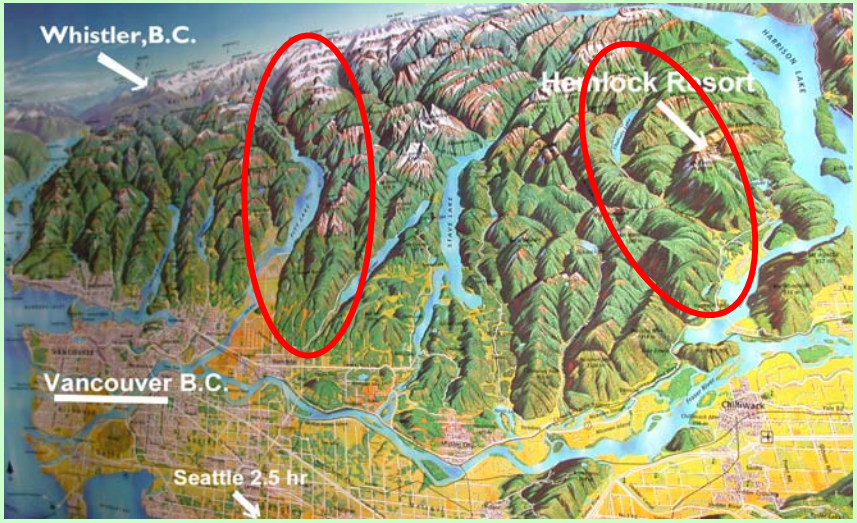
Longfin smelt – *Spirinchus thaleichthys*

Scientific name: *Spirinchus thaleichthys* (Ayers, 1860)
Common name: longfin smelt
Family: Osmeridae
Taxonomic comments:
Previously regarded as two separate species: *S. dilatus* (longfin smelt) and *S. thaleichthys* (Sacramento smelt). The two forms have been synonymized (Lee et al. 1980). Populations from Washington and the Sacramento-San Joaquin Delta are similar genetically but differ significantly in gene frequencies; Stanley et al. (1995)

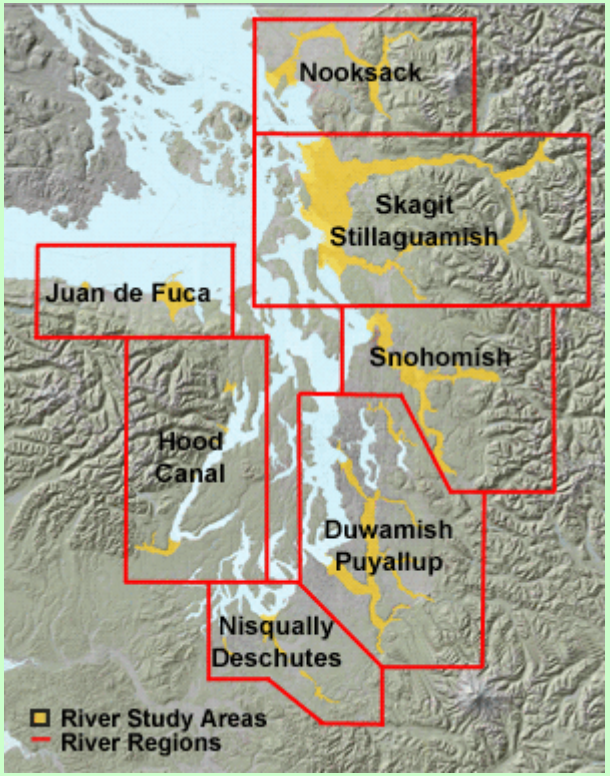
Nonanadromous populations in Harrison and Pit lakes, British Columbia, have been recognized as an undescribed species (*Spirinchus* sp. 1) by some authors.

http://aknhp.uaa.alaska.edu/zoology/species_ADFG/ADFG_PDFs/Fishes/Longfin_smelt_final_ADFG_2006.pdf



They also occur in Lake Washington…but that it the extent of the world distribution.

The small Nooksack River in Puget Sound has a distinct, strong spawning run of Ionfins – IN OCTOBER



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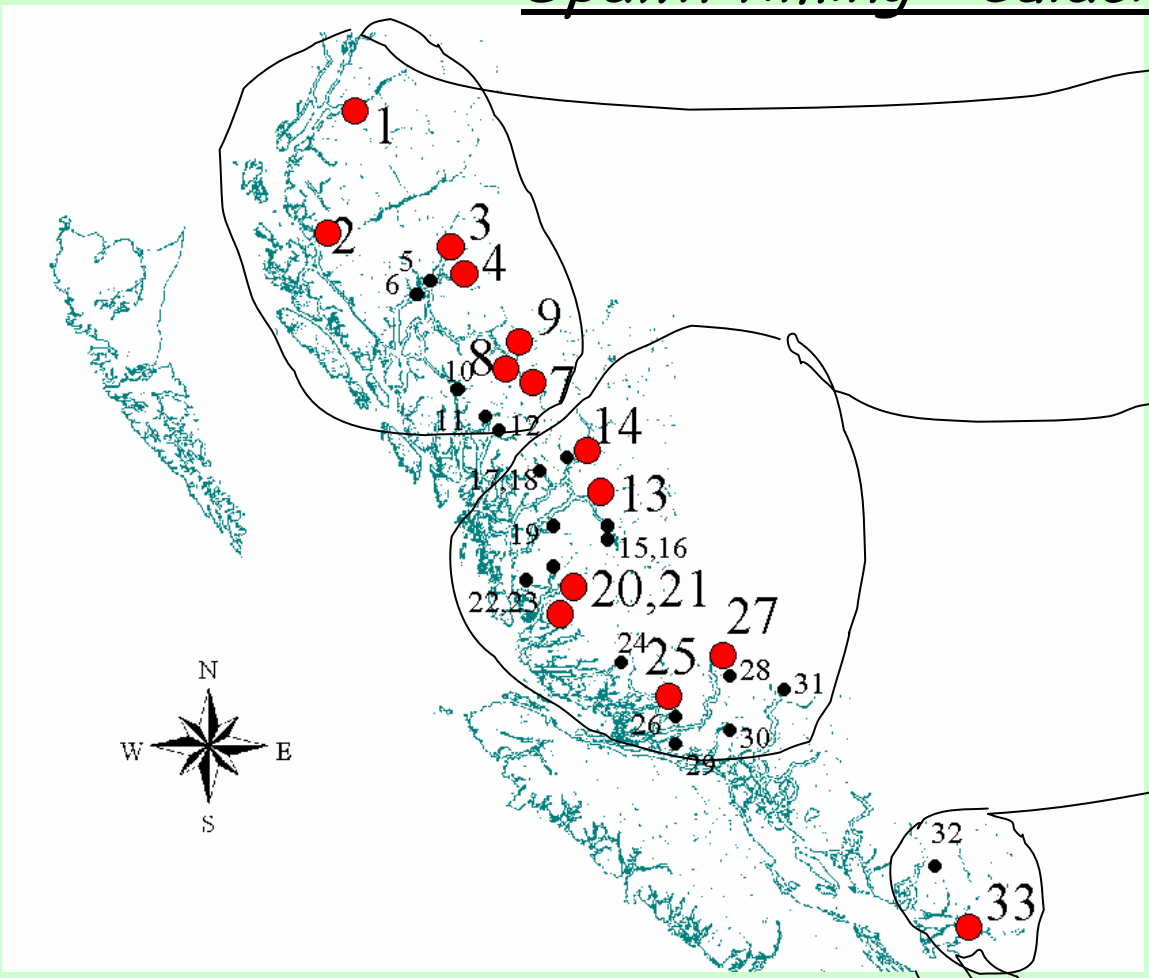
Spawn timing - eulachons



March

March-April

April-May

January-March

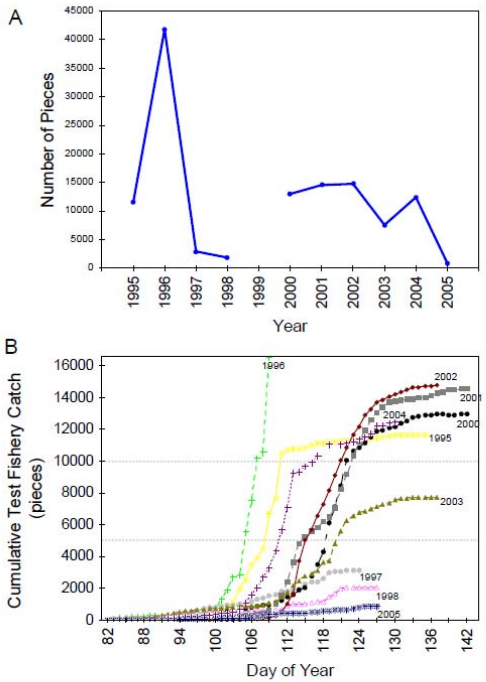


Figure 4: A) The total number of pieces landed in the New Westminster eulachon test fishery between 1995 and 2005 with no test fishery in 1999. B) Cumulative test fishery catches by day of the year for each test fishery year. Dashed lines indicate the 5000 and 10,000 piece reference points.

Within-river (Fraser) annual variation in spawning run times – up to 2-3 weeks

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SSB - from egg/larval surveys

Pacific Scientific Advice
Review Committee

P2002-08

Paper on Fraser assessment, November 2002

FRASER RIVER EULACHON BIOMASS ASSESSMENTS AND SPAWNING DISTRIBUTION: 1995-2002

by

D. E. Hay, P. B. McCarter, R. Joy, M. Thompson and K. West

October 2002

Fisheries and Oceans Canada
Science Branch, Stock Assessment Division
Nanaimo, British Columbia V9T 6N7

Spawn in rivers (March to May)
Fraser is latest (April/May),

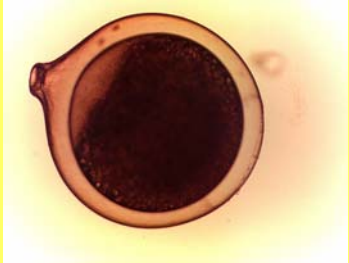
Columbia earliest (Jan-Mar)
Other BC rivers – March-April

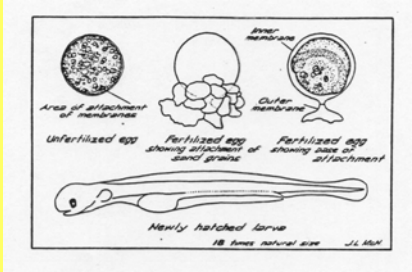
Eggs small, slightly adhesive
Egg incubation – 2-4 weeks

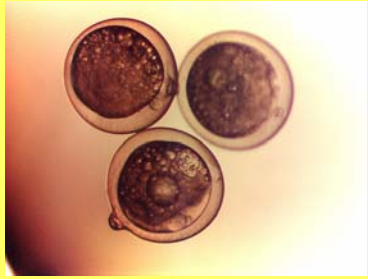
Larvae small (6-7 mm)
Yolk sac – probably need to feed in about 1 week

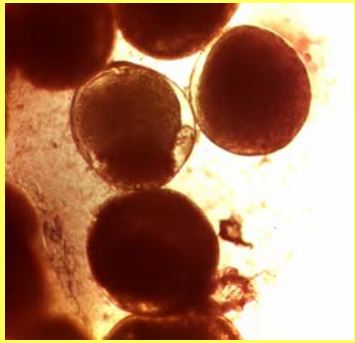
Probably flushed into estuary in 1 day (or less)
faster in smaller rivers)

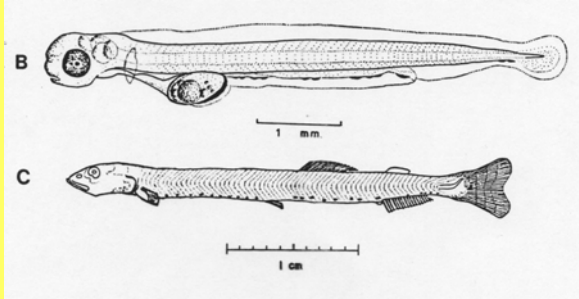
Migrate to shelf during first summer as juvenile



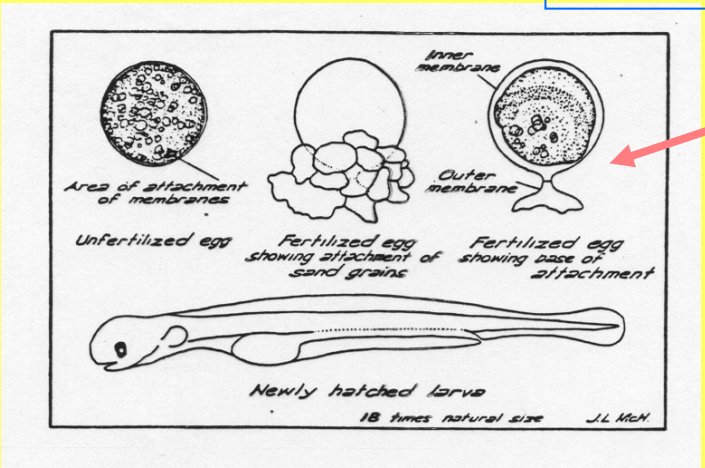


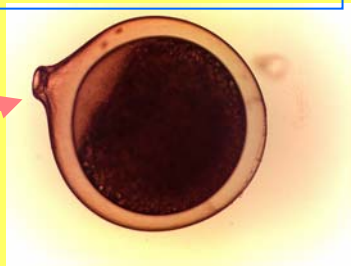


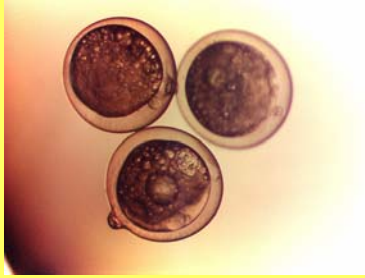


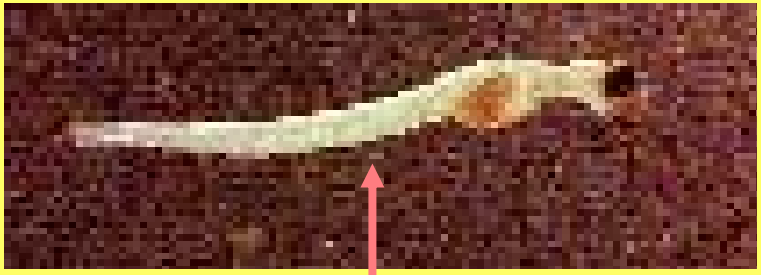


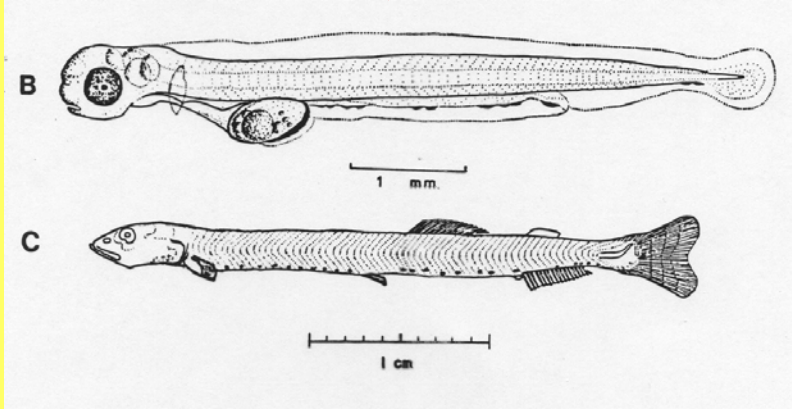
Eggs and larvae



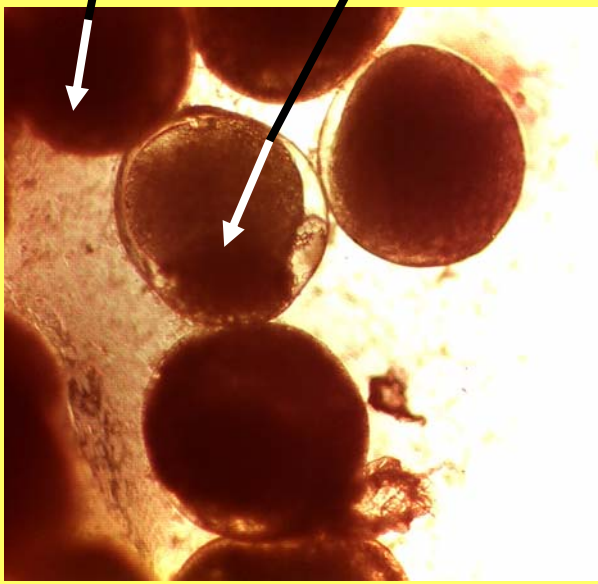








DEAD versus ALIVE



Current Stock assessment methodology

Assessments (in rivers) **-** Assess spawning biomass by estimating total numbers of eggs produced – must count eggs and larvae

We estimate eggs and larval density as:

Egg number = River discharge (m^3) x (numbers/m^3)
Spawning biomass = (egg number)/(eggs per gram in females/2)

River Assessments – only indicate the past (previous spawning biomass – not able to 'forecast'). Probably 'forecasting' is not possible at present
(maybe offshore surveys will allow this in future)

Fraser assessed since 1995

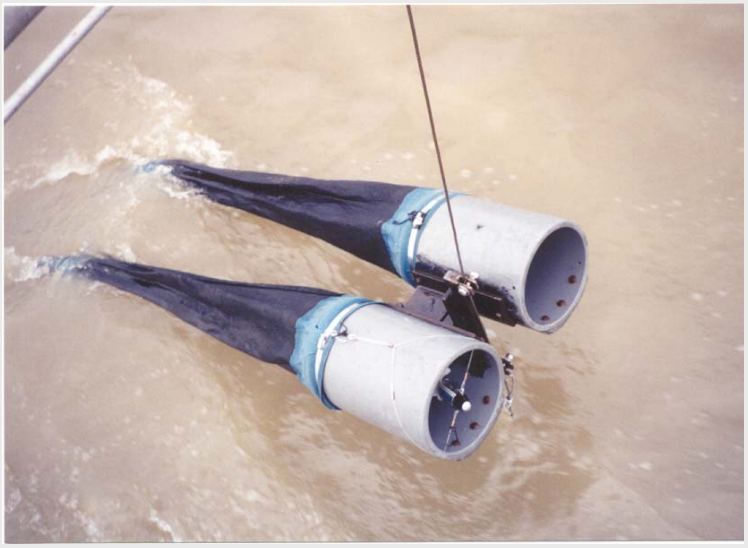
Assessments (other rivers)

The Annual catch in the Columbia has been a guide to abundance. Similarly the availability of eulachon for catches in other rivers also is a guide.

Assessments (offshore)

Done since 1973, incidental to shrimp monitoring
Provides an independent view about eulachons, but relations to Fraser (versus other rivers) is uncertain

The vessel and small BONGOS - filter ~ 10 m^3 in 5-minute tow



SSB - from egg/larval surveys

The BONGOS have flow meters- and take in a lot of river debris

SSB - from egg/larval surveys

In the lab the samples are sieved and eggs and larvae counted manually (~2-4 hours/samples)

Fraser River assessments

For each time period (t) P (production of eggs and larvae) was estimated as the product of the mean density D (numbers/m^3) and river discharge volume V (m^3/s) and the Interval (I) or duration of the time period (t) in seconds:

$$P_t = D_t V_t I_t$$

The total egg/larval production for the spawning season is the sum of the estimates for each interval:

$$P = \sum D_t V_t I_t$$

Fraser River assessments

The estimate of the number of spawning fish, estimated from annual egg and larval production is N = P/ (FS), where

N is the number of mature fish in the stock,
P is the egg production of stock,
F is the mean number of eggs produced per female and
S is the sex ratio or proportion of females in spawning stock.

For eulachons in the Fraser River, we modify this general equation as follows:

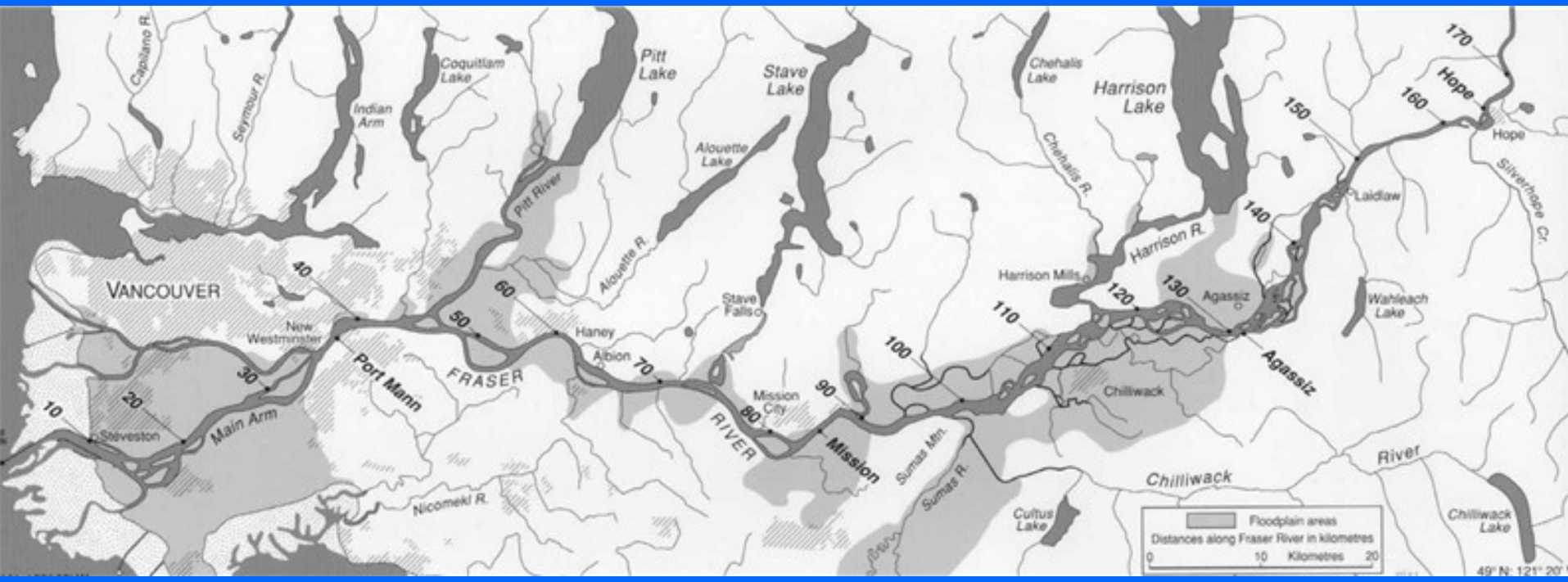
$$B_t = P_t / (R_t \cdot S_t)$$

where B_t is the biomass of the spawning stock at time t, and R is the relative fecundity or numbers of eggs per unit weight of spawning females.

For Fraser river fish there are about 700 eggs per gram for females and about 350 eggs per gram for males and females combined.

In-river egg and larval surveys to determine eulachon spawning stock biomass

Adult eulachon take advantage of tidal intrusions and river eddies to ascend Fraser ~ 10-100 kilometres. Most eulachon eggs and larvae are caught below km 70. Some are captured in Pitt River tributary.



Majority of egg & larval sampling conducted at km 20 - Deas Island on the South (Main) Arm and also sampling in North Arm.

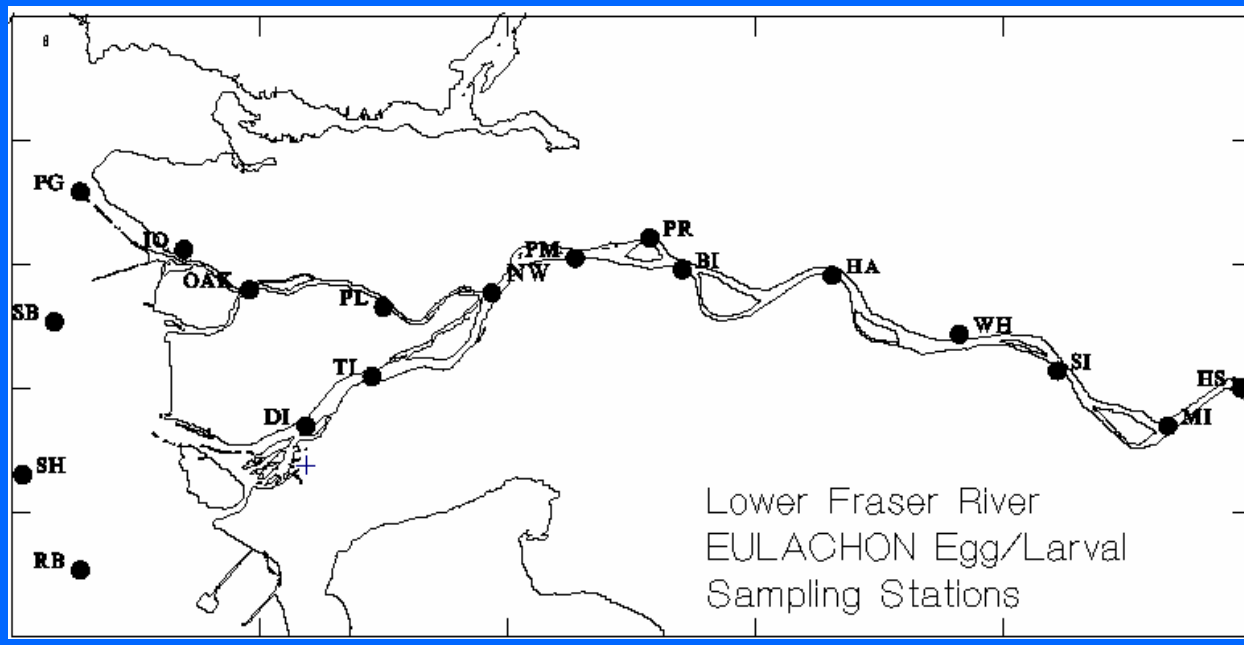
Fraser River Eulachon

An embryonic egg or larva may take less than a day to travel down river. It is believed many are ‘released’ under darkness (hatching enzyme/environ trigger ?).

Some hatched larvae will retain various degrees of curvature due to development inside egg capsules - an indicator of age (in hours). Other straight (or older) larvae can be routinely measured with an ocular micrometer to estimate approximate age. Early growth is similar to other pelagic fish larvae ~ 0.25 mm/day.

Sampling Stations 1995-1998

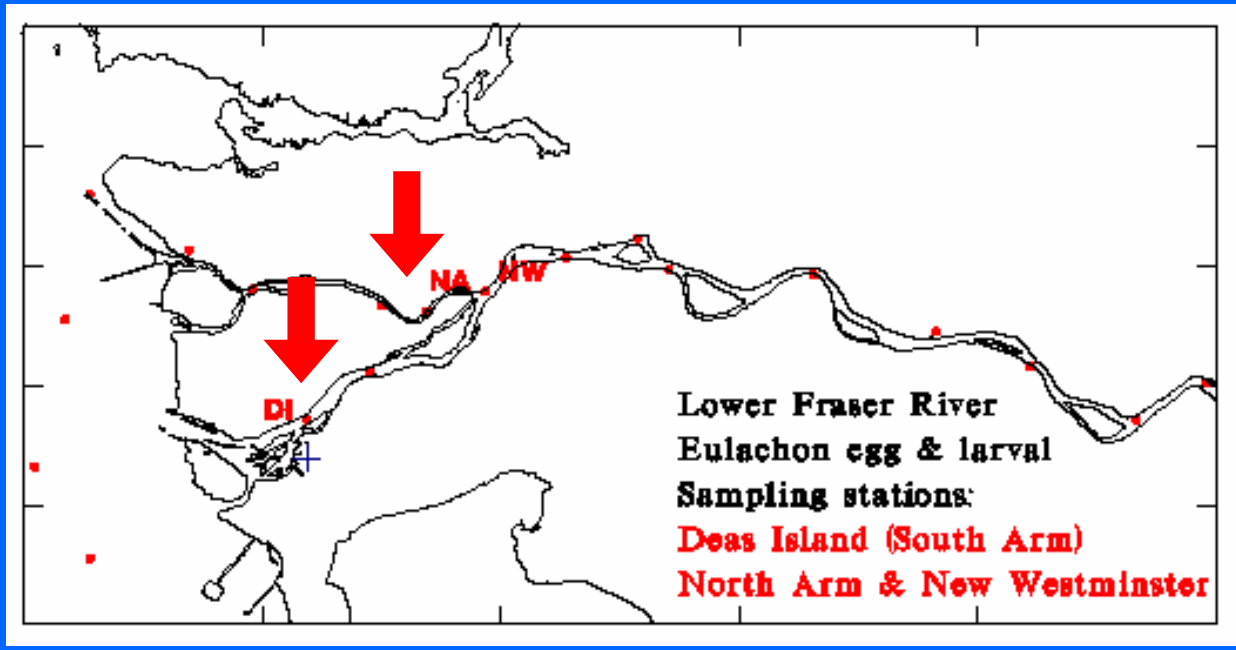
(~20 sites)



Sampling Stations 1995-2006:

North and South Arms

(2 sites)



Egg and Larval Survey Methods

Methodology is adapted from standard ocean ichthyoplankton survey techniques described in detail in reports by Hay and McCarter et. al. (1993-2003)

Spawning biomass is assessed by estimating total numbers of eggs and larvae flushed down river over a 3-7 week period by counting eggs and larvae collected from plankton net samples (18 tows /day).

Egg and Larval Survey Methods

Paired BONGO nets (350µm mesh) are towed for 6 minutes obliquely and at fixed depths down to 10 m. A General Oceanic flowmeter is used to measure the volume of water filtered so that bootstrap mean densities can be calculated (#/m3). Sampling positions are located along transects on the North and South Arms (Deas Is) of the Fraser River.

Egg and Larval Survey Methods

Eulachon eggs and larvae are identified and separated from many other filtered materials and counted in the laboratory. This is the most time (and labour) consuming component of the survey.

Egg and Larval Survey Methods

Egg and larval mean densities are determined bi-weekly at two divergent arms of the lower Fraser River. The number of eggs produced by the upriver spawning stock is then estimated as:

Egg # = River discharge (m^3) x (eggs+larvae/m^3)

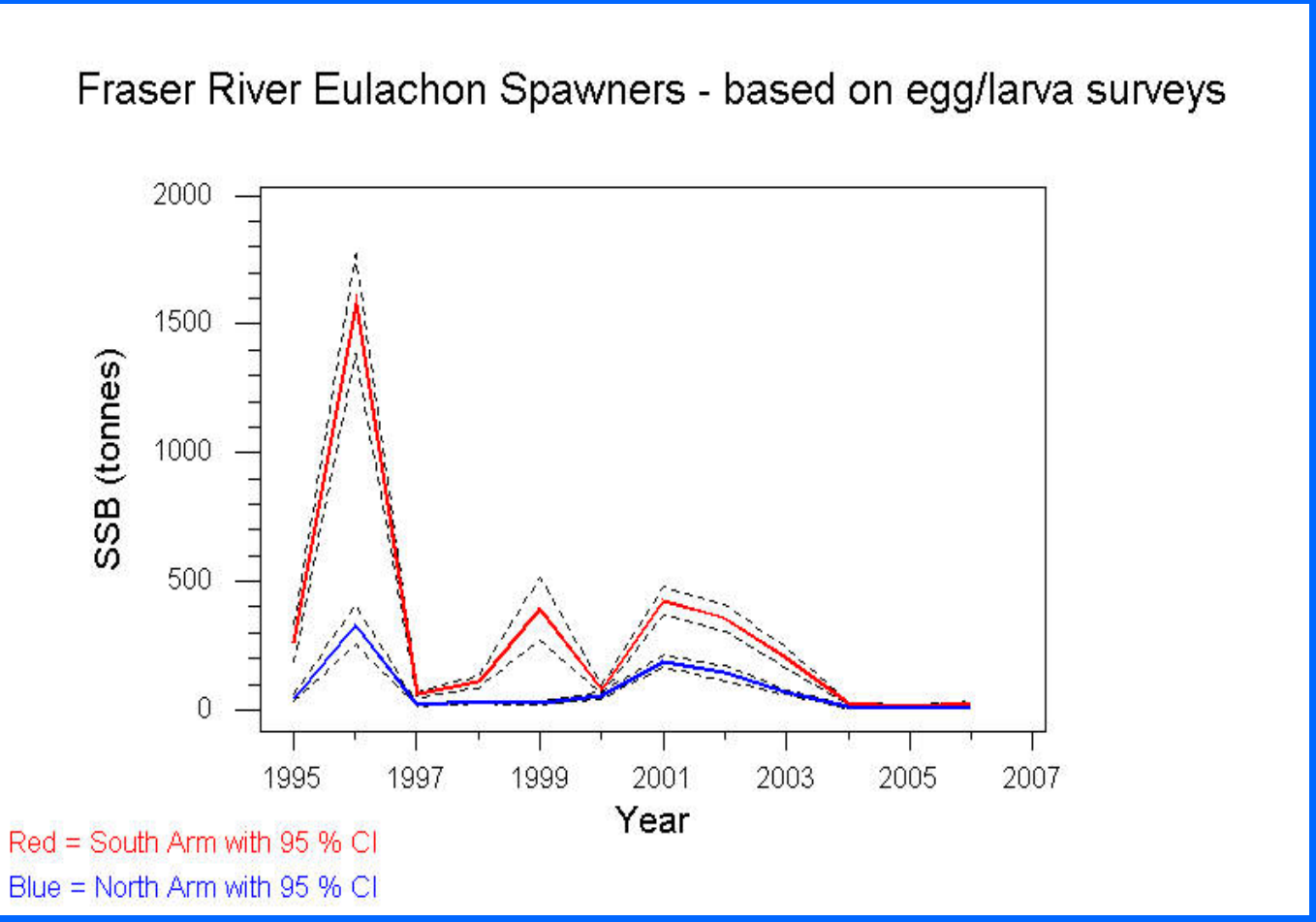
Spawning Biomass can then be estimated as:

SSB = (Egg #) X 2 / Relative fecundity

Relative fecundity:

Eulachon produce about 700 eggs per gram of female body weight. Overall sex ratios are usually 1:1.

Egg and Larval Survey Methods

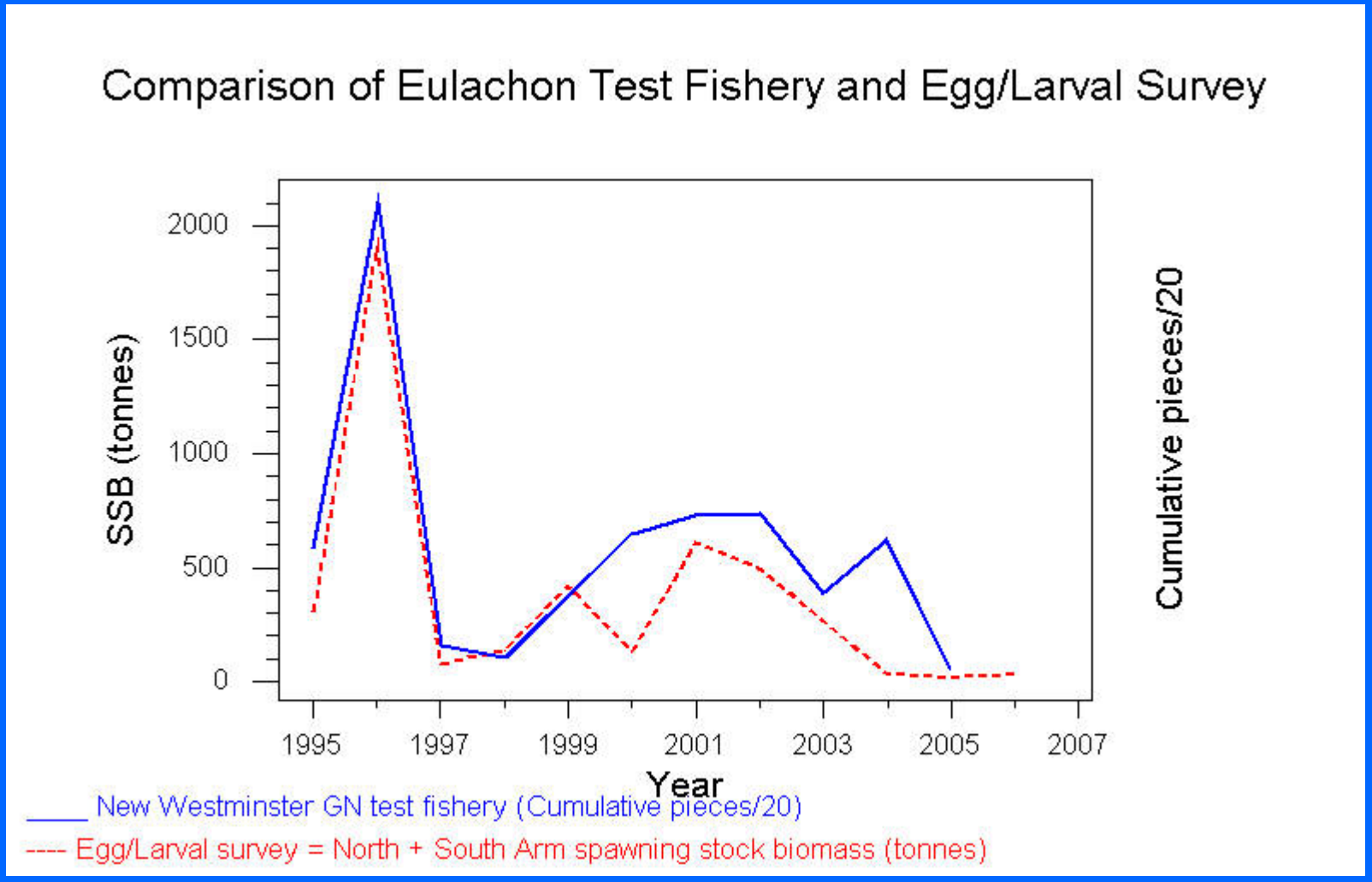


North + South Arm

2006: 29 tonnes
2005: 16 tonnes
2004: 33 tonnes
2003: 266 tonnes
2002: 494 tonnes
2001: 608 tonnes

IF SSB below 150 tonne response point.... for 1 year: caution... for 2 years: concern... for 3 years: Will they return?

Other measures (GN test fishery) appear to track the egg/larval survey but diverge in 2000 and 2004.



No test fishery in 1999 or 2006

Larval surveys in the sea

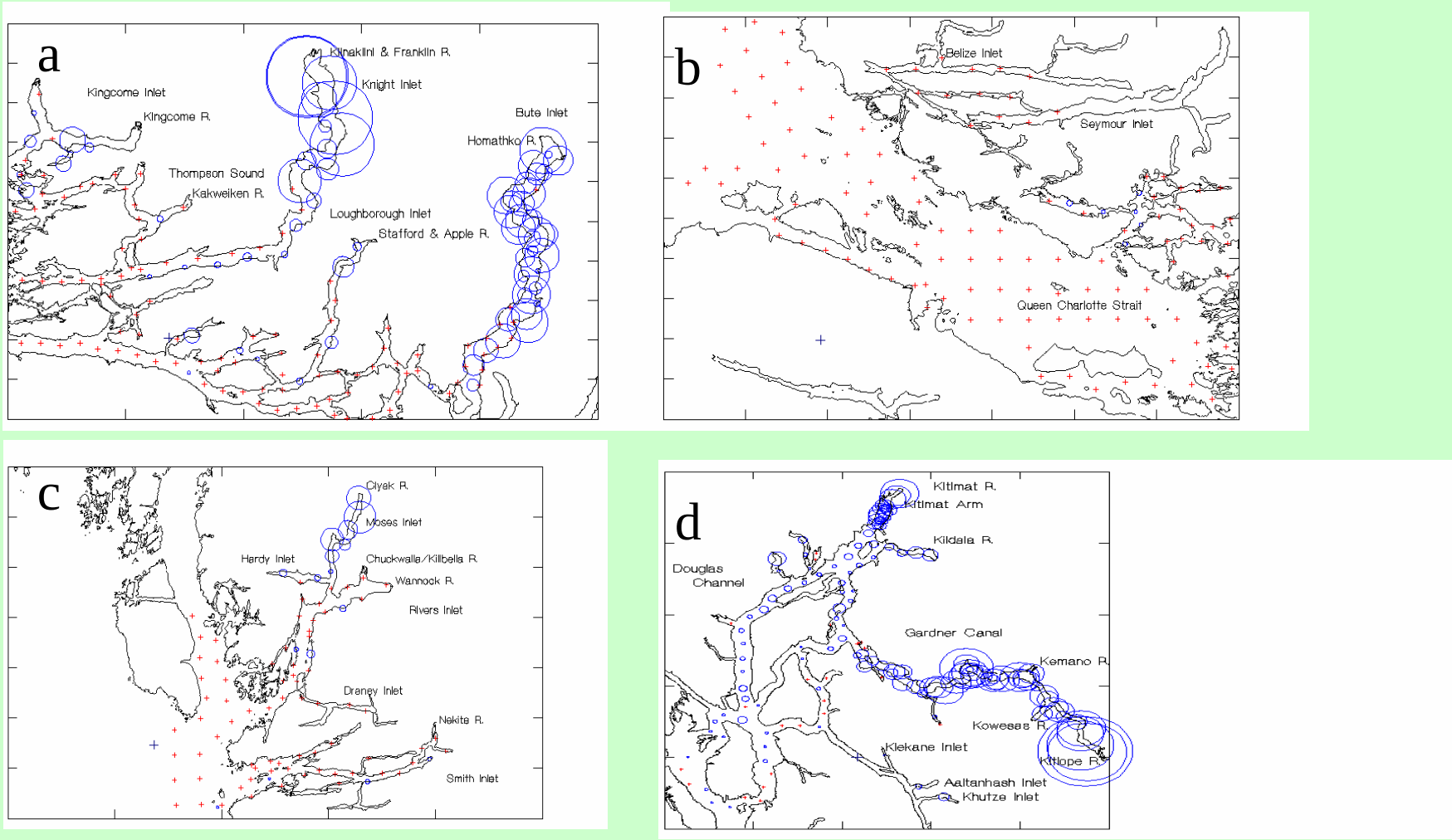


Fig. 4. **Larval eulachon** density map of (a) Johnstone Strait Region (JS) during April 25 – May 5, 1994 (Maximum density = 21.3 larvae/m3). (b) Queen Charlotte Strait Region (QS) during April 25 – May 5, 1994 (Maximum density = 0.1 larvae/m3). (c) Rivers Inlet Region (RI) during April 25 – May 5, 1994. Maximum density = 4.0 larvae/m3). (d) Douglas Channel Region (DC) during May 27 – June 7, 1996 (Maximum density = 32.2 larvae/m3). In all figures, a red cross indicates a station where no eulachon larvae were captured.

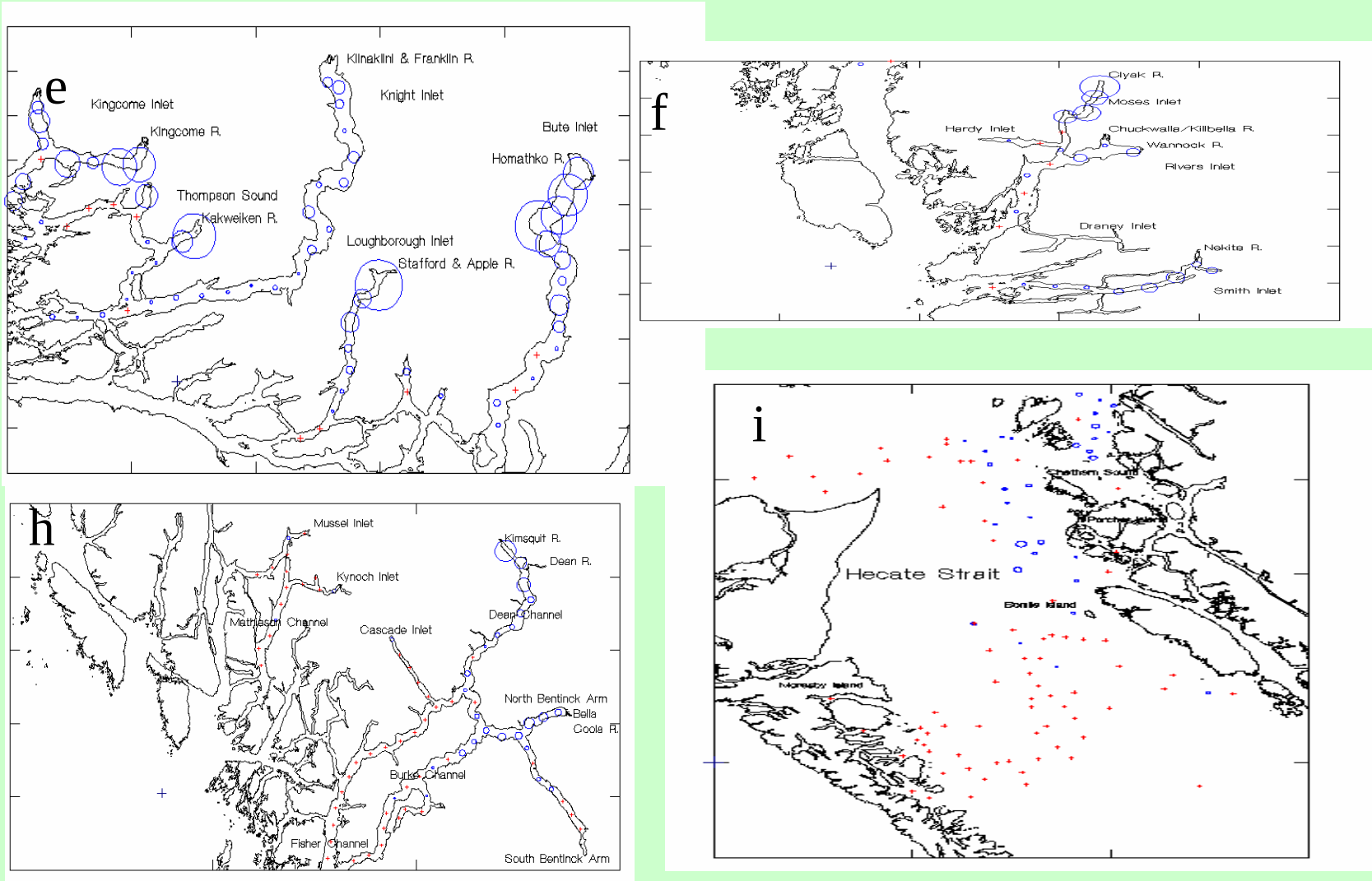


Fig.4 ***Continued***. (e) **Larval eulachon** density map of the Johnstone Strait Region (JS) during April 14 – 25, 1997 (Maximum density = 6.5 larvae/m3). (f) Rivers Inlet Region (RI) during April 14 – 25, 1997 (Maximum density = 3.6 larvae/m3). (g) Burke and Dean Channel Region (BD) during April 14 – 25, 1997 (Maximum density = 1.4 larvae/m3). (h) Hecate Strait during G.B. REED cruise, July 22-August 8, 1985. In all figures, a red cross indicates a station where no eulachon larvae were captured.

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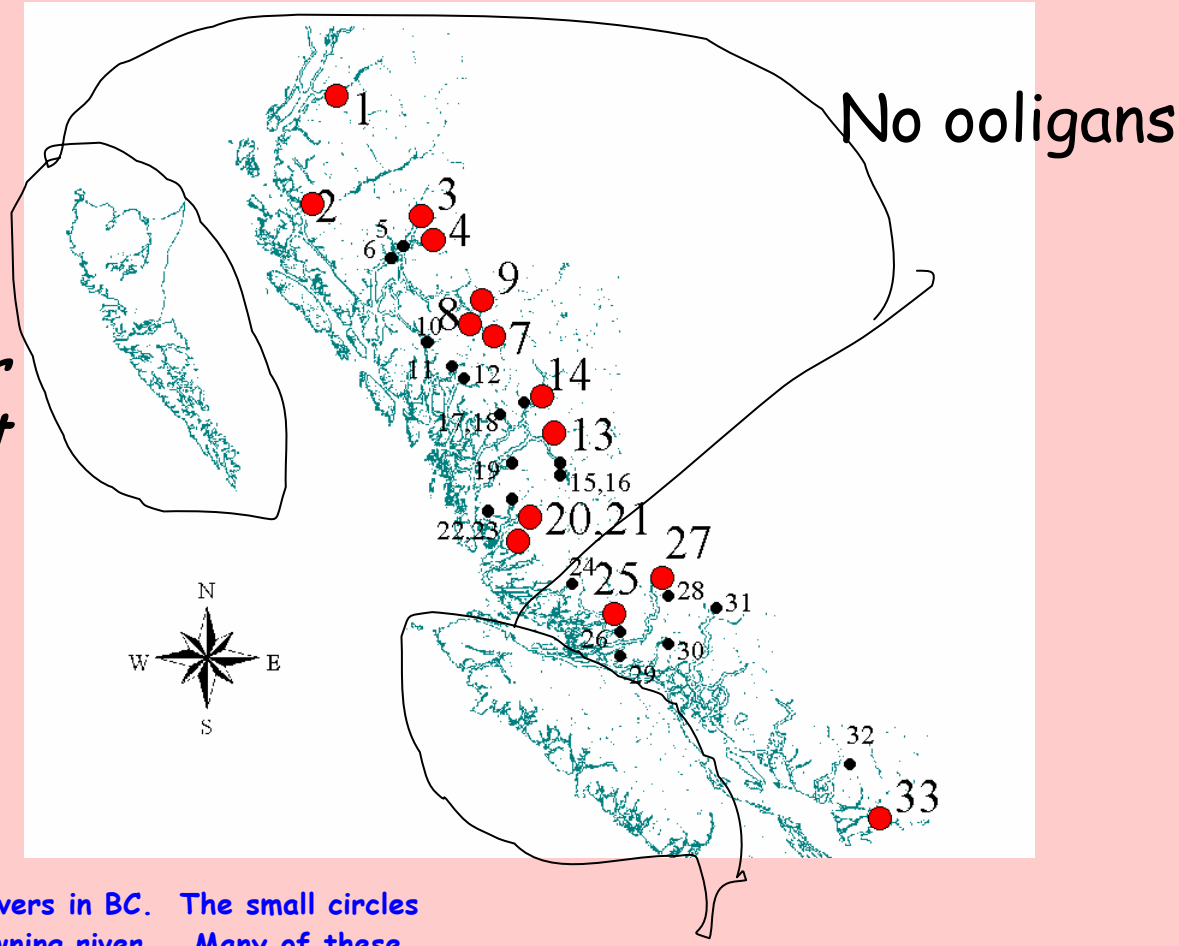
- 12. Loose ends and synthesis?

No eulachons occur in rivers on coastal Islands – they occur mainly in rivers that have spring freshets and that drain glaciers or snowpacks



Known eulachon spawning rivers in BC. The small circles represent every known spawning river . Many of these rivers, however, do not have regular inter-annual spawning. Those that are believed to be regular are indicated with large symbols and numbers, others are shown with small symbols and numbers.

Alaska – distribution updates

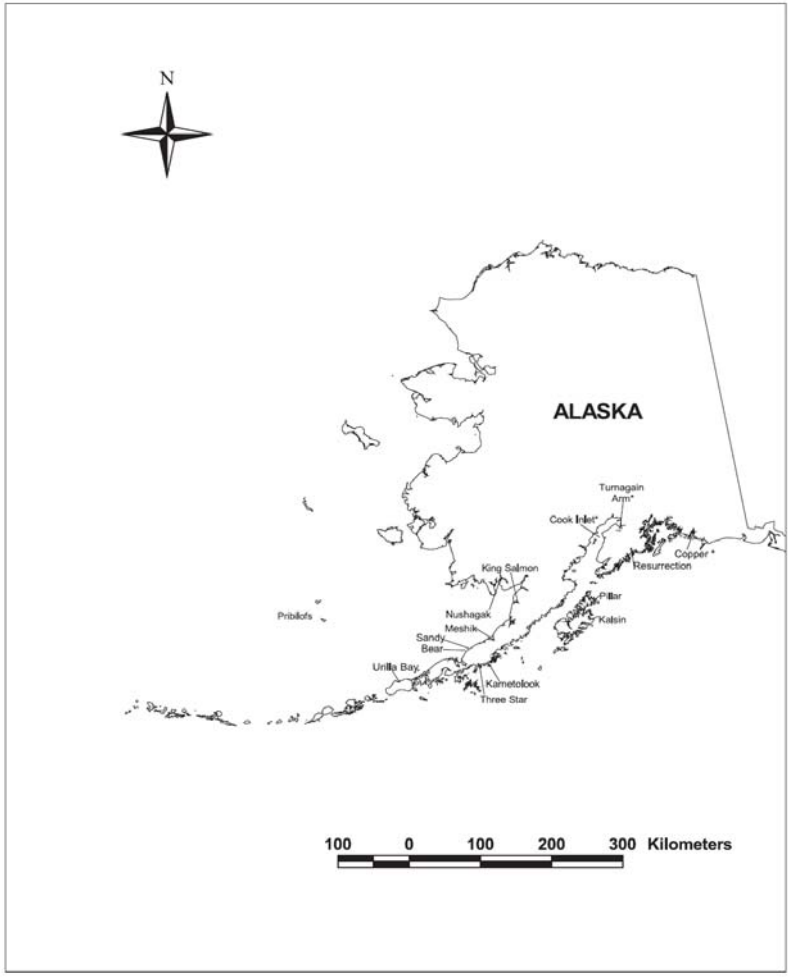


Figure 1. -- Eulachon spawning sites west of Cape Suckling in Alaska. Sites marked with an asterisk (*) have more than one stream that supported a eulachon run. See text.

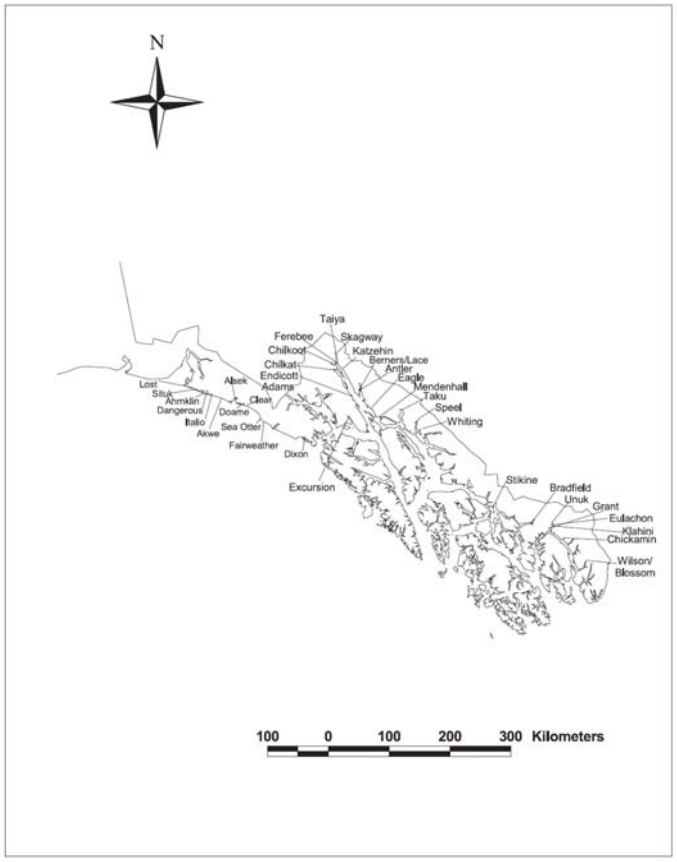


Figure 2. -- Eulachon spawning sites in Southeast Alaska (compiled by J. N. Womble).

distribution updates

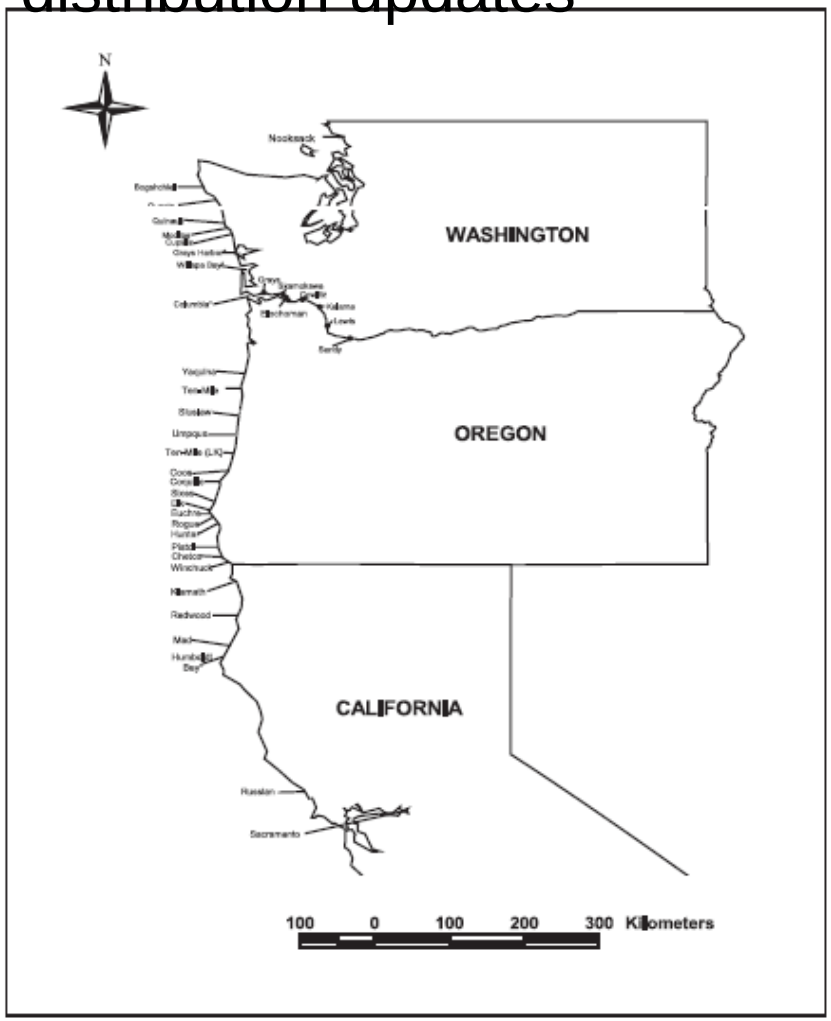


Figure 4. -- Eulachon spawning sites in Washington, Oregon, and California. Sites marked with an asterisk (*) have more than one stream that supported a eulachon run. See text.

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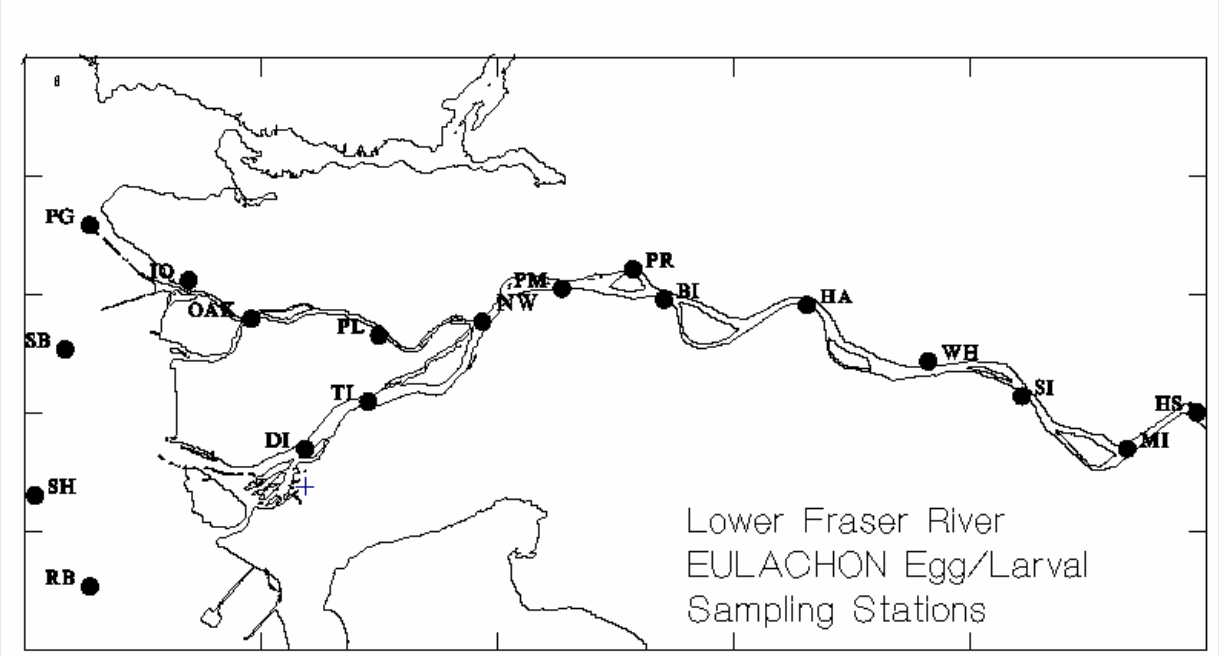
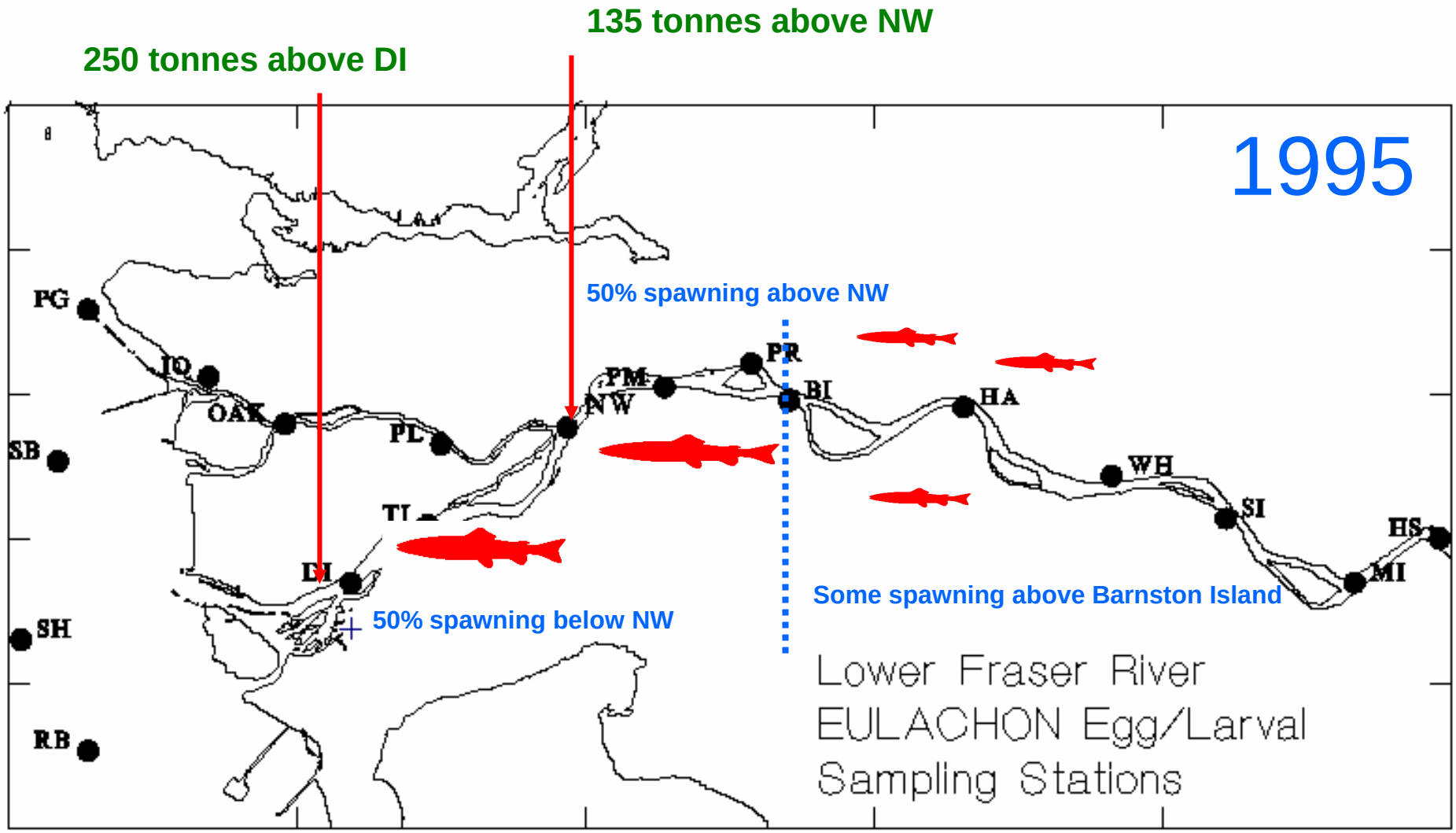
- 12. Loose ends and synthesis?

combined

Fraser River assessments – multiple sites 1995-2001

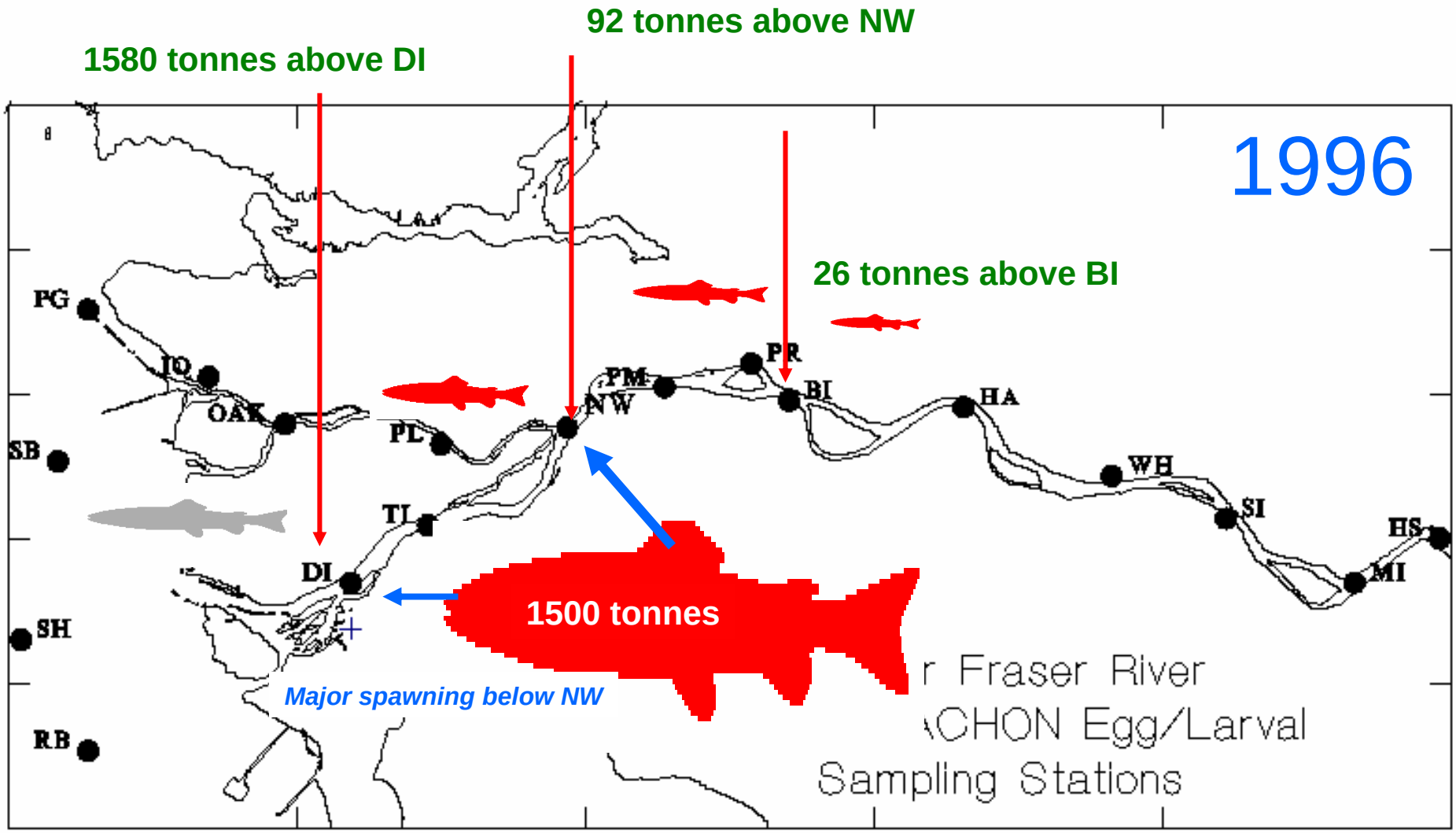




Spawning eulachon

Migrating eulachon

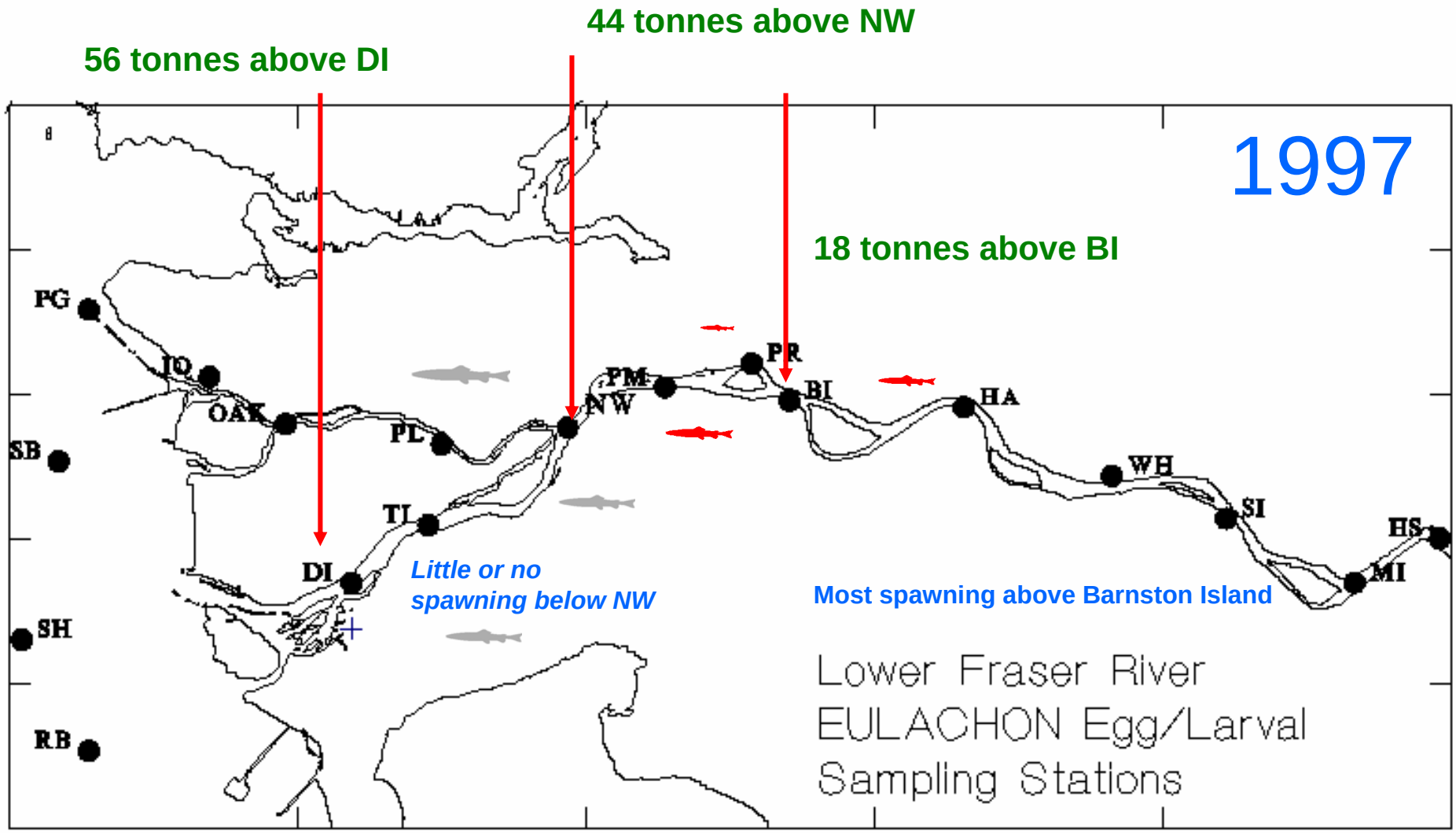
Fraser River assessments



Spawning eulachon

Migrating eulachon

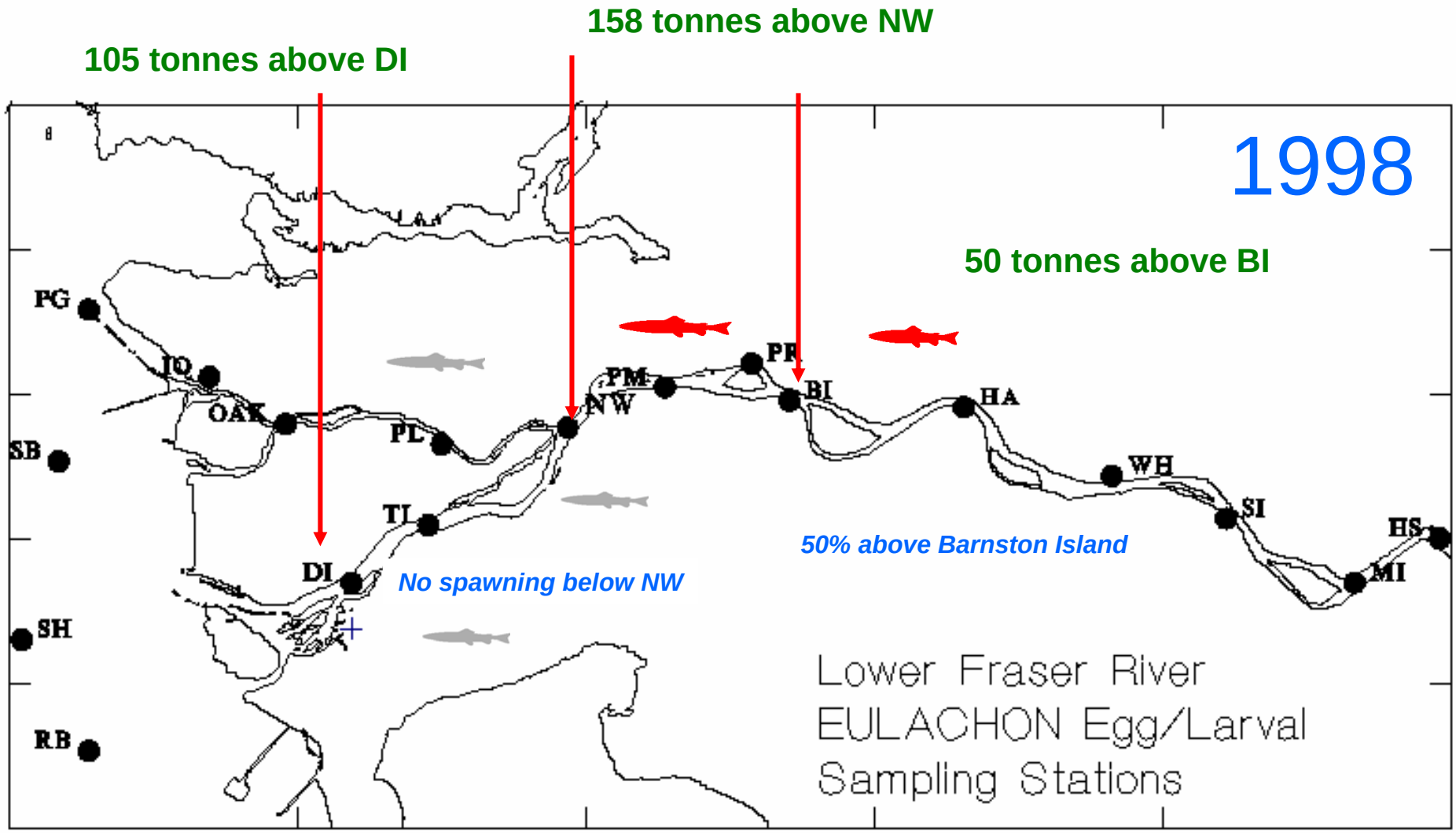
Fraser River assessments



Spawning eulachon

Migrating eulachon

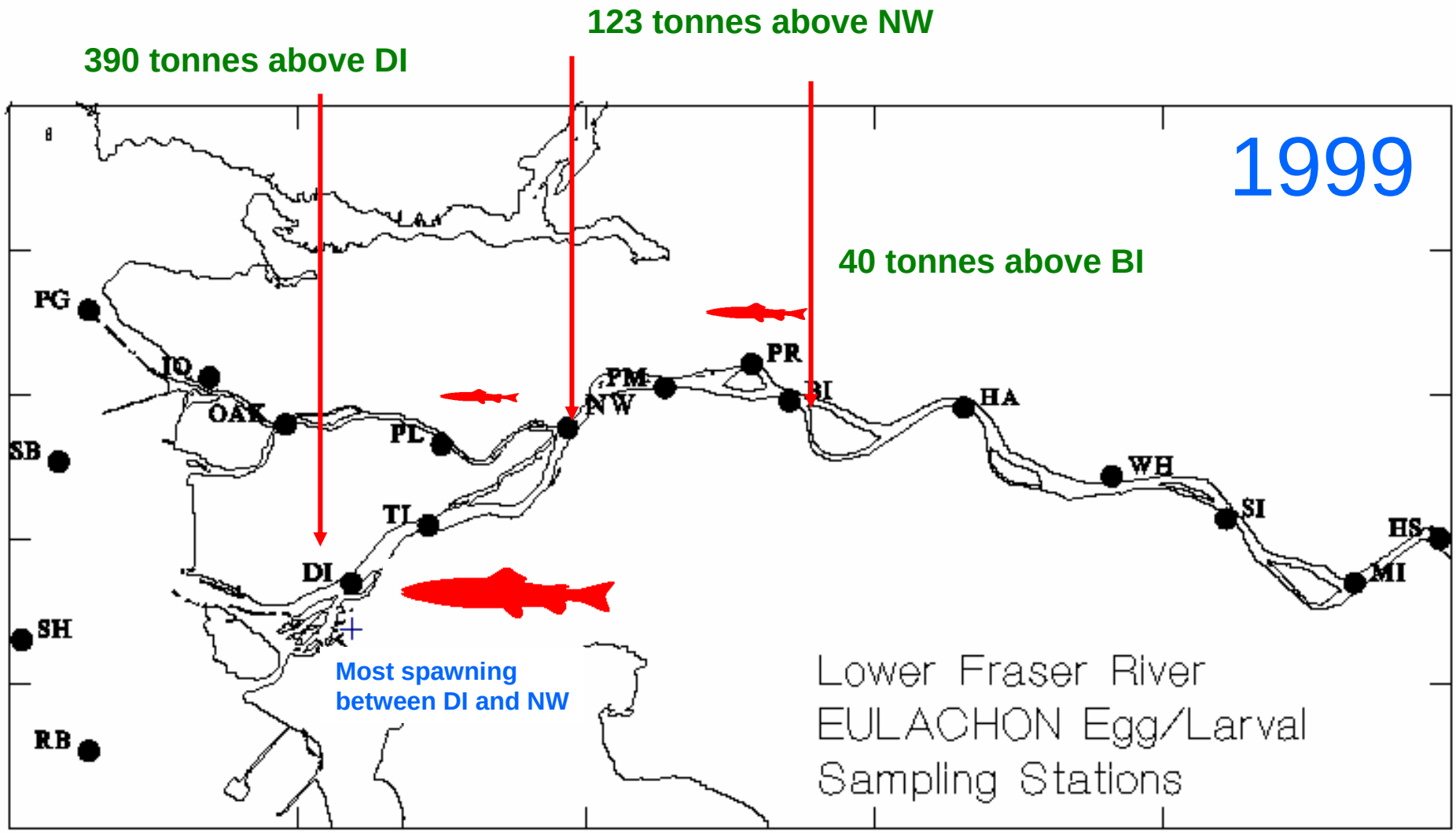
Fraser River assessments



Spawning eulachon

Migrating eulachon

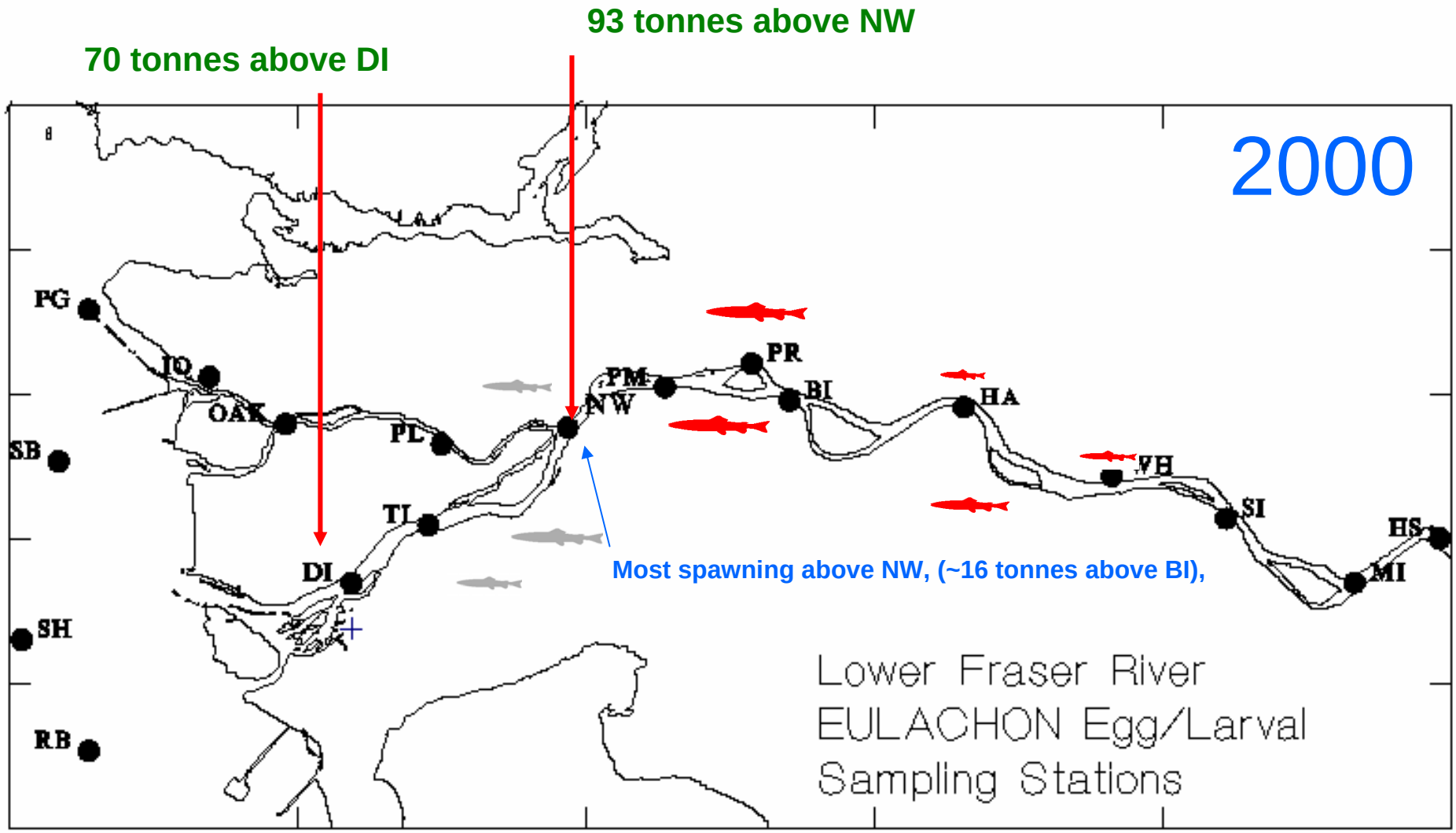
Fraser River assessments



Spawning eulachon

Migrating eulachon

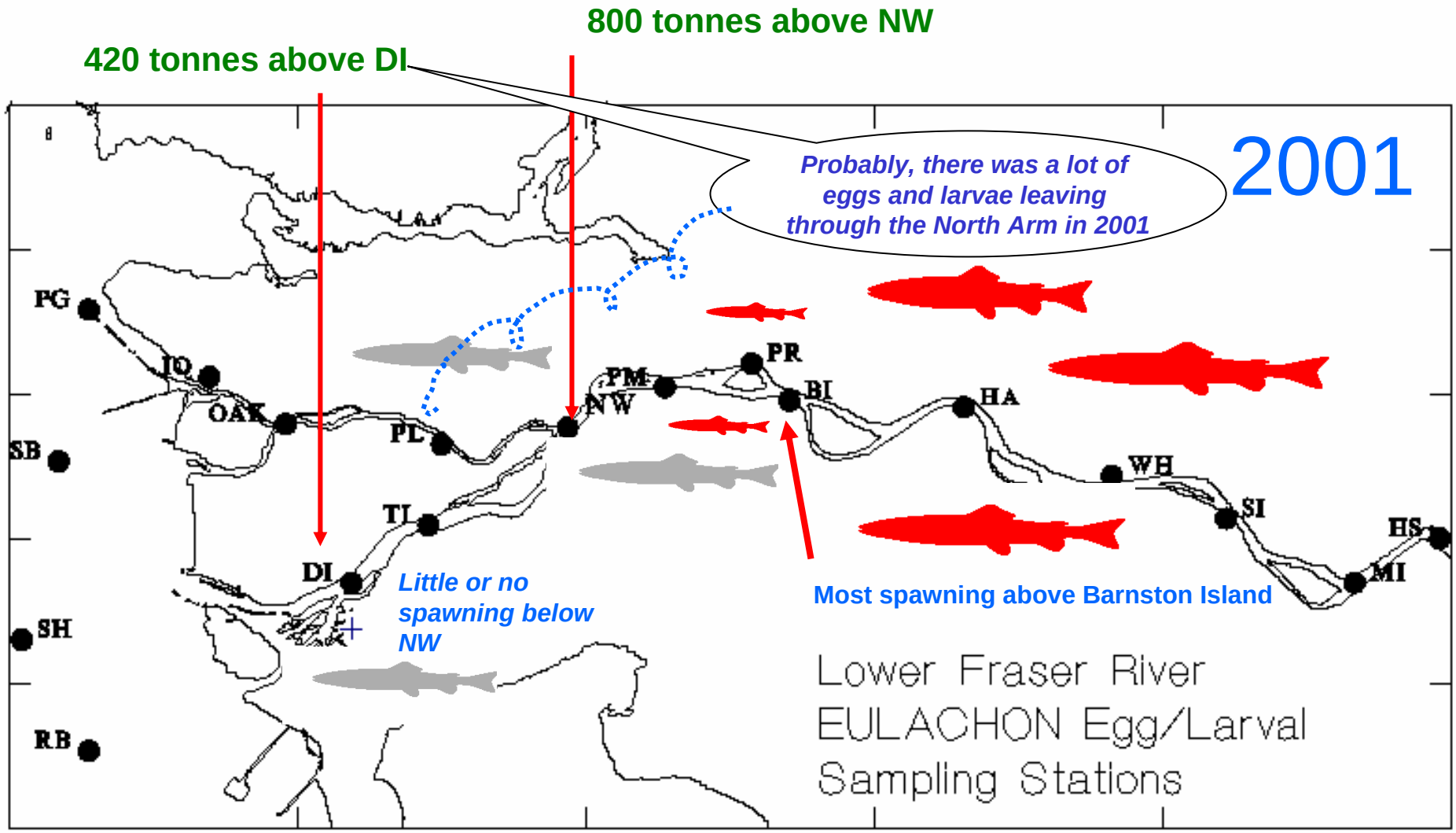
Fraser River assessments



Spawning eulachon

Migrating eulachon

Fraser River assessments



Spawning eulachon

Migrating eulachon

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- 12. Loose ends and synthesis?

combined

Spawning sites and substrates –in large rivers, spawning is at the river edge – allowing people to dipnet eulachons from the shore

- this is not possible in some smaller rivers

"Tumble incubation" – the suggestion is that eulachon eggs are NOT linked closely with specific spawning areas – and that the eggs may move during incubation – specifically they 'tumble' downstream

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11. Speculation/observations on the role of estuaries

Most estuaries are turbid – as a larval rearing site this turbidity may favor small larvae – that feed within a close range and require only limited visual range –

But it may be more difficult for larger predators, feeding on larvae, that require a larger visual range

i.e., size-related reduction of predation in estuaries?

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- <u>12. Loose ends and synthesis?</u>

12. <u>Loose ends and synthesis?</u>

Is spawning habitat really limiting?_Eulachons are mainly a marine species where they spend >95 % of their lives – Are marine factors the most important for eulachons and smelts in general?

12. Loose ends and synthesis

13. -semelparity – teeth, and calcium

Eulachons = semelparous

A toothy eulachon from the sea.

Spawning eulachons in rivers have no teeth.

No toothless eulachons are found in sea.

Therefore, they probably die after spawning.

12. <u>Loose ends and synthesis?</u>

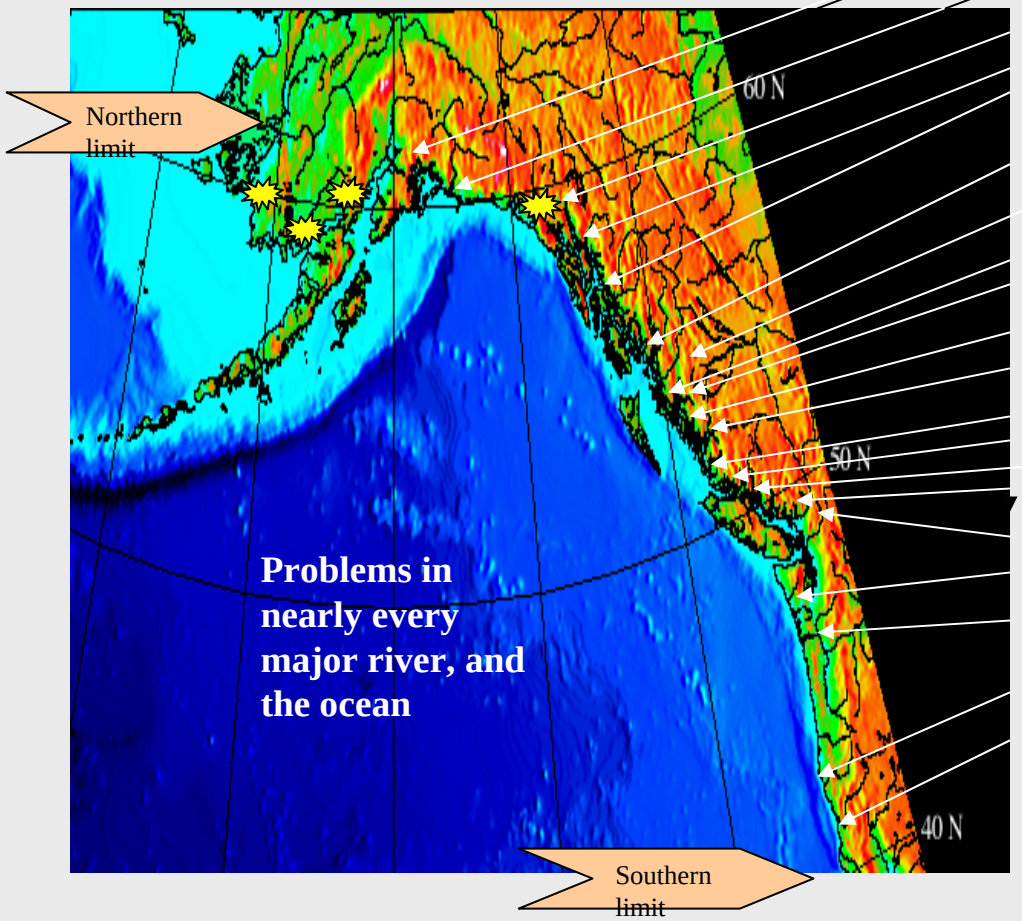
Eulachons are semelparous

12. Loose ends and synthesis?

Trends in coast-wide eulachon abundance (BC)

Eulachons in 2000

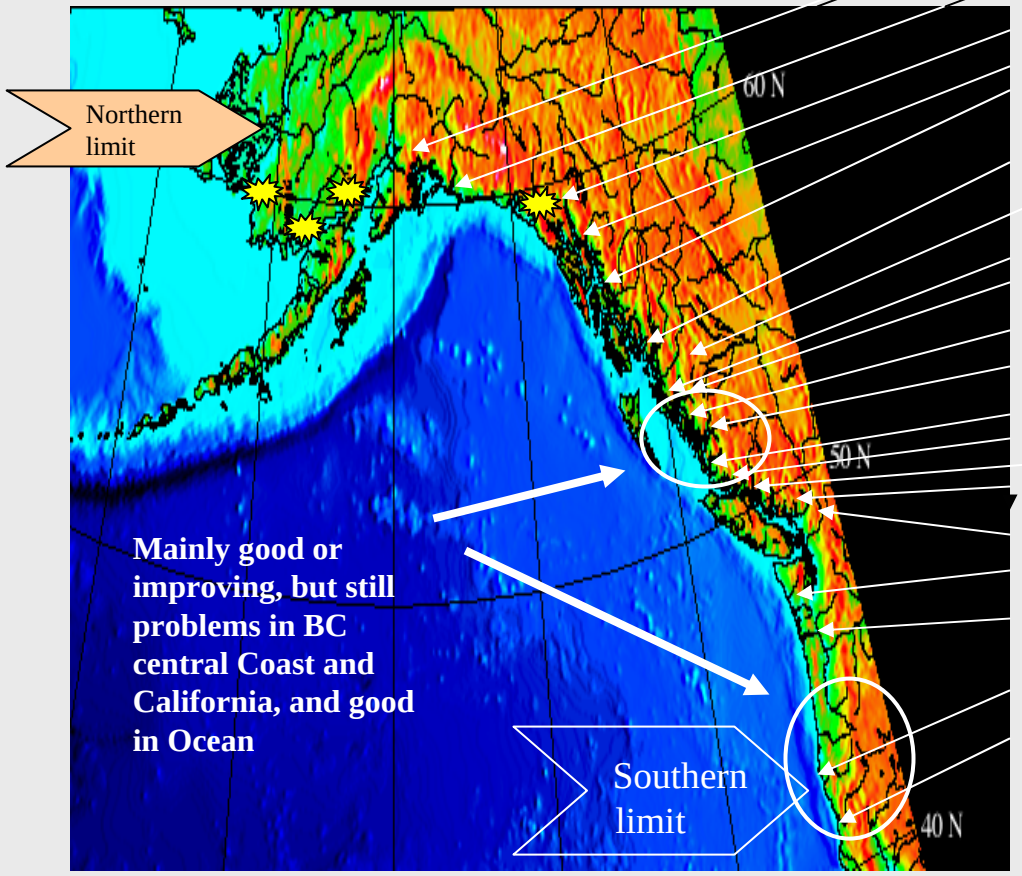
(Slide from PSARC status paper, 2000)



Twentymile River, Cooke Inlet - normal
Copper - no run in 1999, large in 1998
Alsek - unknown for 2000
Chilkoot Chilkat - unknown for 2000
***Stikine** - low, unprecedented in 20 years*
(Bradfield)
***Unuk** - run 'did not occur' in 2000*
Chickamin
***Nass** - catches in 2000 took 3x longer*
***Skeena** - little activity observed in 2000*
***Kitimat** - very low in 2000*
Kildala
***Kemano, Kitlope**, Kowesas - no/low run 2 yrs*
***Bella Coola** - no run for 2 yrs*
Kimsquit
***Owikeeno** - no run for 2 years*
***Kingcome** - poor/nil in 2000*
***Klinaklinni** - very low in 2000 ,*
Franklin
Homathco, Bute Inlet ?
***Fraser** - run in 2000 low but higher than previous yearsnear historical low*
Queet/Chehalis - not regular
***Columbia** - run in 2000 near historical low*
***Klamath** - down for 20+ years*
***Mad River**, California (most southern run) in decline for 20+ years*

Fig. 2. Distribution, southern and northern limits, and recent comments on river-specific status of eulachons in 1999 and 2000. Eulachon runs in all rivers under observation are indicated with bold font. Rivers with no apparent no runs in 2000 are underlined. Other runs were not observed in 2000.

Eulachons in 2002



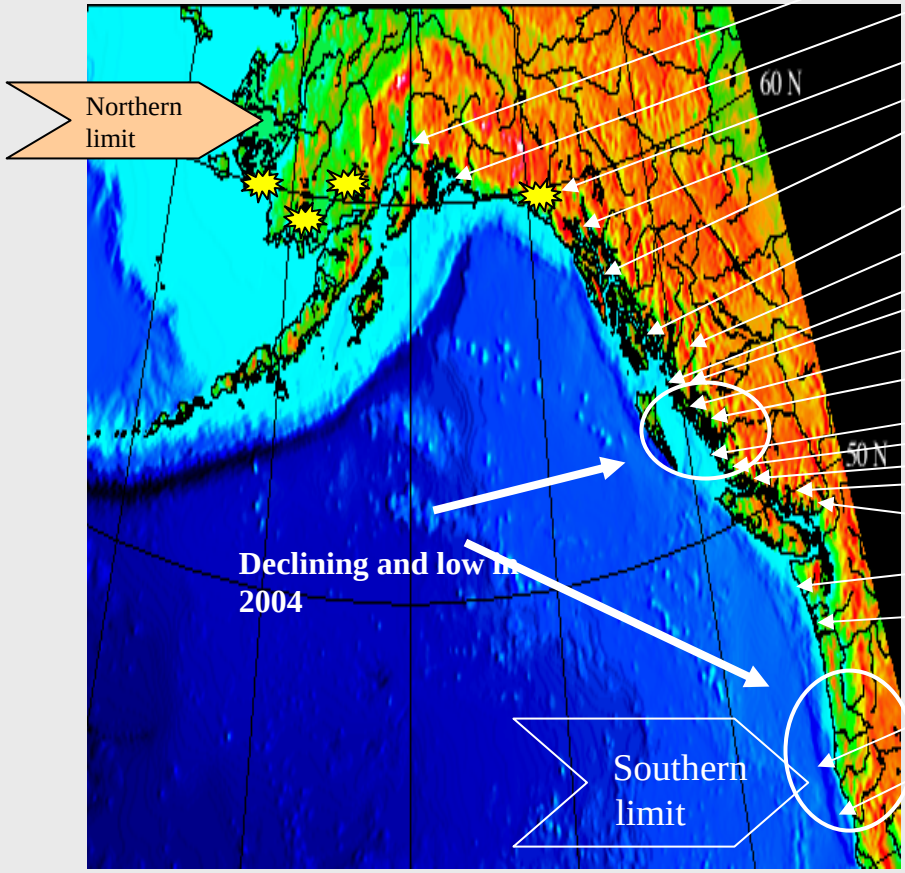
Twentymile River, Cooke Inlet - normal
Copper
Alsek
Chilkoot Chilkat
Stikine

Unuk
Chickamin
Nass
Skeena
Kitimat - very low in 2000
Kildala
Kemano, Kitlope, Kowesas
Bella Coola , Kimsquit-
Owikeeno -
Kingcome - ?
Klinaklinni, Franklin ,
?
Homathco, Bute Inlet ?
Fraser - run improved in 2001
Queet/Chehalis - not regular
Columbia - good in 2001, 2002

Klamath - down for 20+ years
Mad River, California (most southern run) in decline for 20+ years

Distribution, southern and northern limits, and recent comments on river-specific status of eulachons.

Eulachons in 2004



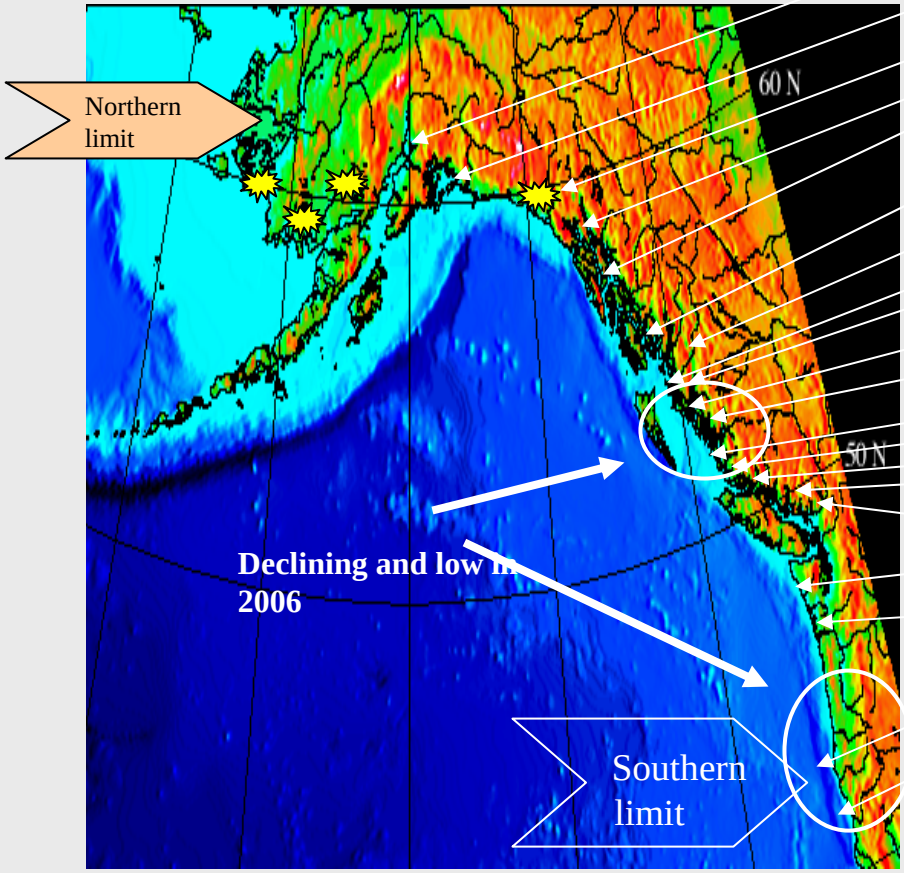
Twentymile River, Cooke Inlet - normal
Copper
Alsek
Chilkoot Chilkat
Stikine

Unuk
Chickamin
Nass
Skeena
Kitimat *- good in 2003…what aboou 2004??*
Kildala
Kemano, Kitlope, Kowesas
Bella Coola , run virtually gone
Owikeeno *– no run for 5years*
Kingcome *- ?*
Klinaklinni, Franklin ,
Homathco, Bute Inlet *?*
Fraser *- lowest ever*
Queet/Chehalis *- not regular*
Columbia *- poor in 2004*

Klamath *- down for 20+ years,*
Mad River*, California (most southern run) in decline for 20+* ***years but small return in 2004***

Distribution, southern and northern limits, and recent comments on river-specific status of eulachons.

Eulachons in 2006



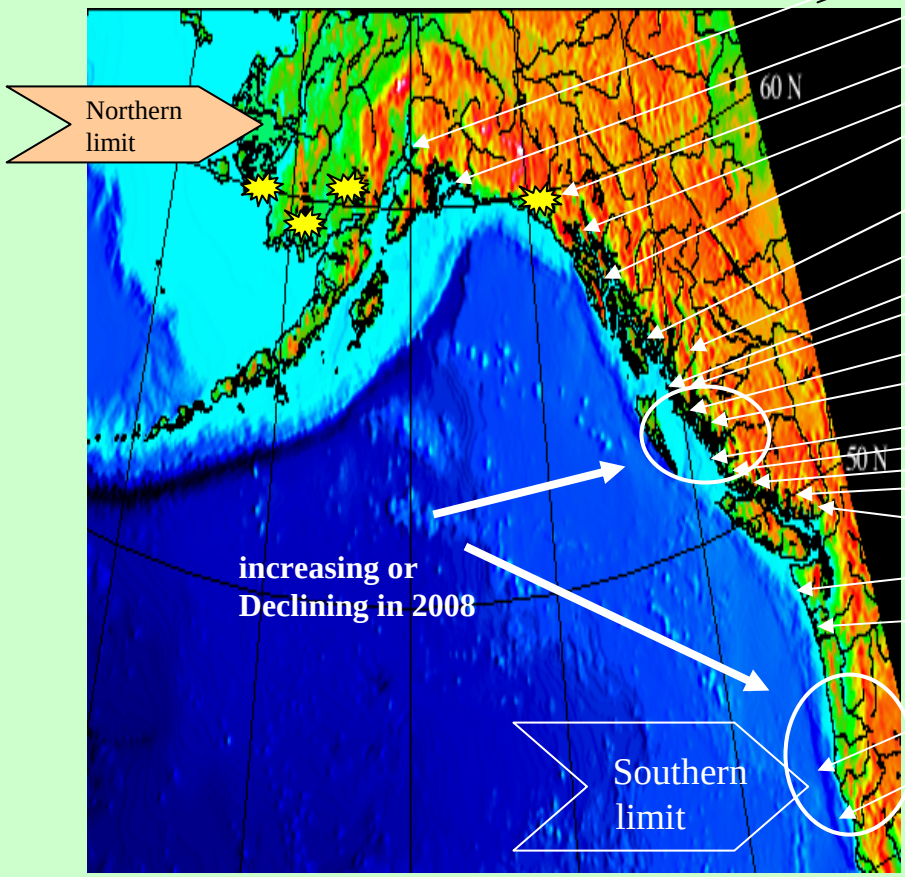
Twentymile River, Cooke Inlet - ?
Copper
Alsek
Chilkoot Chilkat
Stikine

Unuk
Chickamin
Nass
Skeena
Kitimat *- ?*
Kildala
Kemano, Kitlope, Kowesas
Bella Coola , run virtually gone
Owikeeno *– no run for 7 years*
Kingcome *- ?*
Klinaklinni, Franklin ,
Homathco, Bute Inlet *?*
Fraser *- lowest ever(2004) and lower in 2006*
Queet/Chehalis *- not regular*
Columbia *- poor in 2006*

Klamath *- down for 20+ years,*
Mad River ?

Distribution, southern and northern limits, and recent comments on river-specific status of eulachons.

Eulachons in 2008



Twentymile River, Cooke Inlet
Copper
Alsek
Chilkoot Chilkat
Stikine

Unuk
Chickamin
Nass
Skeena
Kitimat - ?
Kildala
Kemano, Kitlope, Kowesas
Bella Coola
Owikeeno –
Kingcome - ?
Kiinaklinni, Franklin
▼?***Homathco, Bute Inlet*** ?
Fraser -
Queet/Chehalis - *not regular*
Columbia -

Klamath -
Mad River ?

Distribution, southern and northern limits, and recent comments on river-specific status of eulachons.

This may be the explanation - or part of the explanation - for the simultaneous reduction in spawning eulachons in different watersheds: increase predation by hake - followed by a decrease in hake after 2000

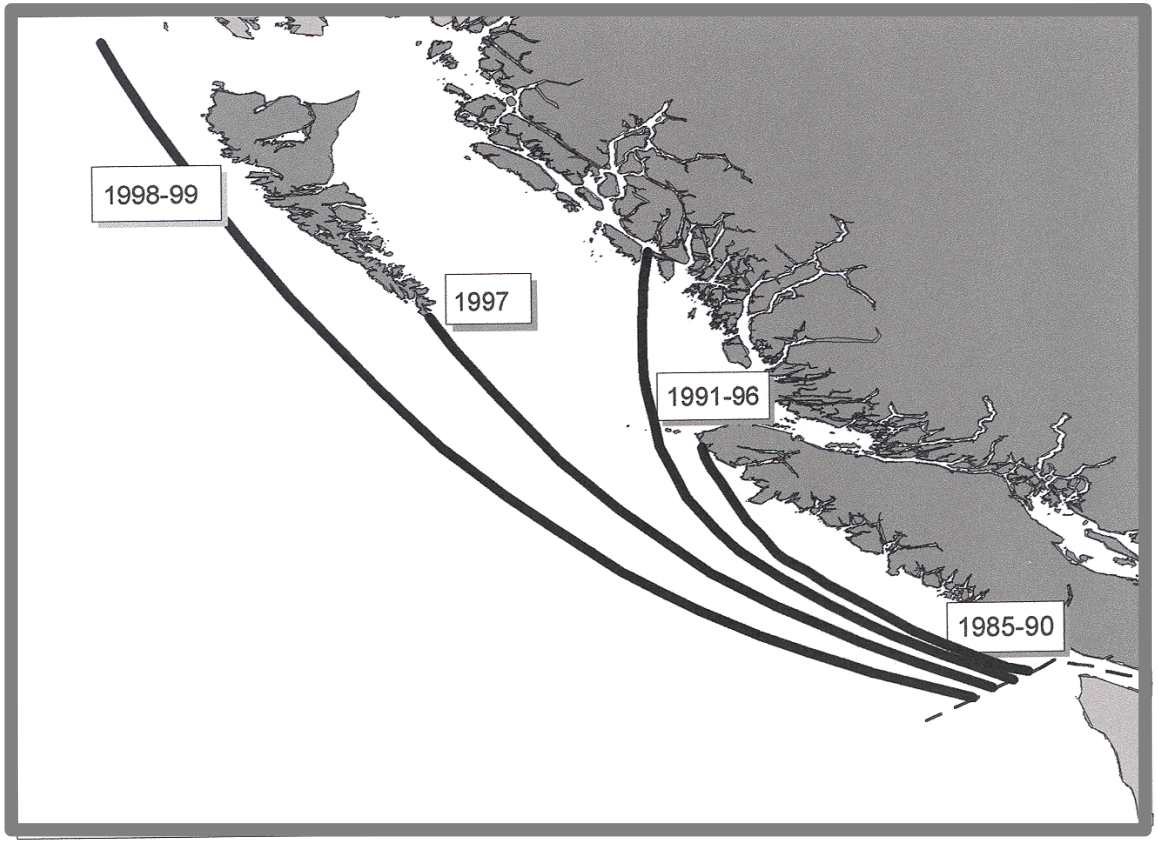
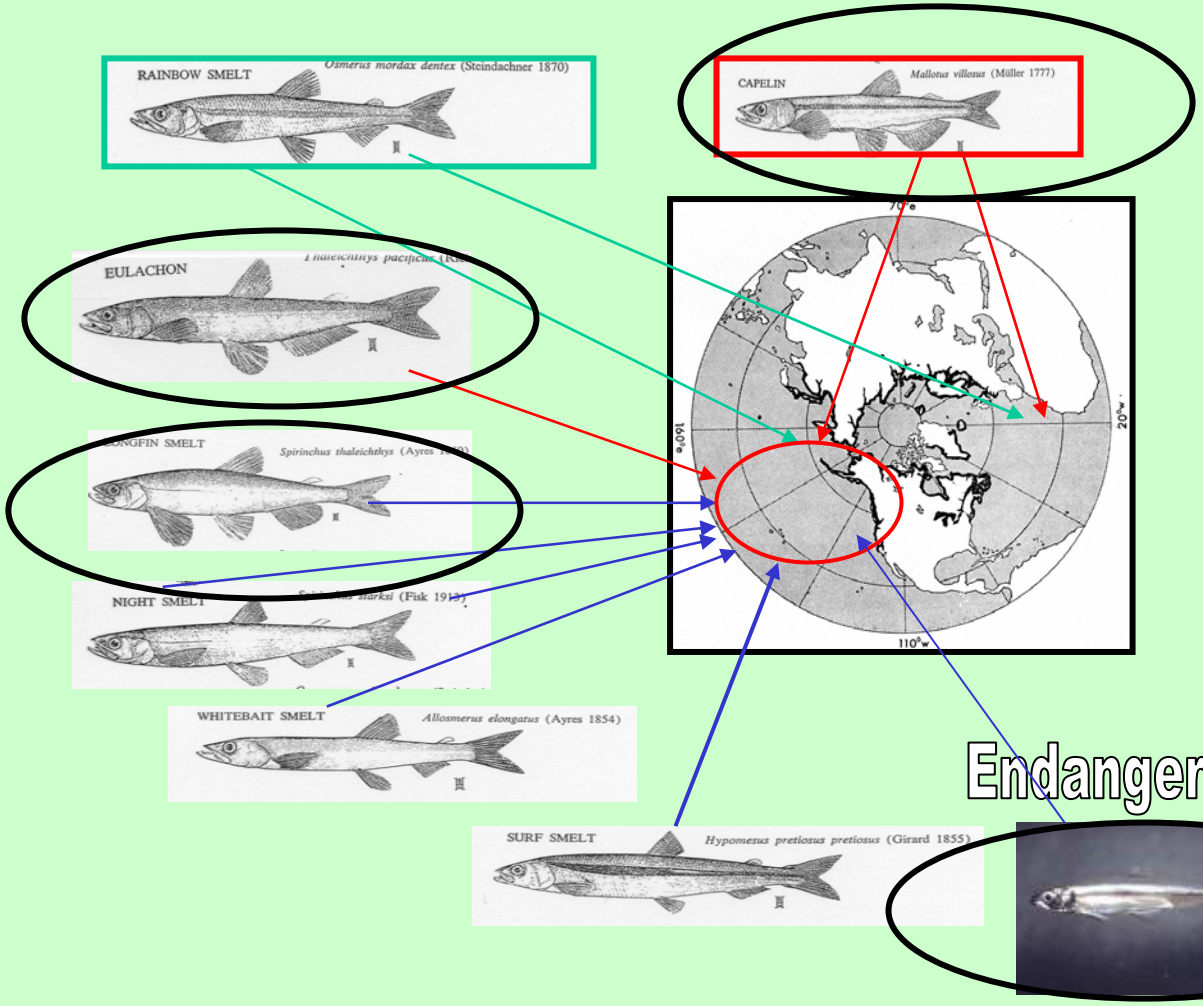


Fig. 23 Changes in the distribution of Pacific hake from 1989-99 off the west coast of Canada (from McFarlane et al. 2000). The lines indicate the northward shift of hake from the mid-1980's to1999.

12. <u>Loose ends and synthesis?</u>

Endangered species within the osmerids

Smelts - Osmeridae
In the World: 6 genera, 10 species - most occur in the Pacific



The delta smelt in California is already on the Redlist

Endangered

Delta smelt *Hypomesus transpacificus*

Smelts – Osmeridae In the World: 6 genera, 10 species - most occur in the Pacific

1. ***Mallotus villosus***	**- capelin**	**- Atlantic and Pacific (East and West Pacific)**
2. ***Thaleichthys pacificus***	**- eulachon**	**- Pacific (East Pacific)**
3. ***Sprinchus thaleichthys***	**- longfin smelt**	**- Pacific (East Pacific)**
4 ***Hypomesus pretiosus***	**- surf smelt**	**- Pacific (East Pacific)**
5 *Spririnchus starksi*	- **night smelt**	- California to SE Alaska
6. *Allosmerus elongatus*	- **whitebait**	- San Francisco to Juan de Fuca
7 ***Hypomesus transpacificus***	**- delta smelt**	**- Sacramento River/estuary, California**
8. *Hypomesus nipponensis* -	**- wagasaki**	- Japan + and introduced to USA
9. *Hypomesus olidus* -	- **pond smelt**	- Arctic: McKenzie, Alaska, N. Asia
10. *Osmerus mordax* dentex* -	- **rainbow smelt**	- Alaska

Examples

1. **EX** – ***EXTINCTION*** – or probable extinction

   – fall-spawning capelin (*Mallotus villosus*) in the Strait of Georgia

2. **EN** - probably ***ENDANGERED*** – many collapsed populations and severe range contraction

   – the anadromous eulachon (*Thaleichthys pacificus*) in all areas
   south of Alaska to the southern edge of distribution, in northern California

3. **VU** - probably ***VULNERABLE*** - risk of loss of unique lake-spawning neotonous 'pygmy' populations

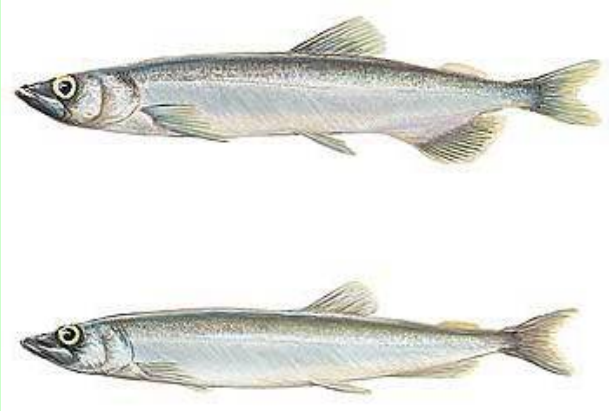
   - the lake resident form of the anadromous longfin smelt (*Spirinchus thaleichthys*)

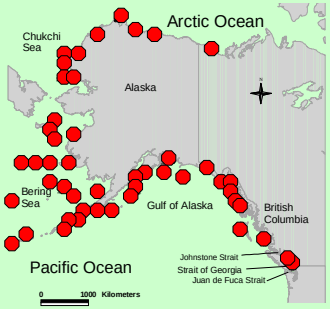
4. **NT** - probably ***NEAR-THRERATENED*** – potential loss of populations in the Strait of Georgia

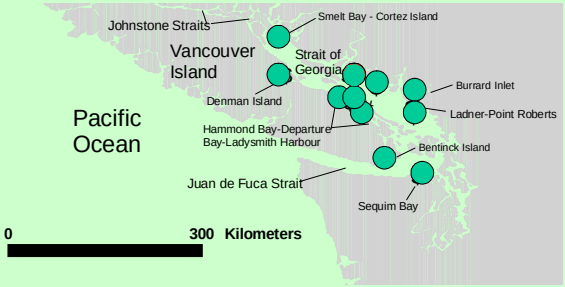
   - surf smelt (*Hypomesus pretiosus*) in the Strait of Georgia

Capelin – *Mallotus villosus*

Fall-spawning capelin (*Mallotus villosus*) disappeared in the 1970's,







Distribution of <u>fall spawning</u> capelin in the Strait of Georgia and Juan de Fuca

Historical Strait of Georgia spawning

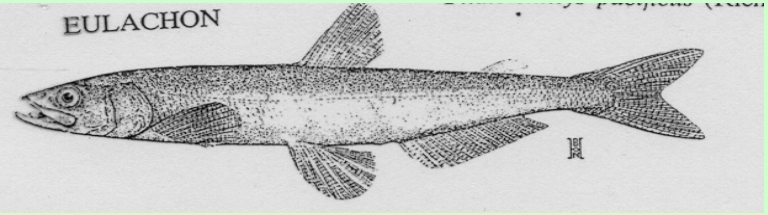
	Locations	**Source**
1.	**Smelt bay, Cortez Island**	**E. Barraclough (1972)**
2.	**Blunden Point, Lantzville,**	**E. Barraclough (1972)**
3.	**Hammond Bay**	**UBC Museum samples, W. Ricker, D. Quale**
4.	**Departure Bay**	**H art and McHugh (1944), UBC Museum samples, W. Ricker, D. Quale**
5.	**Ladysmith Harbour**	**E. Barraclough (1972)**
6.	**North shore of Burrard Inlet**	**H art and McHugh (1944)**
7.	**Denman Island**	**M. Morrell (pers. comm.)**
8.	**Ladner, BC**	**J. Bauer (pers. comm.)**
9.	**Sequim Washington (Southern range Record).**	**Gardner (1981)**

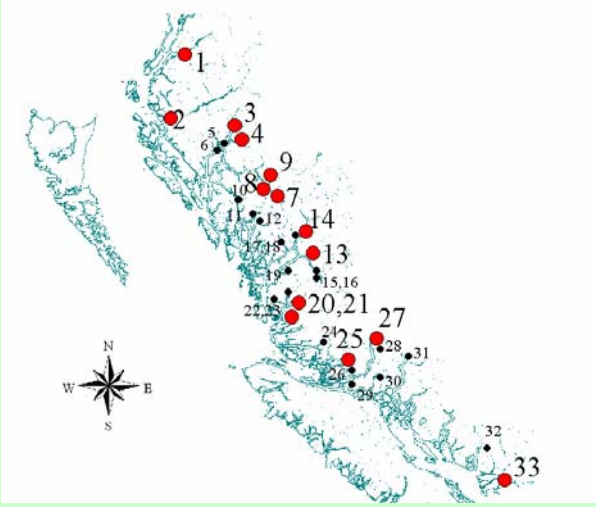
Eulachon – *Thaleichthys pacificus*

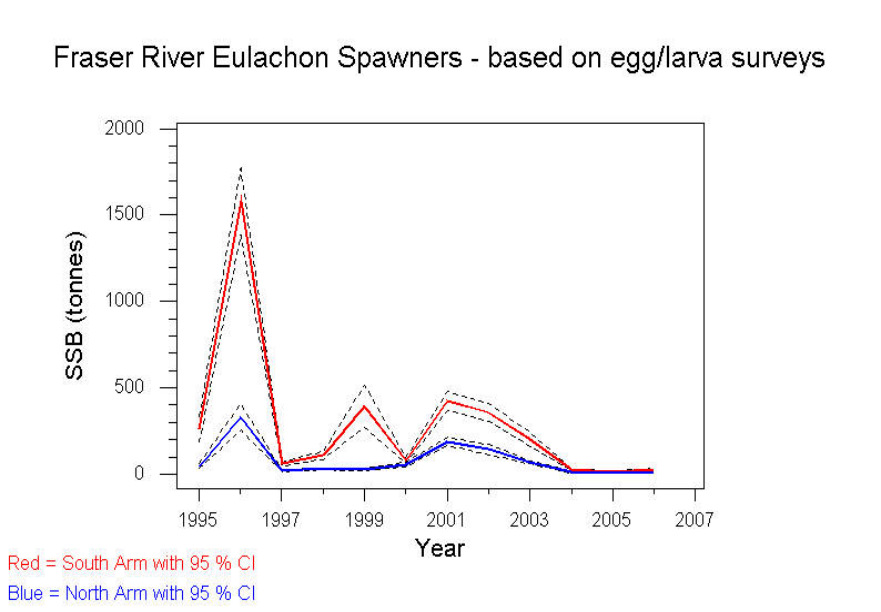
Found only on western coast of North America, northern California to Alaska

In BC (and elsewhere) they seem to spawn in only a relatively few rivers (15-20). In the world, maybe <<100 different runs?

Columbia River - probably largest, followed by Fraser







<u>North + South Arm</u>

2006: 29 tonnes
2005: 16 tonnes
2004: 33 tonnes
2003: 266 tonnes
2002: 494 tonnes
2001: 608 tonnes

Surf smelt - *Hypomesus pretiosus*

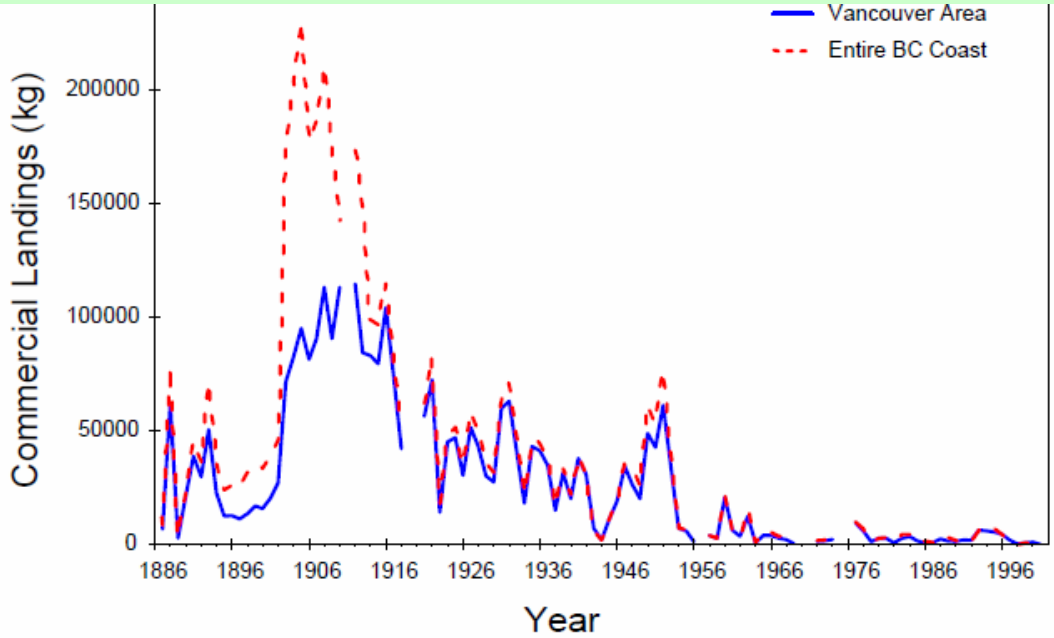


Figure 2: Reported surf smelt catches for Statistical Areas 28 and 29 (Vancouver Area) and for the entire British Columbia coast between 1886 and 2000.

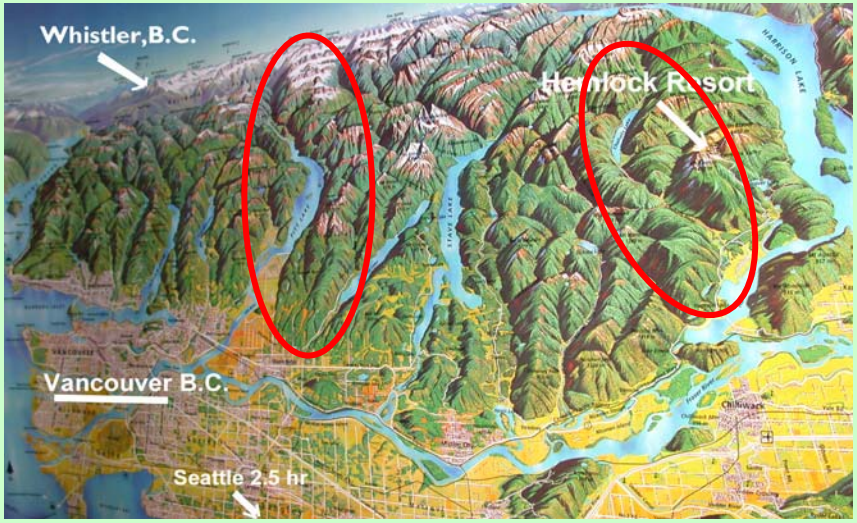
http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2002/RES2002_115e.pdf

Longfin smelt – *Spirinchus thaleichthys*

Scientific name: *Spirinchus thaleichthys* (Ayers, 1860)
Common name: longfin smelt
Family: Osmeridae
Taxonomic comments:
Previously regarded as two separate species: *S. dilatus* (longfin smelt) and *S. thaleichthys* (Sacramento smelt). The two forms have been synonymized (Lee et al. 1980). Populations from Washington and the Sacramento-San Joaquin Delta are similar genetically but differ significantly in gene frequencies; Stanley et al. (1995)

Nonanadromous populations in Harrison and Pit lakes, British Columbia, have been recognized as an undescribed species (*Spirinchus* sp. 1) by some authors.

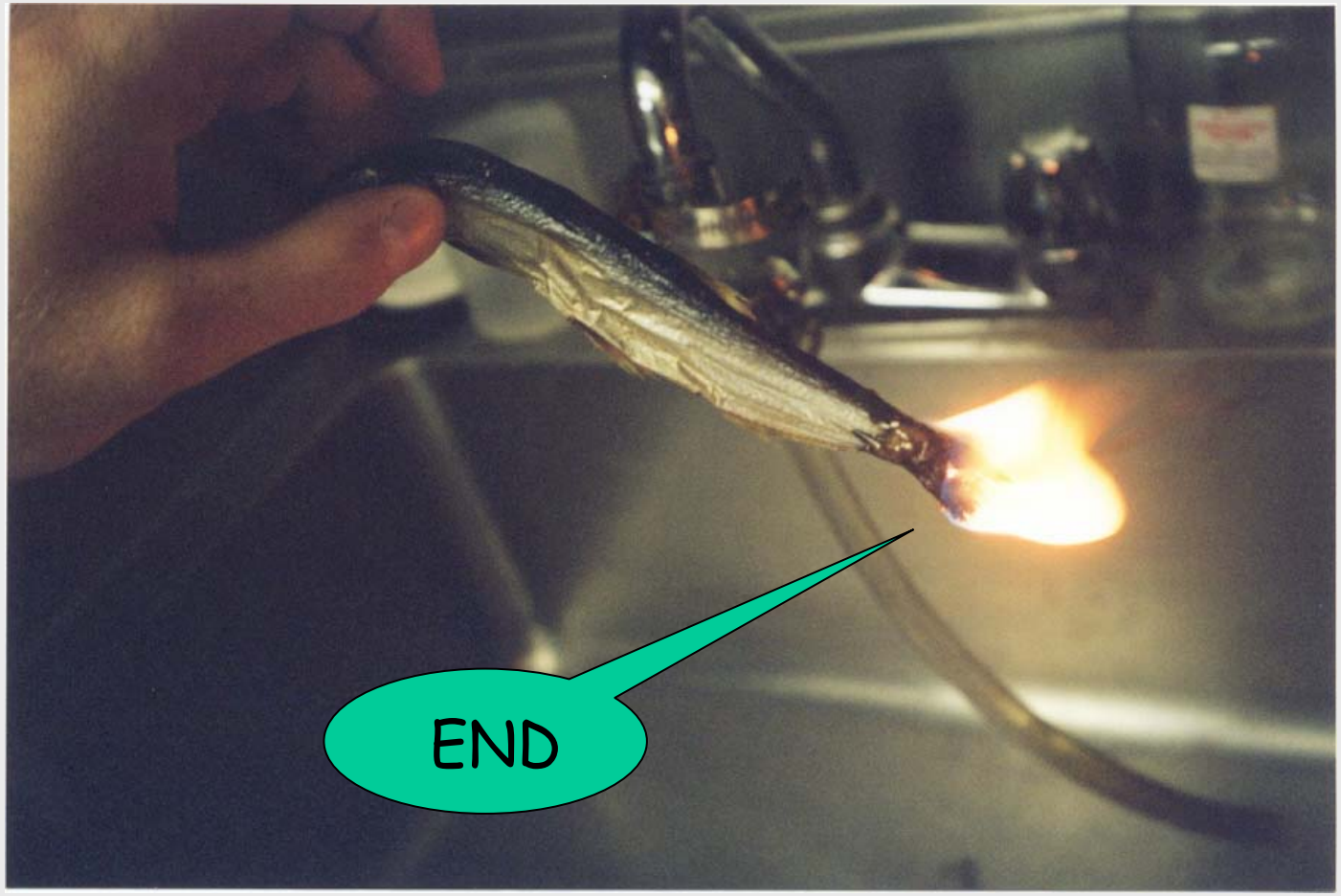
http://aknhp.uaa.alaska.edu/zoology/species_ADFG/ADFG_PDFs/Fishes/Longfin_smelt_final_ADFG_2006.pdf



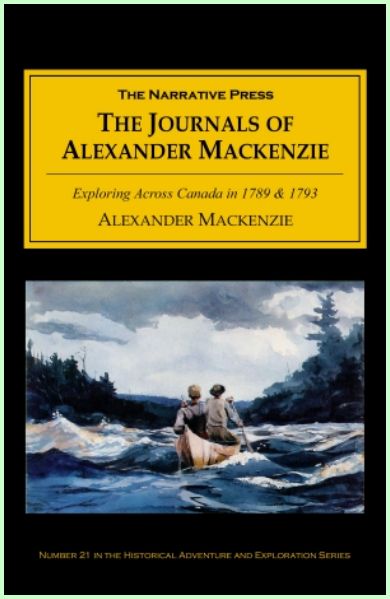
They also occur in Lake Washington…but that it the extent of the world distribution.

End

End….they really are 'candlefish'



Alexander Mackenzie



Alexander Mackenzie (1763-1820),
- explorer and fur trader, was the first European to cross continental North America,
- twelve years before Lewis and Clark.
- Mackenzie's *journal of his explorations appeared in* ***1801.***

He travelled mostly by canoe, determining longitude by he eclipses of the planet Jupiter's satellites.

He made two trips:
-one to the Arctic Ocean in 1789,
-another to Pacific Ocean in 1793 (twelve years before Thomas Jefferson sent Lewis and Clark west).

-ON THE PACIFIC TRIP HE USED **GREASE TRAILS** TO REACH THE PACIFIC FROM THE INTERIOR

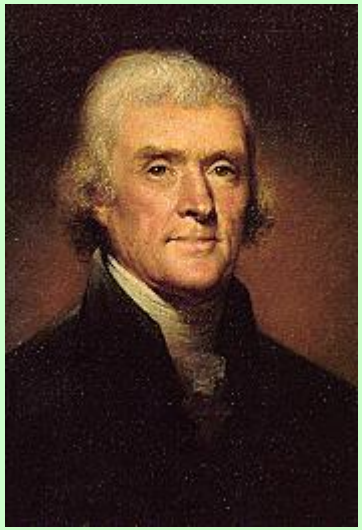
Few people in Canada realize that Mackenzie was an unwitting ‘accomplice’ in **Napoleon’s** planned re-conquest of Canada.

Napoleon had Mackenzie’s book smuggled from England and translated into French.

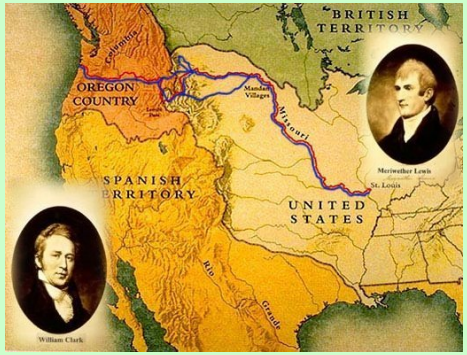
Mackenzie’s description of the Western Canada river system was so precise that Napoleon had set up a scheme during the War of 1812 to use Mackenzie’s book to invade Canada.

Canada would be conquered by a surprise attack from New Orleans, up the Mississippi River.

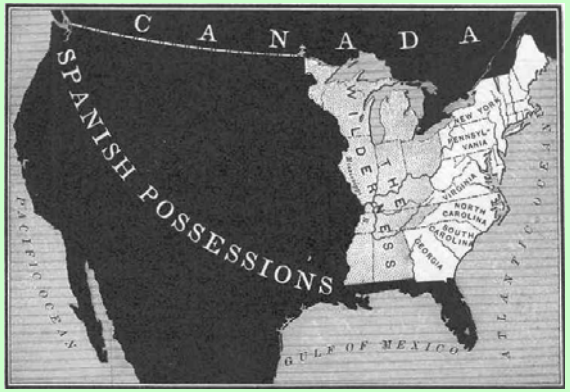
Fortunately for Canada, Napoleon ended up invading Moscow rather than Ottawa.



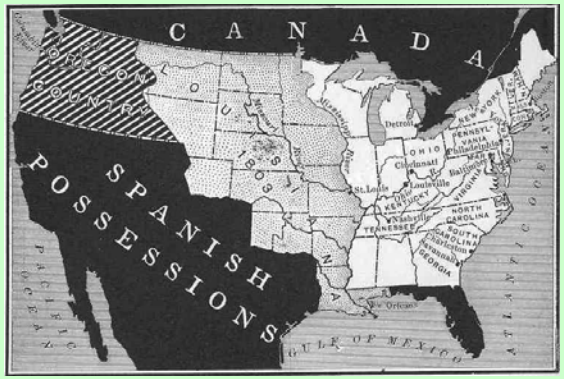
Thomas Jefferson (13 April 1743 N.S.-4 July 1826) was the third President of the United States (1801-09), the principal author of the Declaration of Independence (1776), and one of the most influential Founding Fathers in the United States. Major events during his presidency include the Louisiana Purchase (1803), the Lewis and Clark Expedition (1804–1806) and the failed Embargo Act of 1807.



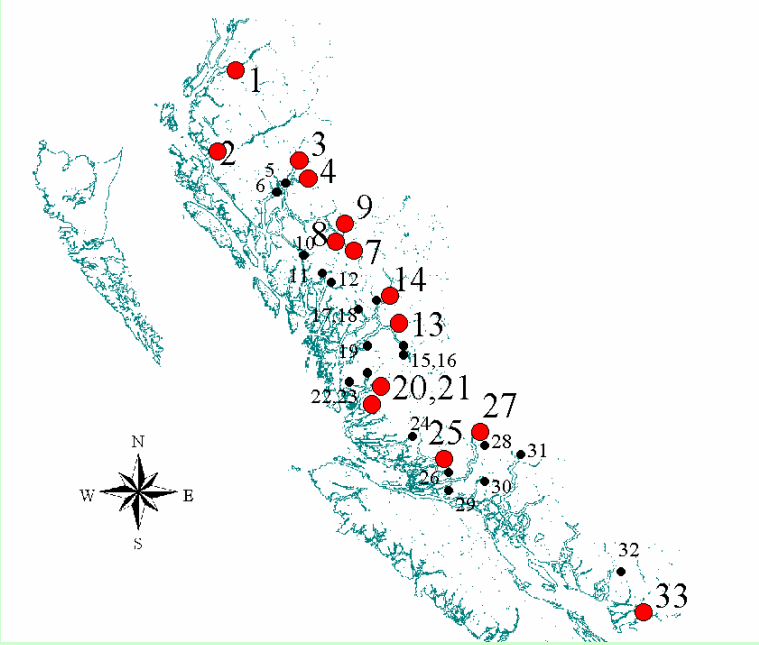
Before 1803



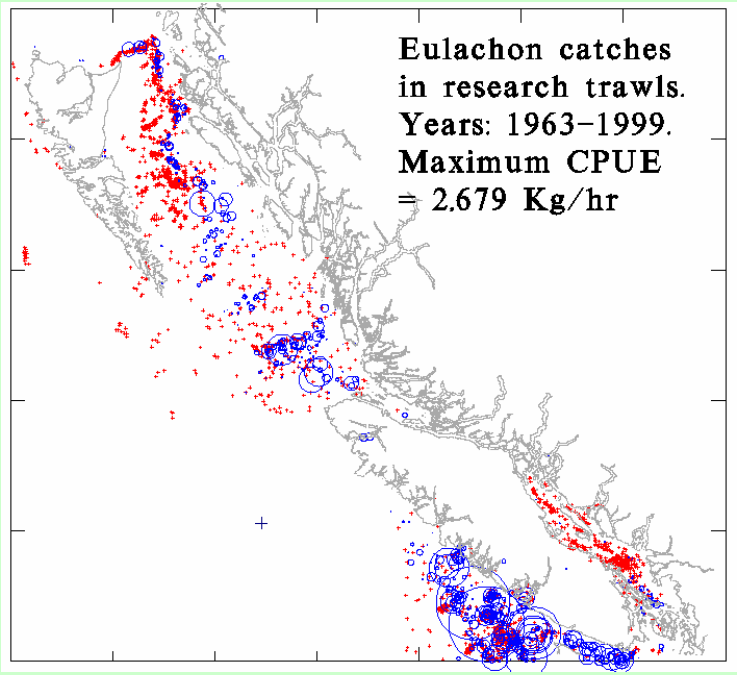
After 1803



Spawning sites/rivers



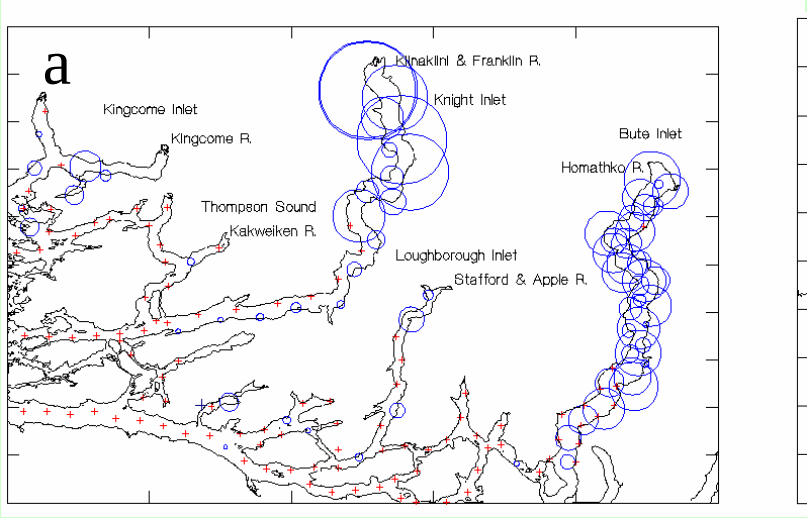
Offshore areas (blue)

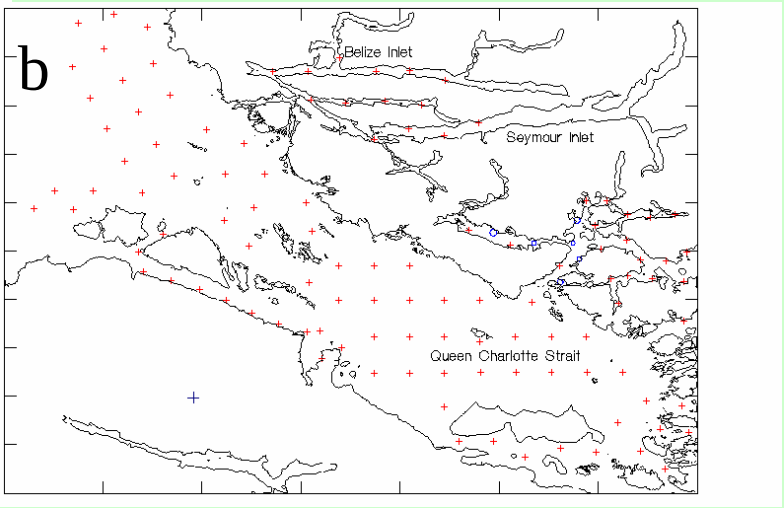


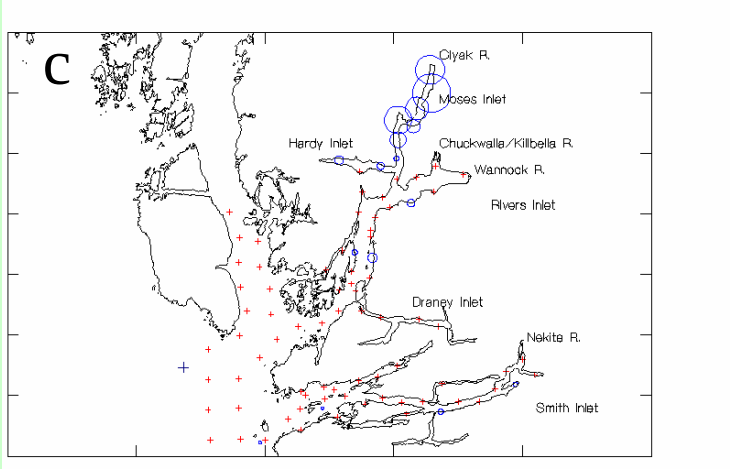
~2-3 % of life in rivers

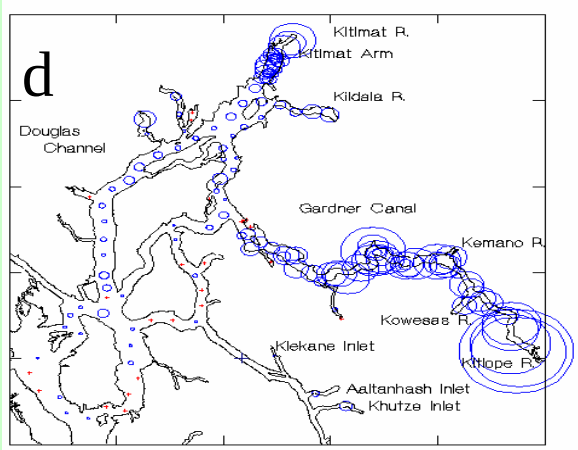
~97-98% of life in sea

Blue circles are eulachon larvae

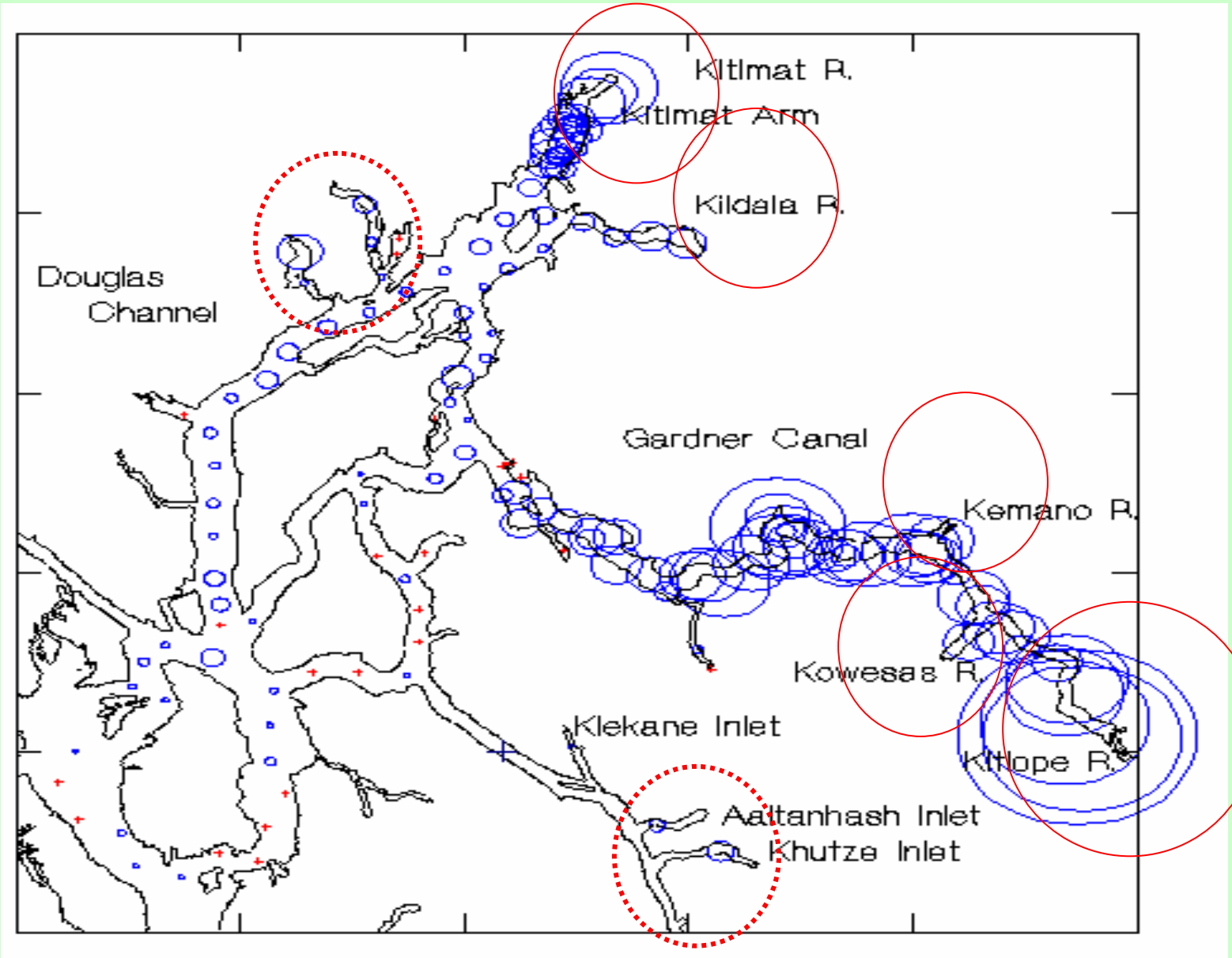


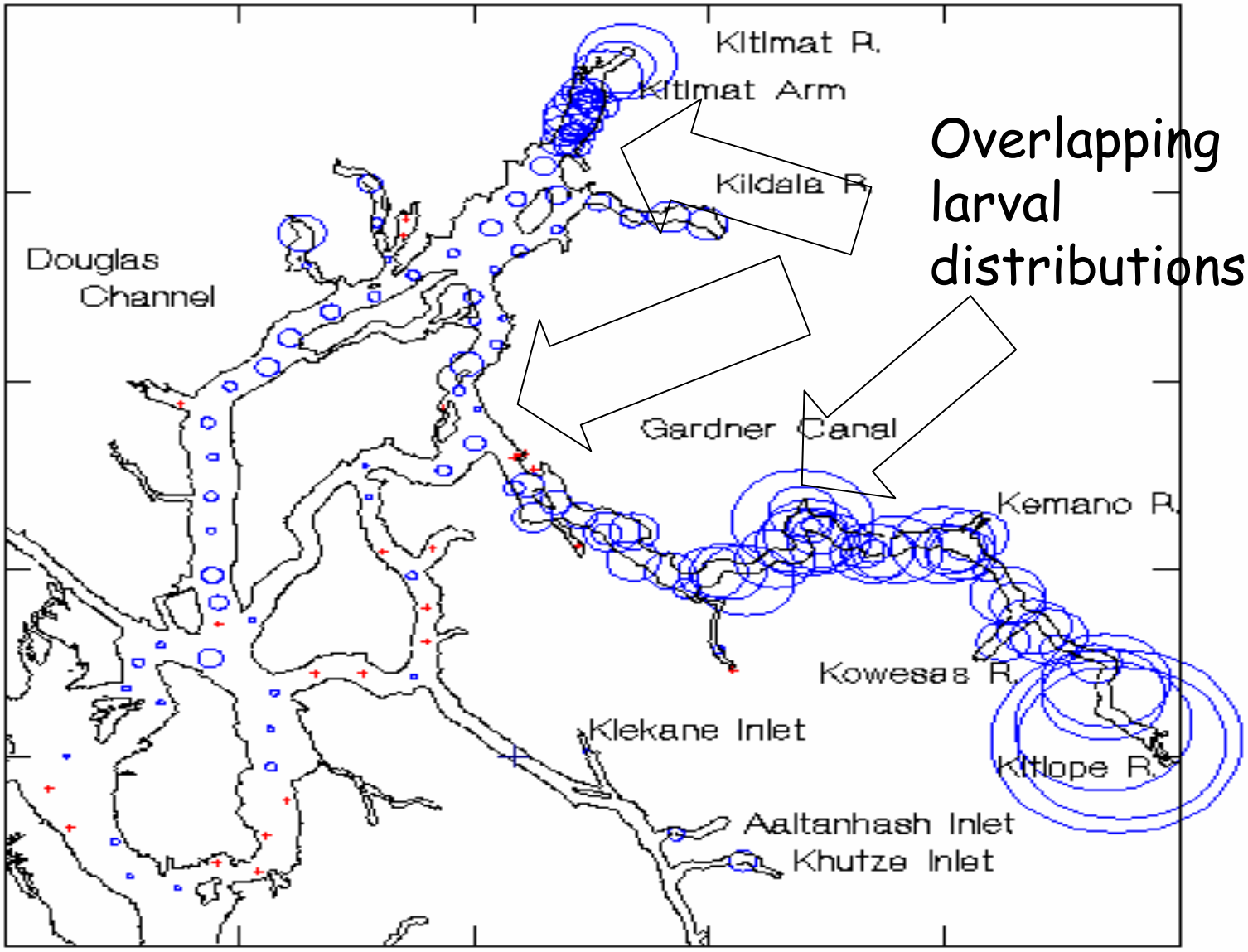






Larval eulachon density map of (a) Johnstone Strait Region (JS) during April 25 – May 5, 1994 (Maximum density = 21.3 larvae/m3). (b) Queen Charlotte Strait Region (QS) during April 25 – May 5, 1994 (Maximum density = 0.1 larvae/m3). (c) Rivers Inlet Region (RI) during April 25 – May 5, 1994 . Maximum density = 4.0 larvae/m3). (d) Douglas Channel Region (DC) during May 27 – June 7, 1996 (Maximum density = 32.2 larvae/m3). In all figures, a red cross indicates a station where no eulachon larvae were captured.


Kitimat R.
Kitimat Arm
Kildala R.
Douglas
Channel
Gardner Canal
Kemano R.
Kowesas R.
Klekane Inlet
Kitlope R.
Aaltanhash Inlet
Khutze Inlet



Overlapping larval distributions

Molecular Ecology (1999) 8, S143–S158

Marine population structure in an anadromous fish: life-history influences patterns of mitochondrial DNA variation in the eulachon, *Thaleichthys pacificus*

JENNIFER E. McLEAN,* D. E. HAY† and ERIC B. TAYLOR*‡
*School of Fisheries, University of Washington, Seattle, WA 98155, USA, †Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, BC V9R 5K6, Canada, ‡Department of Zoology, University of British Columbia, Vancouver, BC V6T 1Z4, Canada

Population Structure and Stock Identification of Eulachon (*Thaleichthys pacificus*), an Anadromous Smelt, in the Pacific Northwest

Terry D. Beacham, Douglas E. Hay, Khai D. Le

Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, B.C., Canada V9T 6N7

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Stock identification of eulachon (*Thaleichthys pacificus*), an anadromous smelt in the eastern Pacific

Douglas E. Hay and Terry D. Beacham
Department of Fisheries and Oceans
Pacific Biological Station
Nanaimo, B. C.
Canada V9T 6N7
E-mail: hayd@pac.dfo-mpo.gc.ca; hayd@mail1.pknu.ac.kr

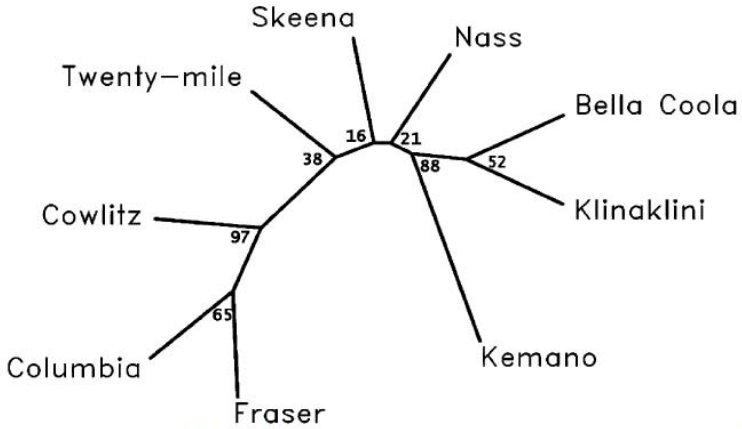


Fig. 2. Unrooted neighbor-joining tree of Cavalli-Sforza and Edwards (1967) chord distance for 9 populations of eulachons surveyed at 14 microsatellite loci. Bootstrap values at the tree nodes indicate the percentage of 500 trees where populations beyond the node clustered together.

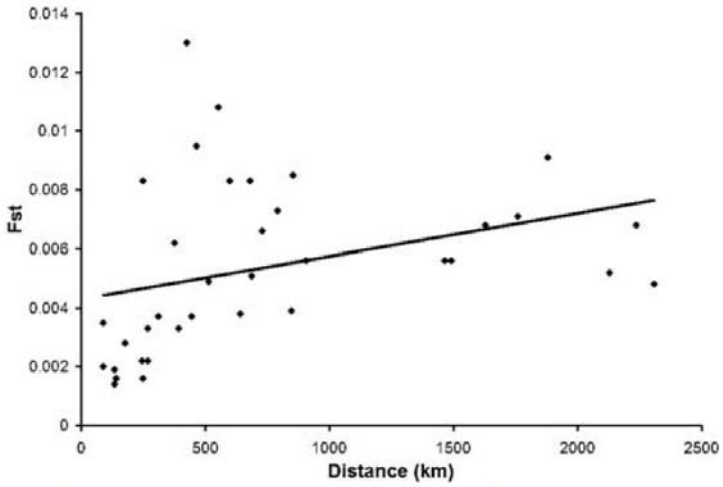
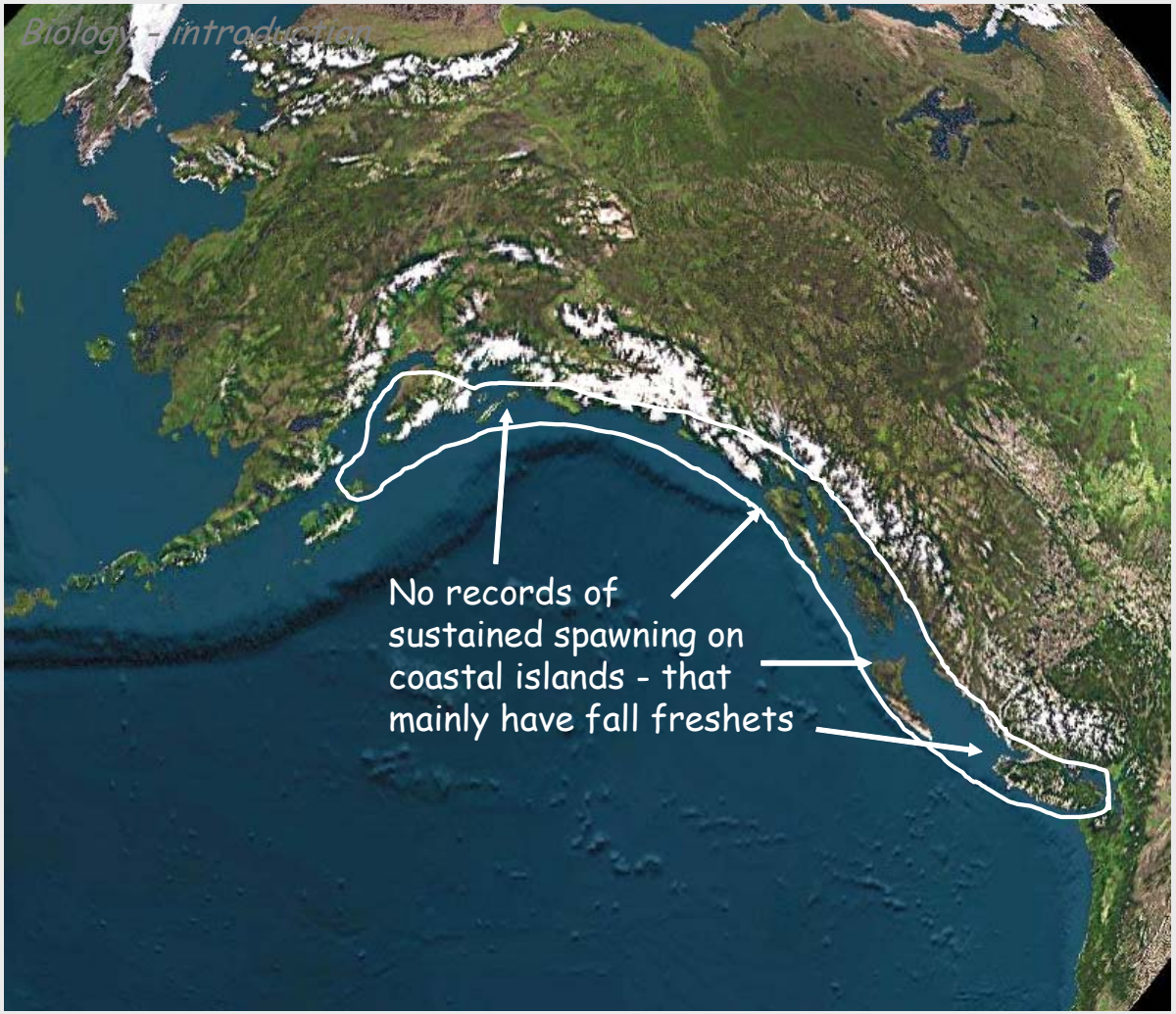


Fig. 3. Pairwise F_{ST} versus geographic distance for 9 populations of eulachons in the Pacific northwest.

There are no records of consistent spawning in rivers that drain coastal islands (like Vancouver Island, or Queen Charlotte Island or Kodiak Island - all of which have 'fall freshets'. Eulachons spawn in rivers with 'spring freshets' that drain snowpacks