Climate change: important impacts on unimportant species?

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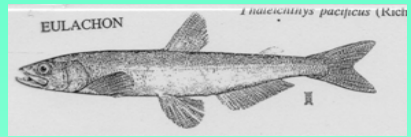
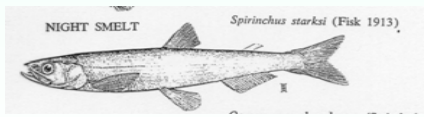


Mainly this presentation will be about ‘smelts’ (Osmeridae), which are small ‘forage’ species in the eastern North Pacific…



Climate change: important impacts on unimportant species?

Most of the biotic changes in osmerids are NOT caused by commercial fisheries.

Habitat degradation can explain the decline for a few populations - but not all.

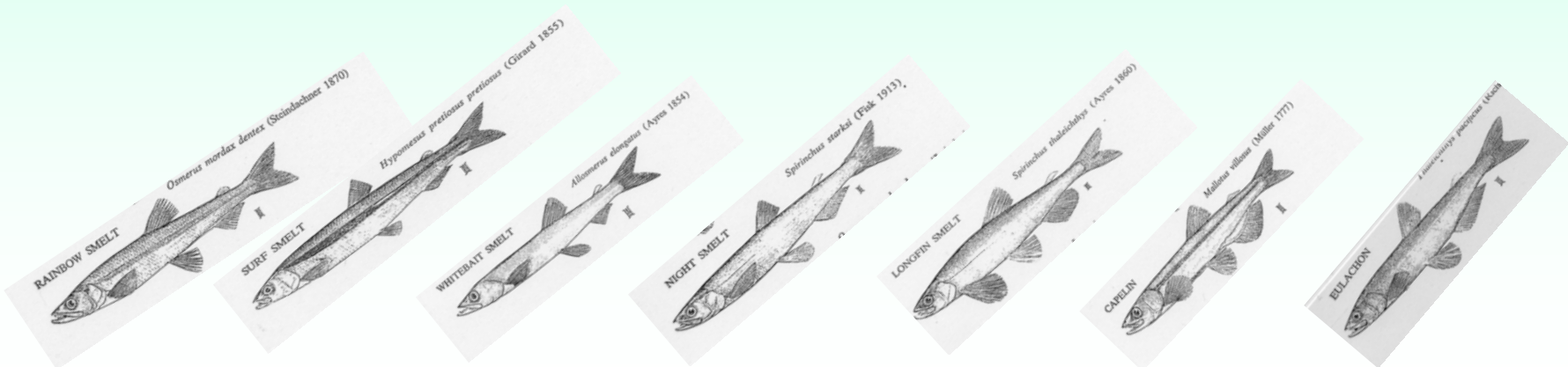
So, if the changes cannot be explained by excess fishing, or by habitat change…

…..the assumption is that the observed changes in osmerids (and other) species occur mainly as a direct or indirect result of climate change

Climate change: important impacts on unimportant species?

- unimportant species: little or no commercial value

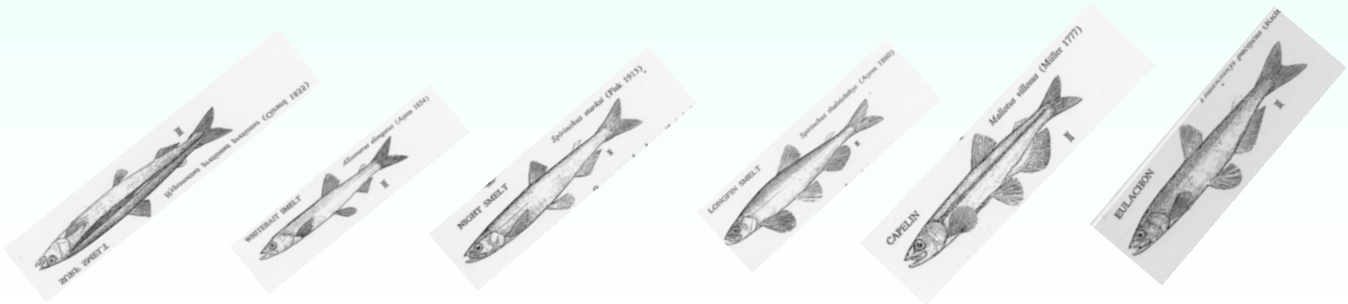
(and not fished hard commercially)



Climate change: important impacts on unimportant species?

- unimportant species: little or no commercial value

- they are not ‘unimportant’ in an ecological sense



Climate change: important impacts on unimportant species?

By ‘impacts’ I mean a decrease in abundance or reduction of range that warrants consideration for classification by the ICUN* Redlist

*International Union for Conservation of Nature and Natural Resources

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

The Categories and their application

EXTINCT (EX)
no reasonable doubt that the last individual has died.

EXTINCT IN THE WILD (EW)
known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.

CRITICALLY ENDANGERED (CR)
best evidence indicates extremely high risk of extinction in the wild.

ENDANGERED (EN)
best evidence indicates very high risk of extinction in the wild.

VULNERABLE (VU)
best evidence indicates high risk of extinction in the wild.

NEAR THREATENED (NT)
does not qualify for Critically Endangered, Endangered or Vulnerable now, but close or likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC)
does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD)
inadequate information to make a direct, or indirect, assessment of its risk of extinction

NOT EVALUATED (NE)
A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

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..so, if a species or populations such a listing, it has been 'impacted'

	Number of described species	Number of species evaluated in 2006	Number of threatened species in 1996/98	Number of threatened species in 2000	Number of threatened species in 2002	Number of threatened species in 2003	Number of threatened species in 2004	Number of threatened species in 2006	Number threatened in 2006, as % of species described	Number threatened in 2006, as % of species evaluated**
Vertebrates										
Mammals	5,416	4,856	1,096	1,130	1,137	1,130	1,101	1,093	20%	23%
Birds	9,934	9,934	1,107	1,183	1,192	1,194	1,213	1,206	12%	12%
Reptiles	8,240	664	253	296	293	293	304	341	4%	51%
Amphibians*	5,918	5,918	124	146	157	157	1,770	1,811	31%	31%
Fishes	29,300	2,914	734	752	742	750	800	1,173	4%	40%
Subtotal	**58,808**	**24,284**	**3,314**	**3,507**	**3,521**	**3,524**	**5,188**	**5,624**	**10%**	**23%**
Invertebrates										
Insects	950,000	1,192	537	555	557	553	559	623	0.07%	52%
Molluscs	70,000	2,163	920	938	939	967	974	975	1.39%	45%
Crustaceans	40,000	537	407	408	409	409	429	459	1.15%	85%
Others	130,200	86	27	27	27	30	30	44	0.03%	51%
Subtotal	**1,190,200**	**3,978**	**1,891**	**1,928**	**1,932**	**1,959**	**1,992**	**2,101**	**0.18%**	**53%**
Plants										
Mosses***	15,000	93	---	80	80	80	80	80	0.53%	86%
Ferns and allies***	13,025	212	---	---	---	111	140	139	1%	66%
Gymnosperms	980	908	142	141	142	304	305	306	31%	34%
Dicotyledons	199,350	9,538	4,929	5,099	5,202	5,768	7,025	7,086	4%	74%
Monocotyledons	59,300	1,150	257	291	290	511	771	779	1%	68%
Subtotal	**287,655**	**11,901**	**5,328**	**5,611**	**5,714**	**6,774**	**8,321**	**8,390**	**3%**	**70%**
Others										
Lichens	10,000	2	---	---	---	2	2	2	0.02%	100%
Mushrooms	16,000	1	---	---	---	---	---	1	0.01%	100%
Subtotal	**26,000**	**3**	---	---	---	**2**	**2**	**3**	**0.01%**	**100%**
TOTAL	**1,562,663**	**40,168**	**10,533**	**11,046**	**11,167**	**12,259**	**15,503**	**16,118**	**1%**	**40%**

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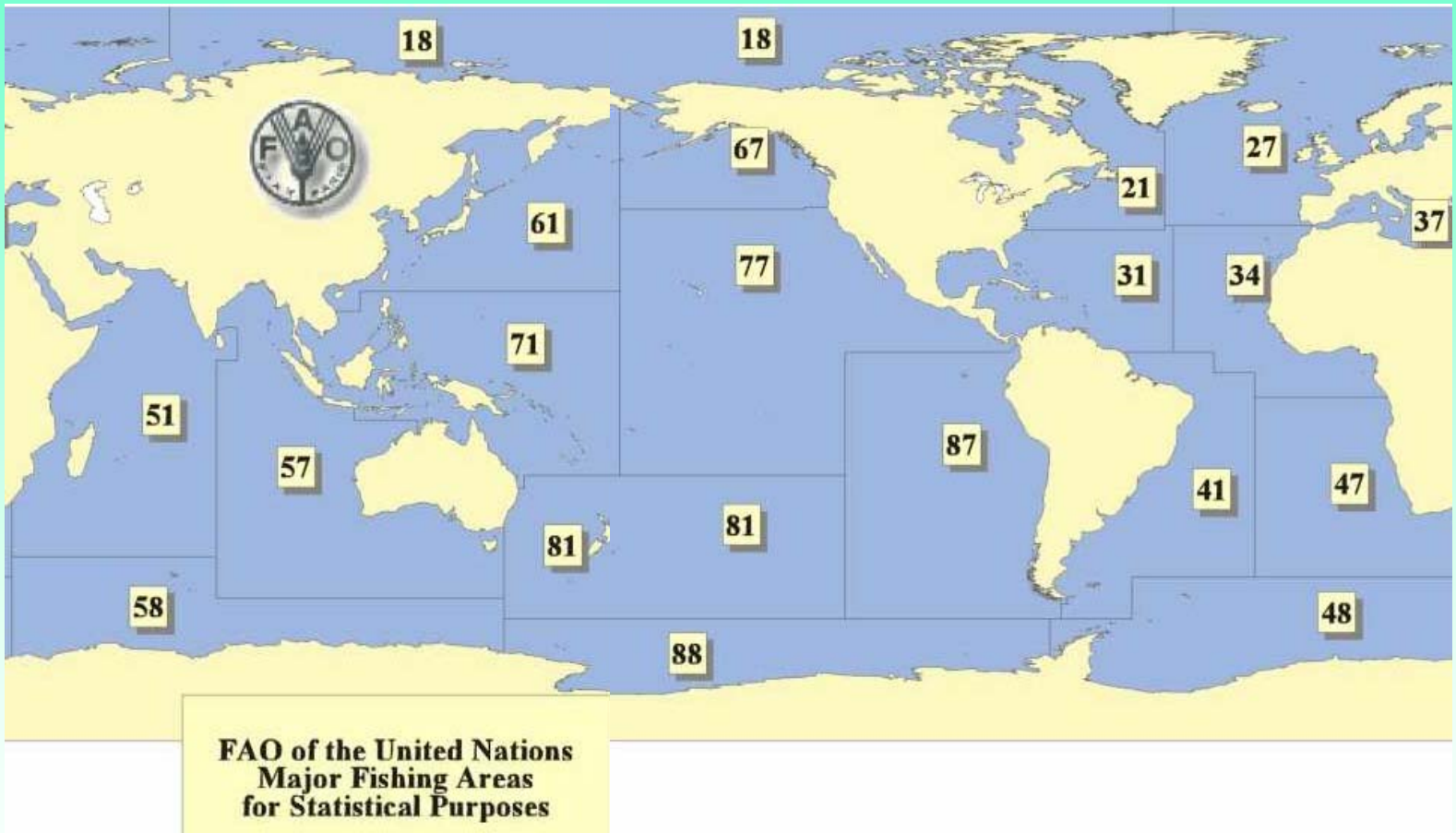
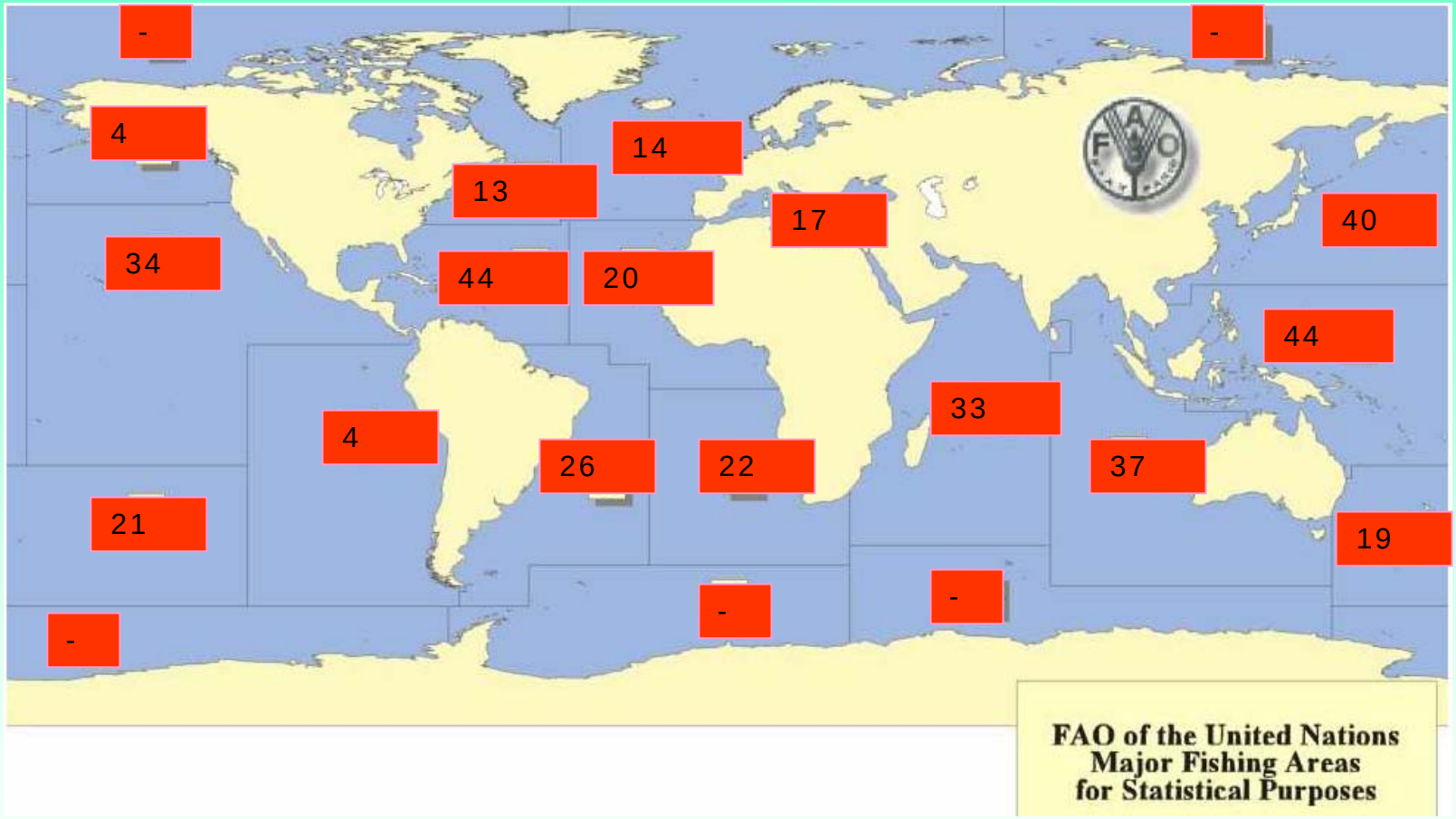
This is a map of the FAO fishing areas



NUMBER of Red-List MARINE species – number threatened++ of species on list (excluding sharks)



CWP, Fishing Statistical Area c1990- .
CWP, Handbook of Fishery Statistics.
FIGIS Fishing Area Fact Sheets.
FAO - Rome. Updated Tue Jul 04 12:50:31 CEST 2006.
Available via FIGIS from:
http://www.fao.org/figis/servlet/static?dom=area&xml=Area18.xml

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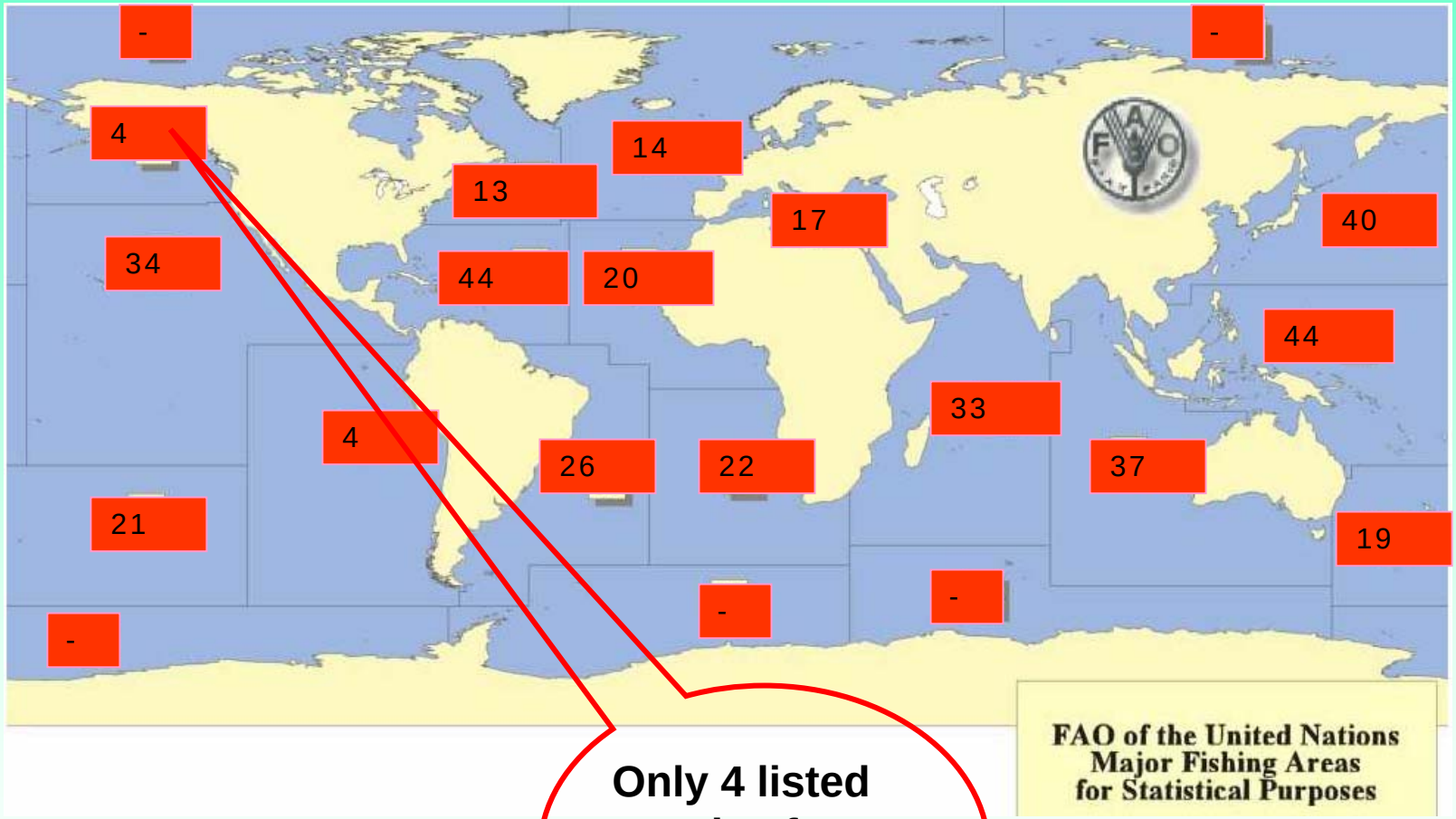

Only 4 listed species from the NE Pacific

CWP, Fishing Statistical Area c1990- .
CWP, Handbook of Fishery Statistics.
FIGIS Fishing Area Fact Sheets.
FAO - Rome. Updated Tue Jul 04 12:50:31 CEST 2006.
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Four examples from osmerids: - none of which are on the Redlist

EX - potential/probable extinction - <u>disappearance</u>

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

Osmerids are ‘smelts’

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

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NT - probably 'near threatened' – <u>potential loss</u> of populations in the Strait of Georgia

- surf smelt (*Hypomesus pretiosus*) in the Strait of Georgia, may be at a historical low

ALSO I will try to show that the Redlist is not consistently applied between the Pacific and Atlantic….

The frequency of ‘listed’ species in the Pacific is low relative to the Atlantic.

How can this difference be explained?

Maybe by (1) over-zealous fish-listing activity in the Atlantic areas or

(2) inadequate fish-listing activity in the Pacific.

Using the four ‘osmerid’ examples, I try to show that the explanation may be inadequate fish-listing activity in the Pacific.

Maybe the changes we see in osmerids also occur in other species.

There appears to be a decline in many (most?) of other small forage fish in the eastern North Pacific, especially small, inshore populations of herring (*Clupea pallasi*) and other osmerid species

Mainly these are either:

(1) commercially unimportant species

or (2) non-commercial elements of commercially important species

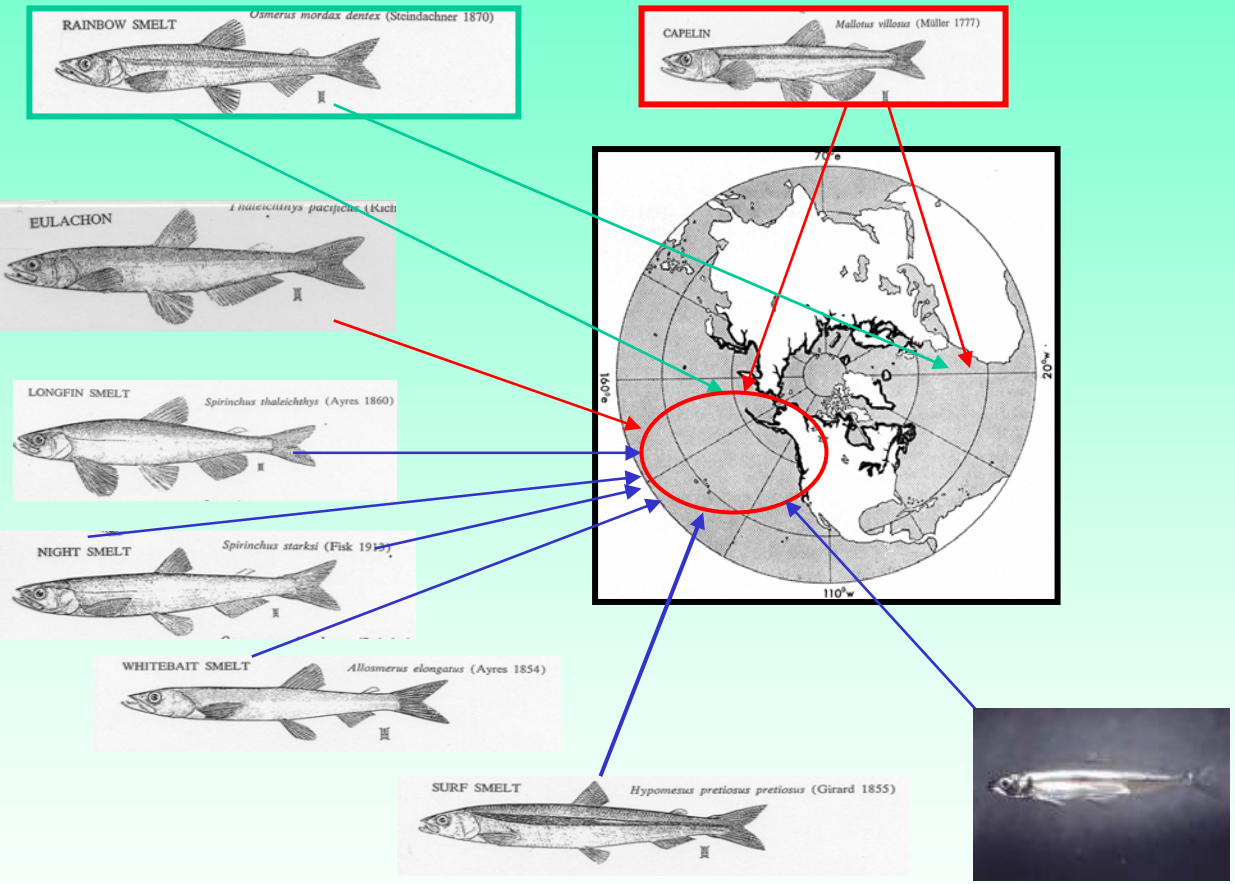
- Most of these fish have habitats associated with either the nearshore or estuaries

Most ‘smelts’ (Osmeridae) live in the North Pacific.

Mainly it is only the capelin that has any commercial interest – but only in Alaska (and that is limited).

A smelt’ may be seen to be important is if it is a ‘forage’ species used by commercial fishes or sea birds or marine mammals

Background: Global distribution of smelts (Osmeridae) that are indigenous to the NE Pacific



Delta smelt Hypomesu transpacificuss

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 only?)
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

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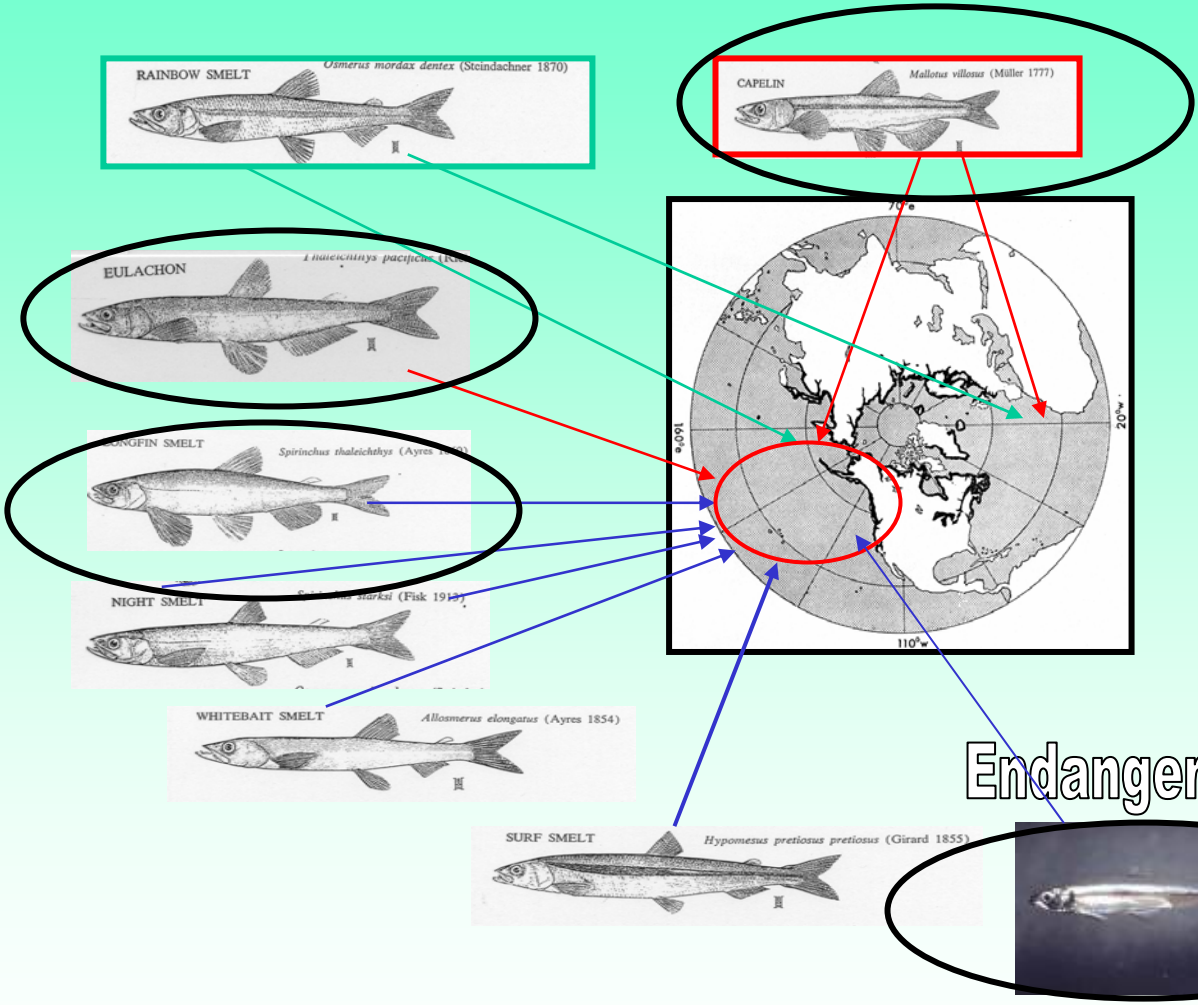

The delta smelt in California is already on the Redlist

Endangered

Delta smelt Hypomesu transpacificuss

Example 1: Capelin – *Mallotus villosus*

EX - ?

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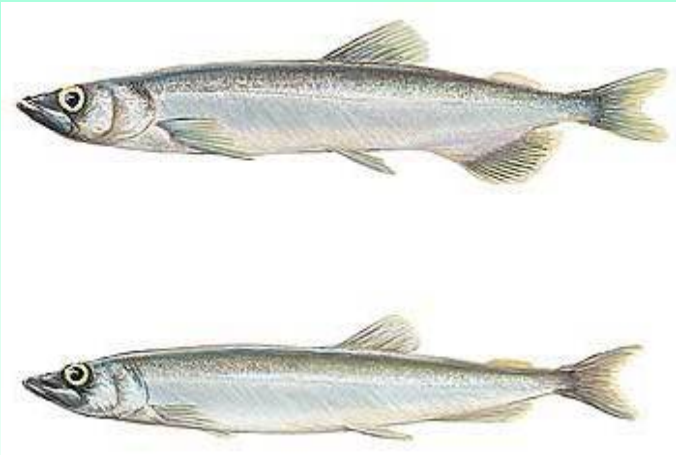
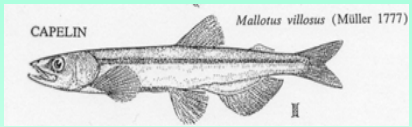
EX - ?

Extinct?

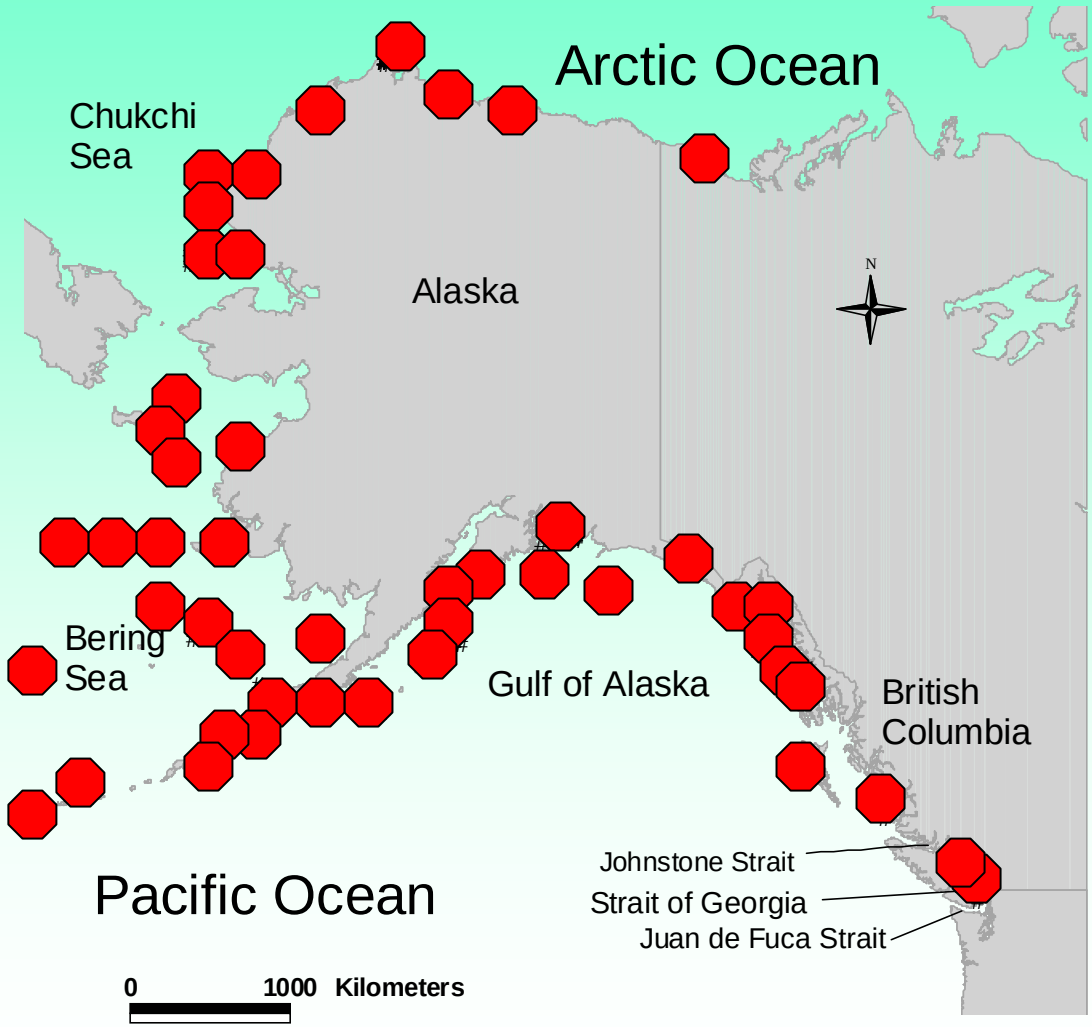
Capelin – *Mallotus villosus*

There is evidence that a (rare) fall-spawning capelin (*Mallotus villosus*) disappeared in the 1970's, possibly around the 1977 regime shift.

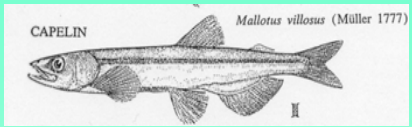




General distribution of capelin in the eastern Pacific



capelin (*Mallotus villosus)* in the Strait of Georgia



Strait of Juan de Fuca

In the Strait of Georgia,

- capelin spawning for 60+ years, from 1912-1972

- there since the glacial recession (12000 y bp)?

- spawned in fall - September and October, on spring tide/full-new moon

- fall spawning of capelin does not occur in other areas.

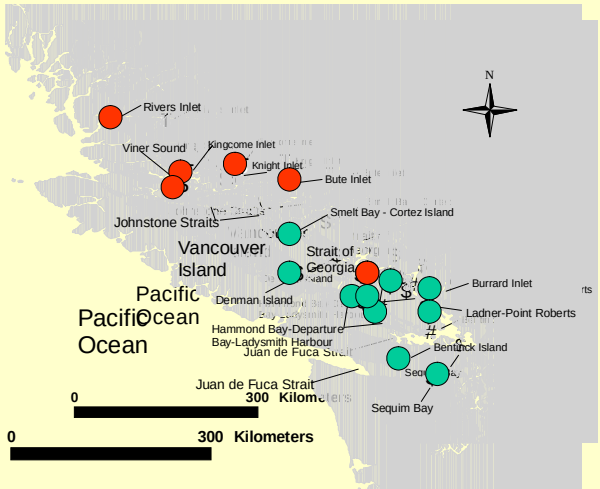
…. there was no fishery for capelin….except for a very small sports fishery in some areas

….does the loss of this unique fall-spawning capelin population represent an example of a marine extinction?

…..Probably…because:

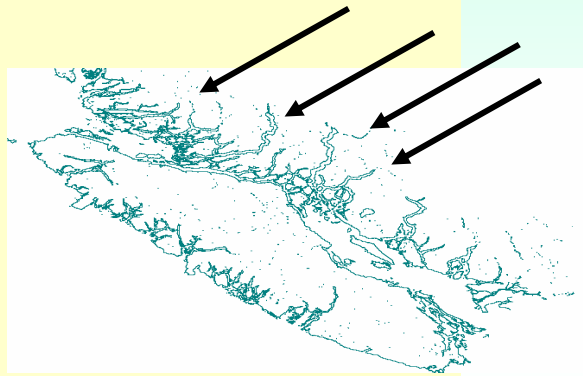
- the population had a unique distribution and spawning time
- it has not been re-colonized after 30 years
- future genetic analyses may confirm/refute this

- fall spawning capelin disappeared from disappeared from all spawning areas approximately synchronously, in the mid-1970's



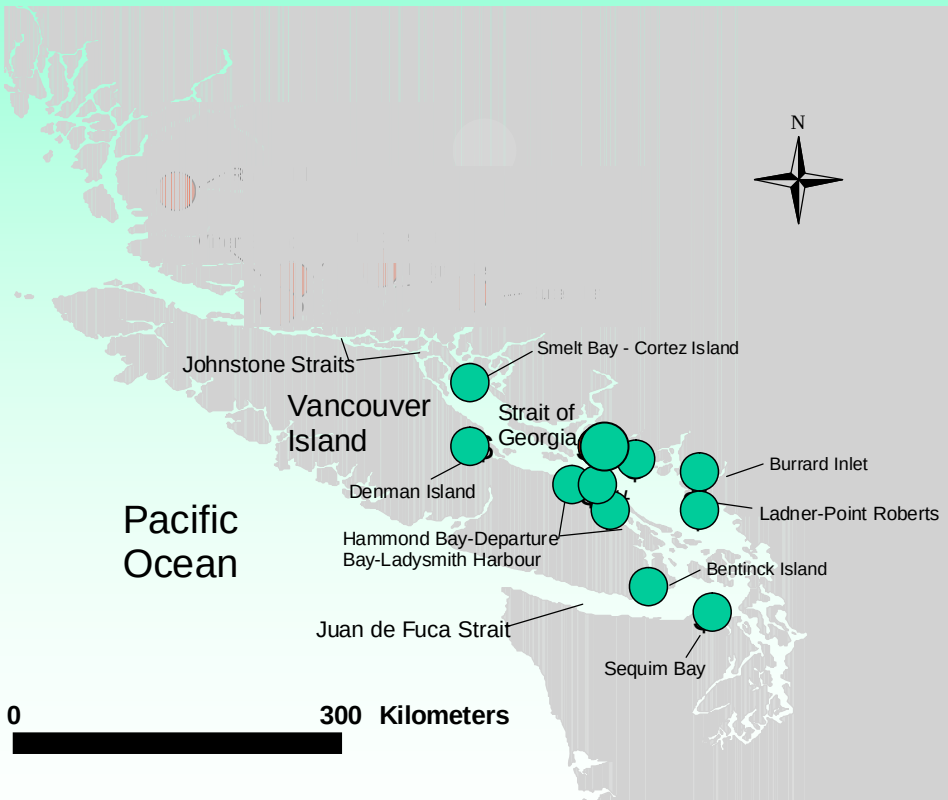
- disappearance has not been recognized or reported until recently.

- since ~ 1995 spawning capelin have ‘reappeared’ in March and April, at the heads of several inlets



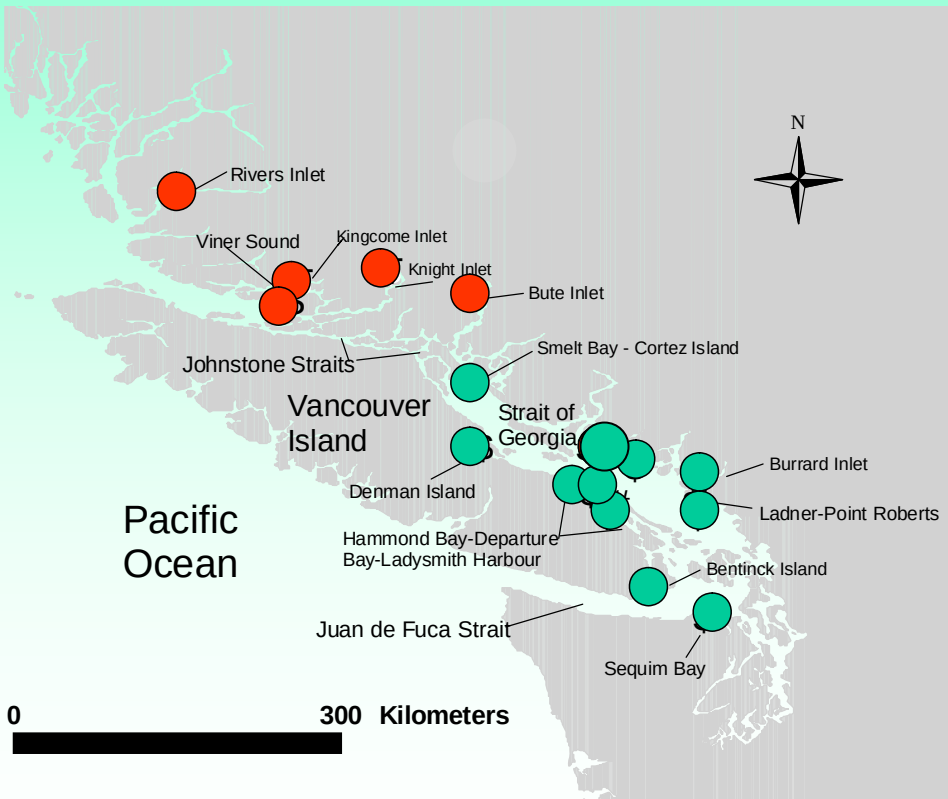
Distribution of fall spawning capelin in the Straits of Georgia and Juan de Fuca

1912 - mid-1970's



Distribution of fall spawning capelin in the Straits of Georgia and Juan de Fuca

1912 - mid-1970's and the 1990's in Johnstone Strait



Distribution of fall spawning 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	Hart and McHugh (1944), UBC Museum samples, W. Ricker, D. Quale
5.	Ladysmith Harbour	E. Barraclough (1972)
6.	North shore of Burrard Inlet	Hart 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)

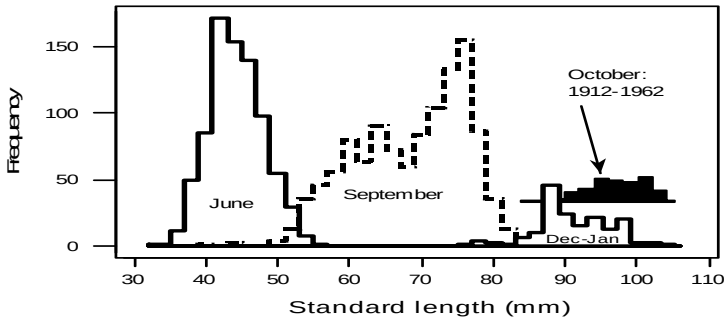
Recent (post 1995) spring-spawning areas

1.	Bute Inlet	R. Hobbs, Pers. comm.
2.	Knight Inlet	M. Berry, samples
3.	Kingcome Inlet March 1995	M. Berry, samples
4.	Rivers Inlet, April 1997	G. Hanuse, samples

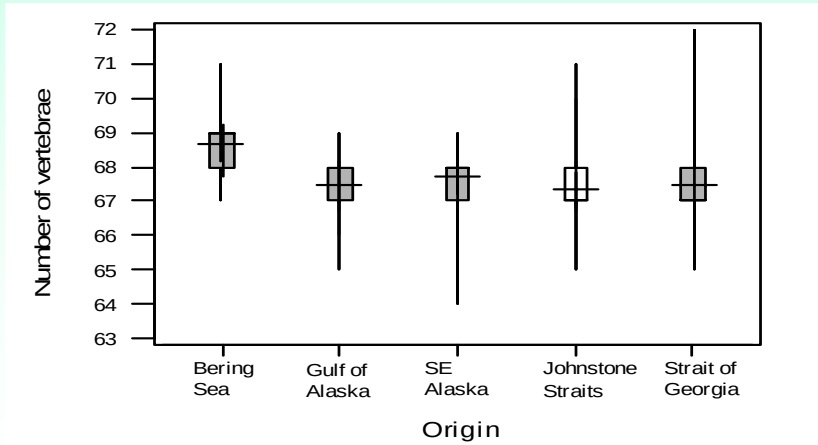
Comparison of sizes - length and weight.

frequency distributions of standard lengths of capelin collected at 4 different times and places:

(i) June 1999	**Strait of Georgia,**
(ii) Sept. 1999	**Strait of Georgia,**
(iii) Dec. 1999	**Johnstone Strait**
(iv) *Oct. 1912-1962*	**Strait of Georgia,**



Vertebral numbers and fish sizes compared within and among old and recent samples



- We do not understand what has happened or what we might have lost.

- At worst, the fall spawning capelin was a unique, reproductively isolated population(s) that inhabited the SOG since the post-glacial period of 10-15,000 years.

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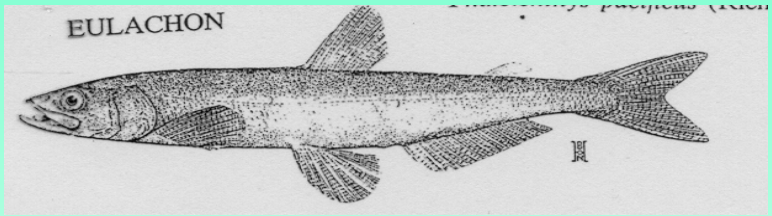
Example 2: Eulachon – *Thaleichys pacificus*



EN - ?

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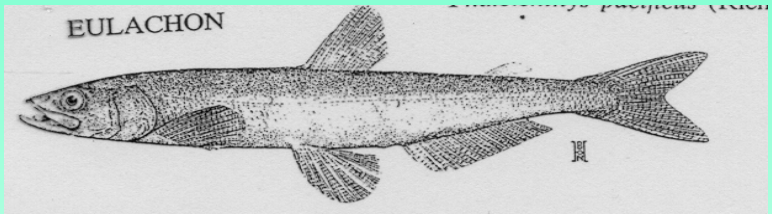


EN - ?

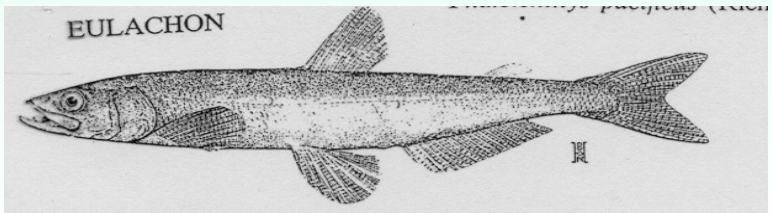
Endangered

Distribution

Found only on the western coast of North America, from northern California to Alaska (southern Bering Sea).

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, or Nass - probably next largest or maybe 1 or 2 Alaskan Rivers. Most other runs - probably are much smaller.



Eulachon populations collapsed in 1993/94.

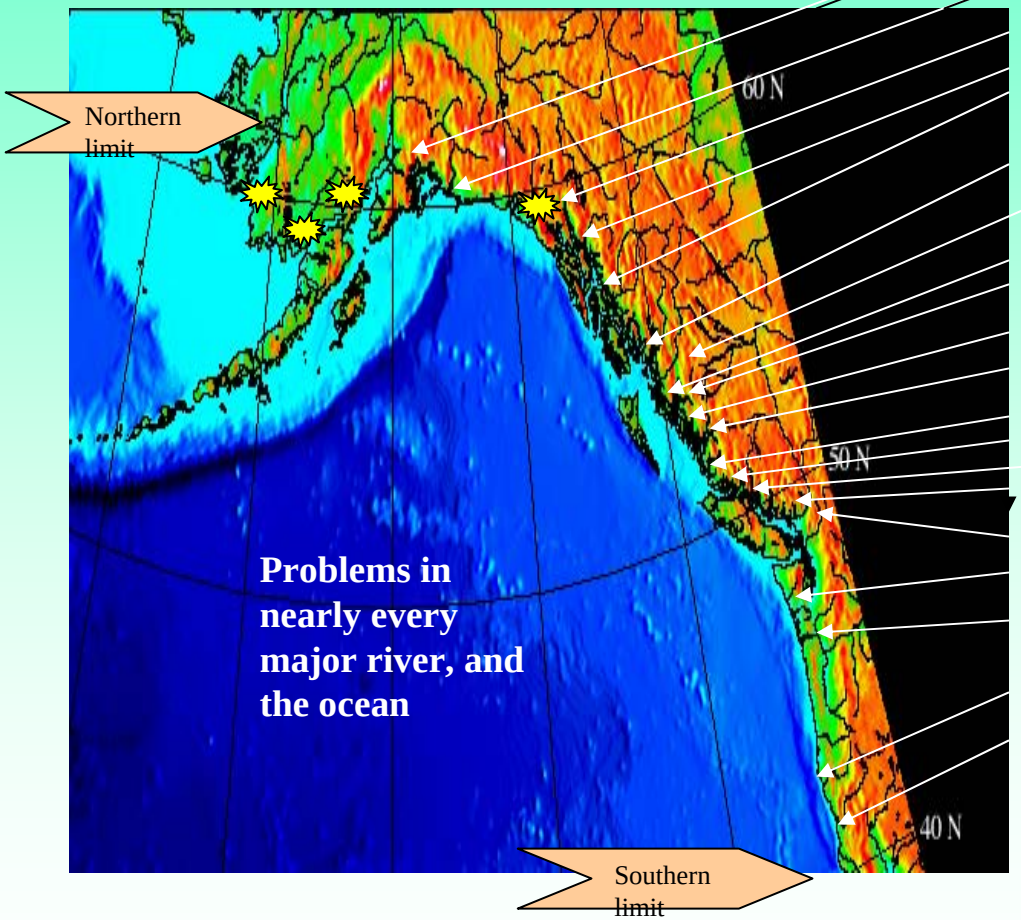
A few runs recovered, but have subsequently collapsed.

In general, it seems that in 2006, nearly every population south of the Gulf of Alaska has declined or disappeared.

They have disappeared from California rivers for ~b 20 years

Slide from PSARC status paper, 2000

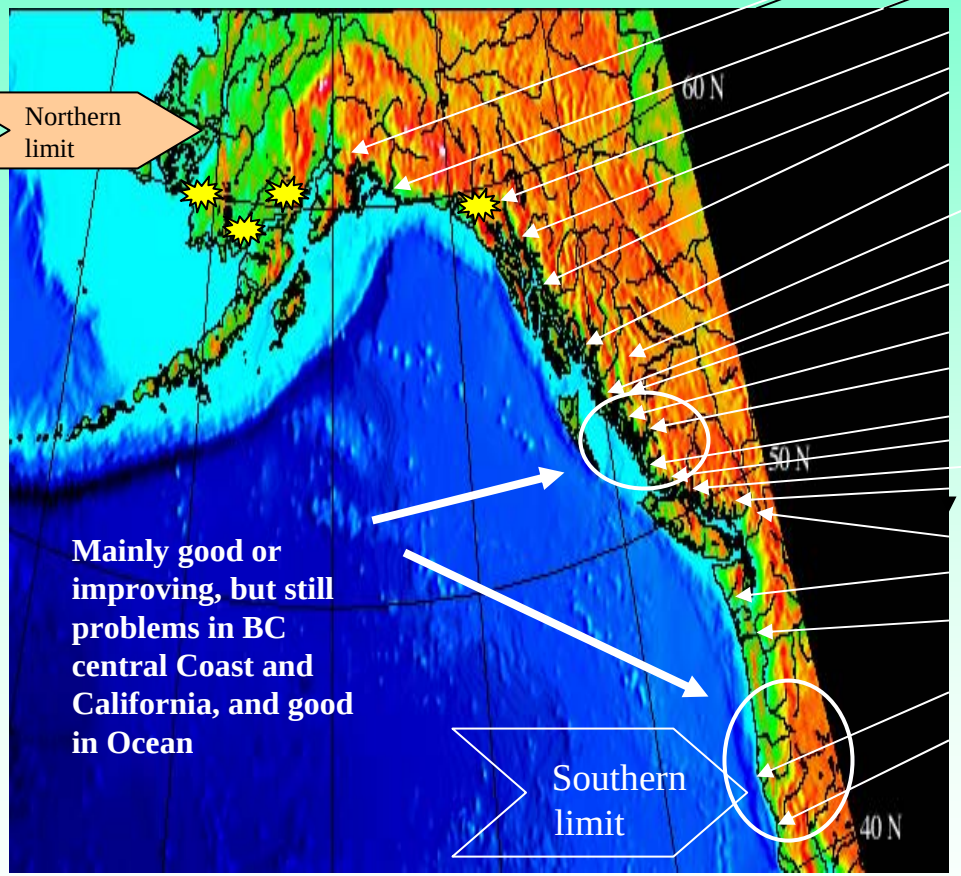
Eulachons in 2000



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

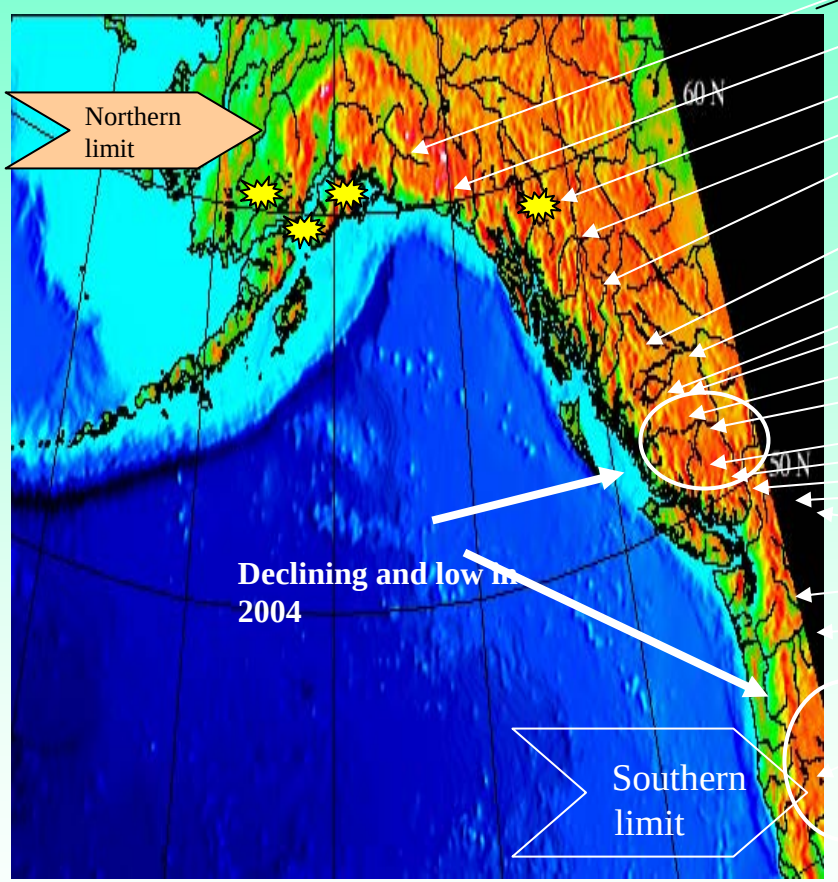
Unuk
Chickamin
Nass
Skeena
Kitimat *- very low in 2000*
Kildala
Kemano, Kitlope, Kowesas
Bella Coola , Kimsquit-

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



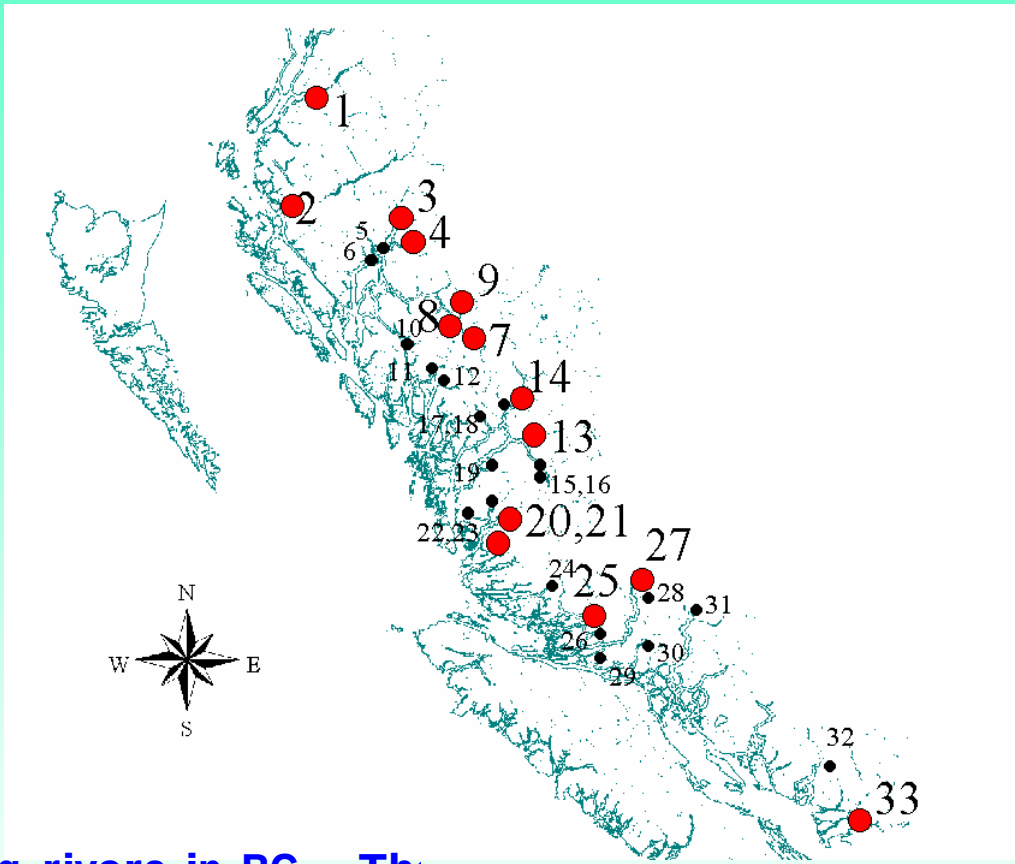
Twentymile River, Cooke Inlet - normal
Copper
Alsek
Chilkoot Chilkat
Stikine

Unuk
Chickamin

Nass
Skeena
Kitimat *- good in 2003*
Kildala
Kemano, Kitlope, Kowesas
Bella Coola , run virtually gone
Owikeeno *-*
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.



Known eulachon spawning rivers in BC. Th represent every known spawning river . M rivers, however, do not have regular inter· Those that are believed to be regular are large symbols and numbers, others are sho symbols and numbers.

Example 3: Longfin smelt – *Sprinchus thaleichthys*

VU - ?

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VU - ?

Vulnerable

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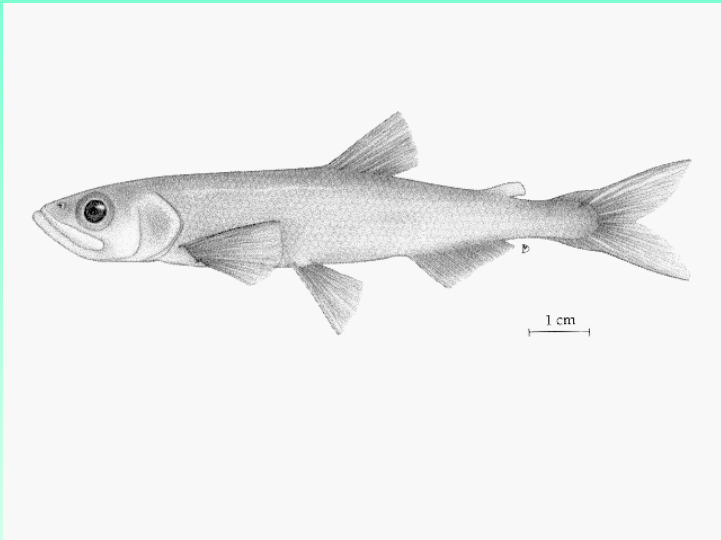
VU - ?



There is very little information in this species but some of the best ‘available’ recent information is from the Alaska Dept. Fish and Game

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

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) stated that the delta population warrants management as an isolated and genetically distinct entity. Nonanadromous populations in Harrison and Pit lakes, British Columbia, have been recognized as an undescribed species (*Spirinchus* sp. 1) by some authors.

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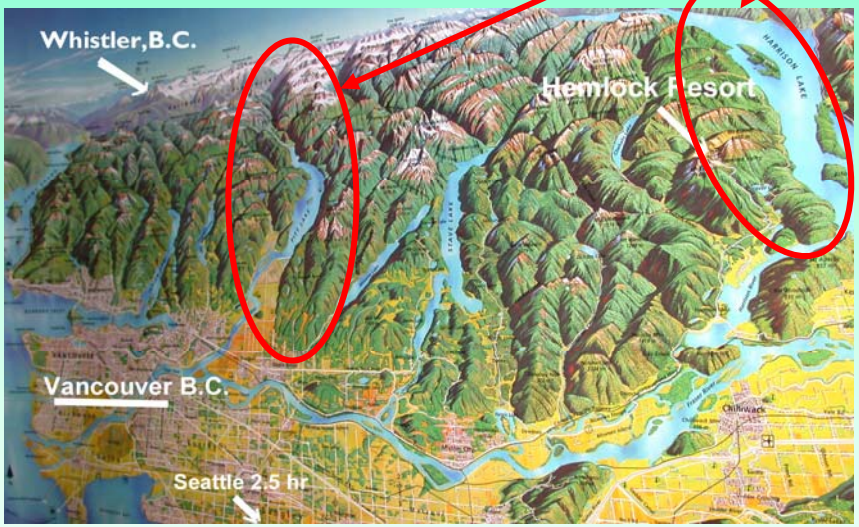
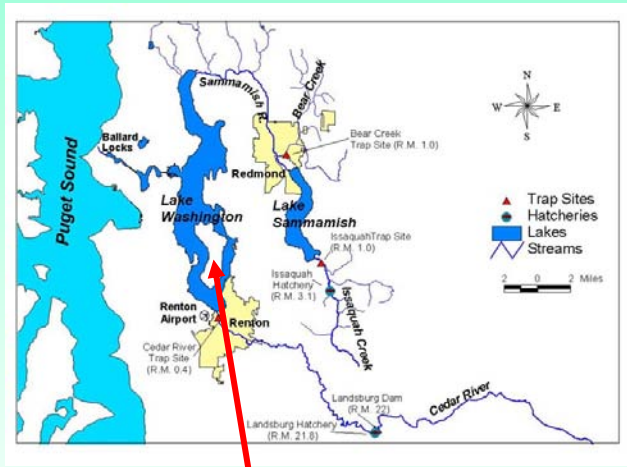




They also occur in Lake Washington…but that it the extent of the world distribution.

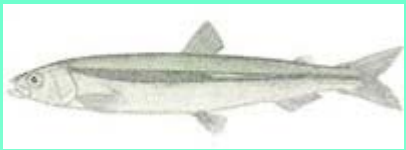
Example 4: Surf Smelt – *Hypomesus pretiosus*

NT - ?

Example 4: Surf Smelt – *Hypomesus pretiosus*

NT - ?

Near-threatened



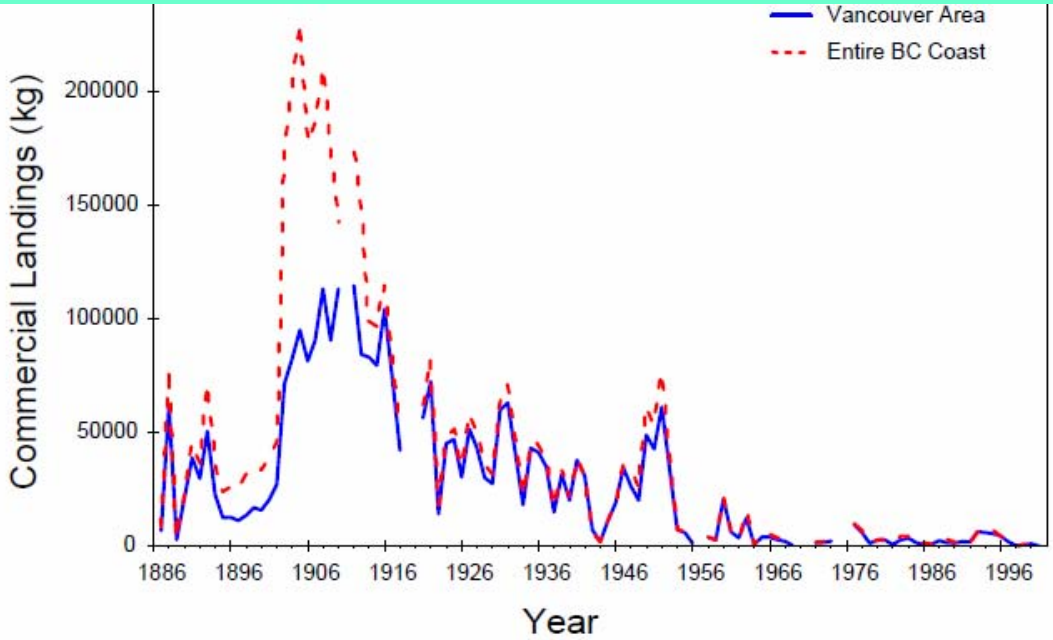
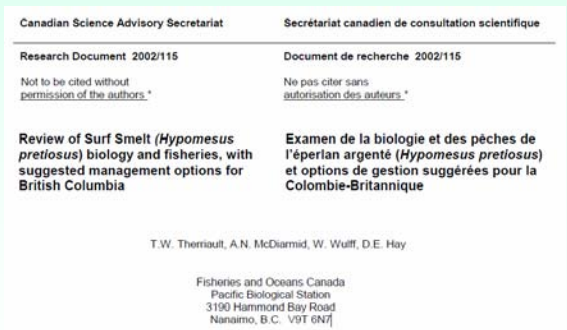


Figure 2: Reported surf smelt catches for Statistical Areas 28 and 29 (Vancouver Area) and for the entire British Columbia coast between 1886 and 2000.



Canadian Science Advisory Secretariat | Secrétariat canadien de consultation scientifique

Research Document 2002/115 | Document de recherche 2002/115

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Review of Surf Smelt (*Hypomesus pretiosus*) biology and fisheries, with suggested management options for British Columbia

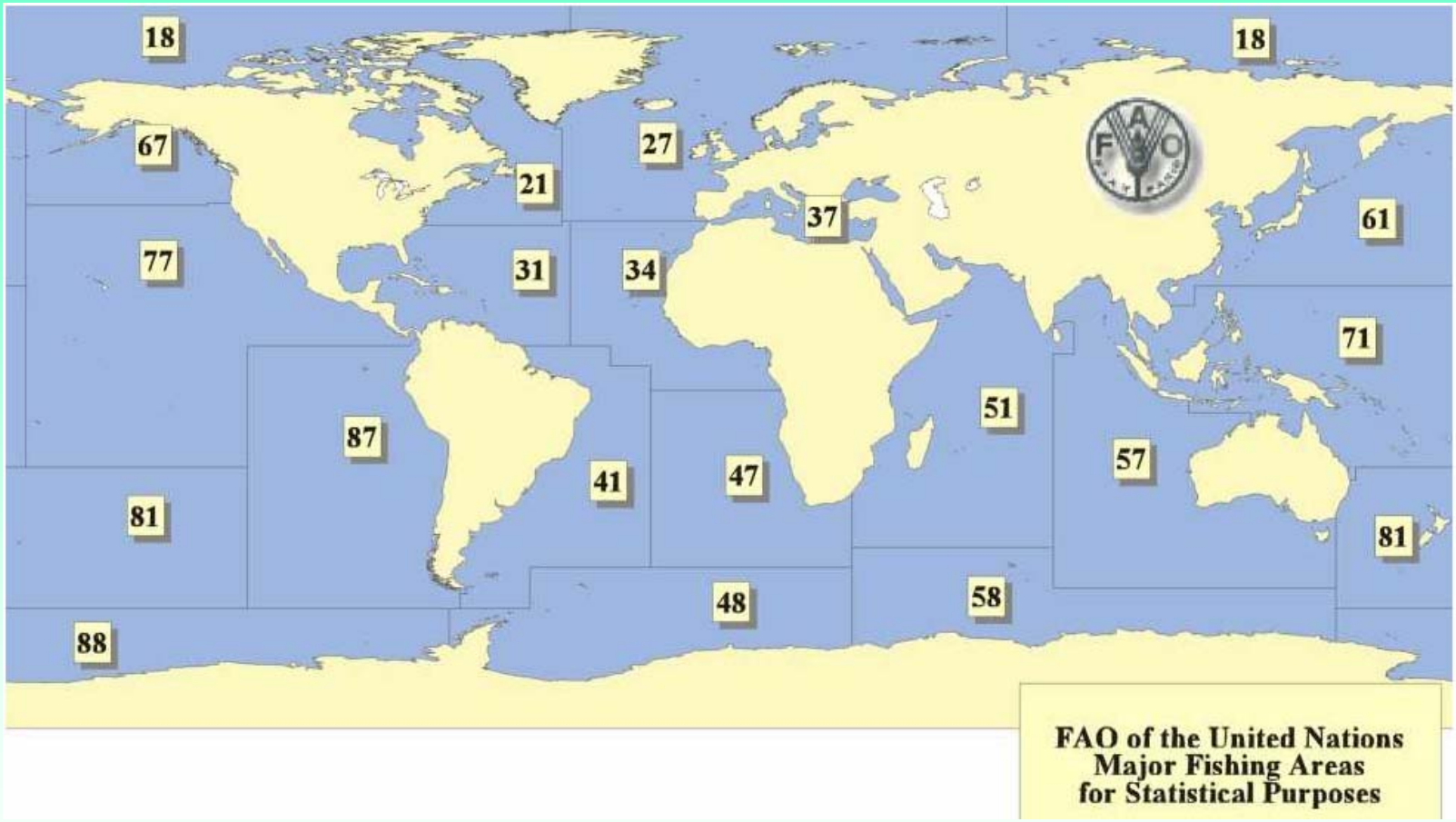
Examen de la biologie et des pêches de l'éperlan argenté (*Hypomesus pretiosus*) et options de gestion suggérées pour la Colombie-Britannique

T.W. Therriault, A.N. McDiarmid, W. Wulff, D.E. Hay

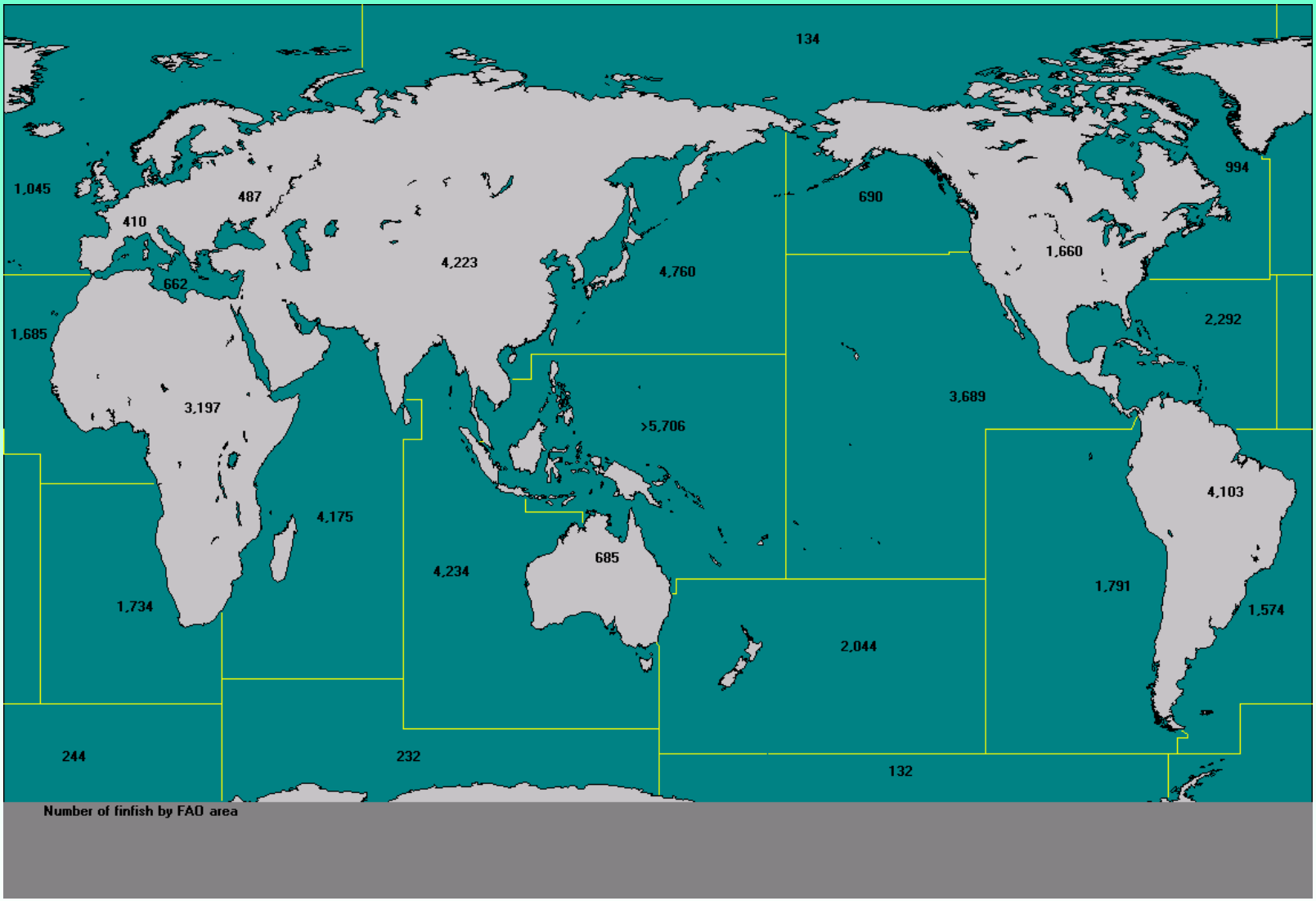
Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, B.C. V9T 6N7

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

FAO fishing areas and IUCN fish lists


18
18
67
27
21
37
61
77
31
34
71
51
87
57
41
47
81
81
48
58
88
FAO of the United Nations
Major Fishing Areas
for Statistical Purposes

From Fishbase: the number of fish species in FAO areas



http://www.fishbase.org/search.php

Froese, R. and D. Pauly. Editors. 2006.FishBase.
World Wide Web electronic publication.
www.fishbase.org, version (07/2006).

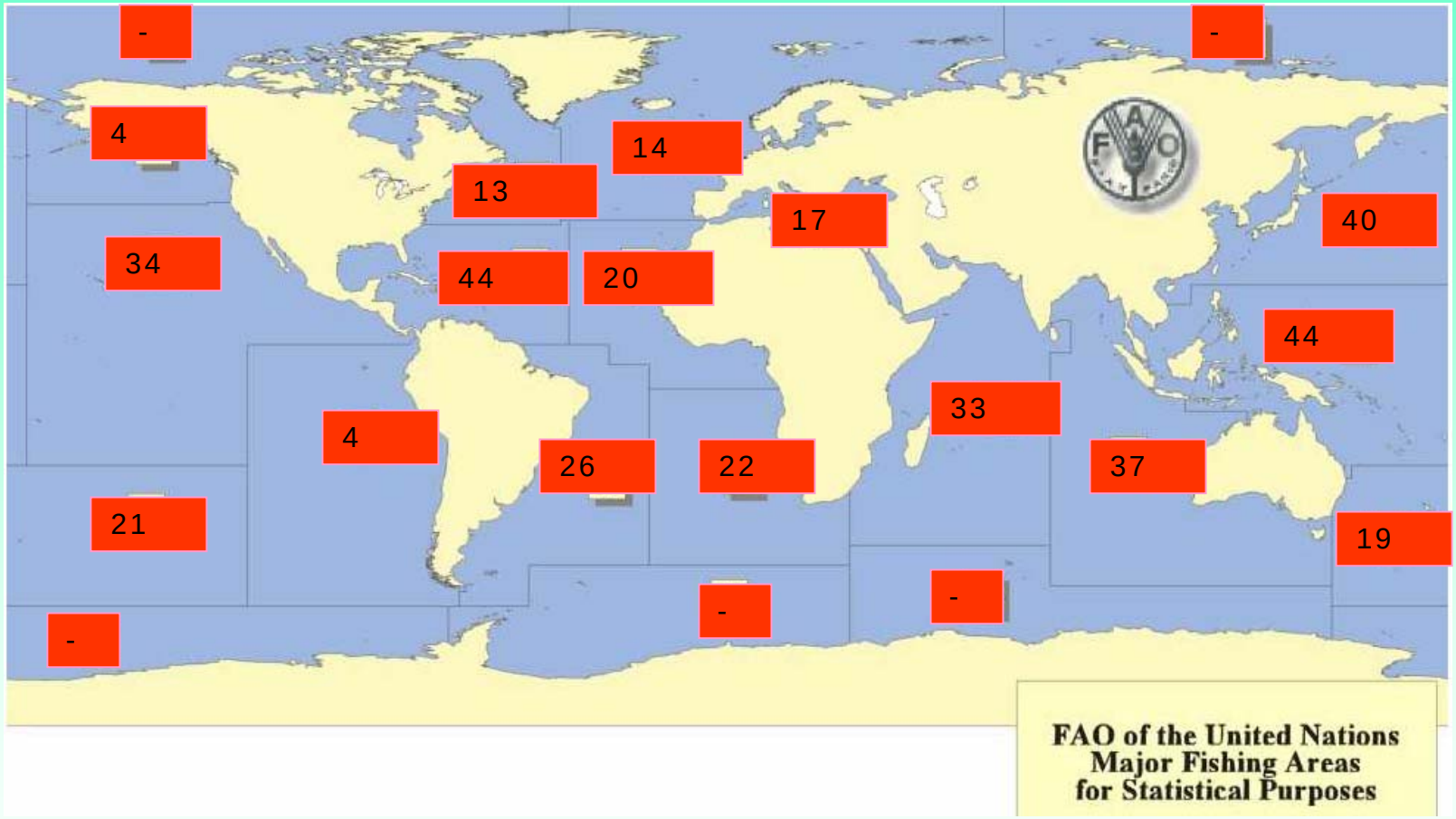
Table 2.1. Elasmobranch catches by FAO Statistical Area 1967–1991. Mean catch, variation and index of Relative Production (IRP) are given for the last 25 years, and catch trends for the last 10 years.

http://www.fao.org/DOCREP/003/V3210E/V3210E02.htm

F A O Major Fishing Areas	Area Million Km2
27 NE Atlantic Ocean	16.9
61 NW Pacific Ocean	20.5
51 W Indian Ocean	30.2
21 NW Atlantic Ocean	5.2
37 Mediterranean & Black Seas	3.0
71 W Central Pacific Ocean	33.2
41 SW Atlantic Ocean	17.6
57 E Indian Ocean	29.8
34 E Central Atlantic Ocean	14.0
87 SE Pacific Ocean	16.6
31 W Central Atlantic Ocean	14.7
77 E Central Pacific Ocean	57.5
81 SW Pacific Ocean	33.2
67 NE Pacific Ocean	7.5
47 SE Atlantic Ocean	18.6

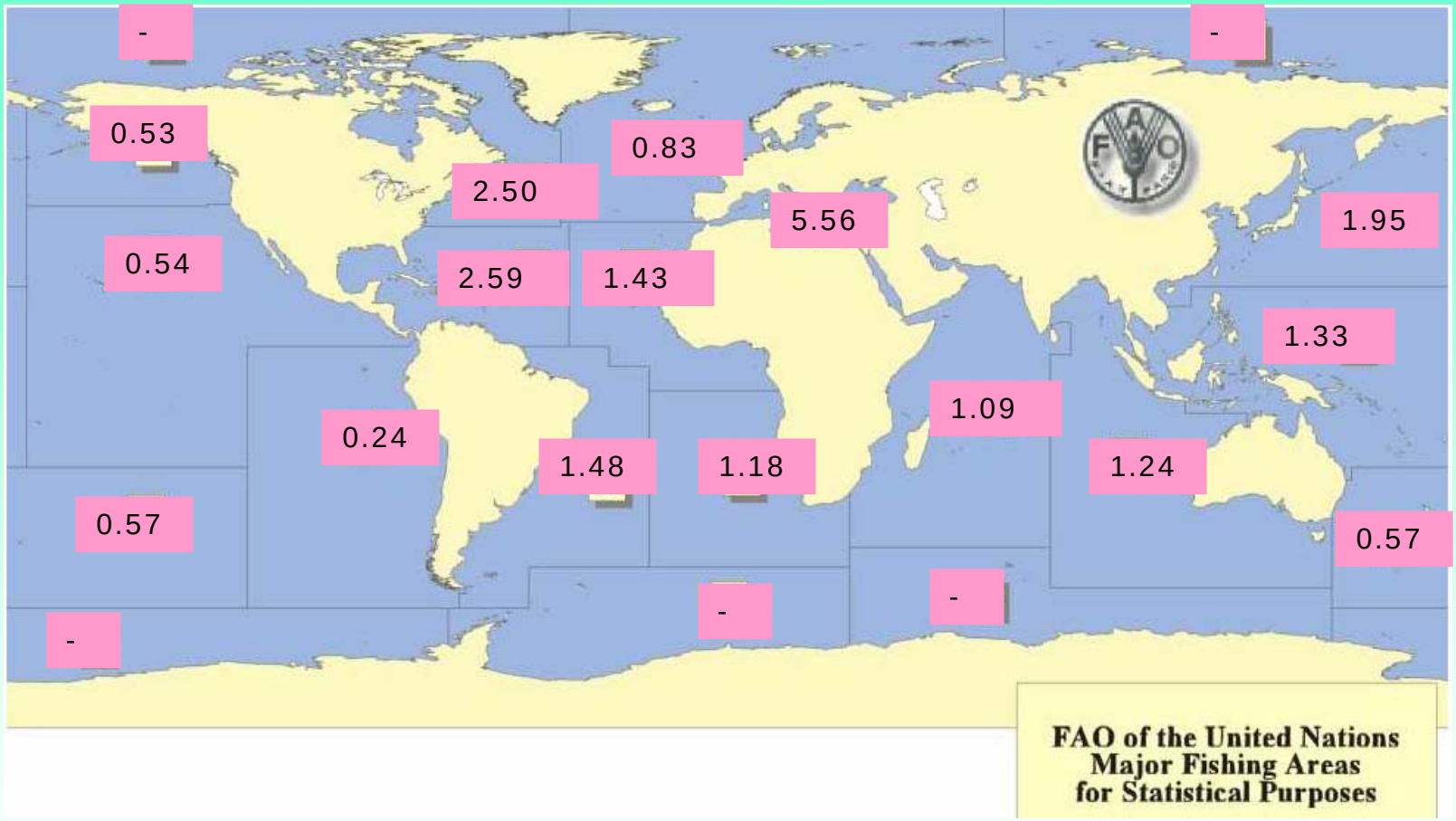
Areas (km^2) for each marine area

NUMBER of Red-List MARINE species – number threatened++ of species on list (excluding sharks)



CWP, Fishing Statistical Area c1990- .
CWP, Handbook of Fishery Statistics.
FIGIS Fishing Area Fact Sheets.
FAO - Rome. Updated Tue Jul 04 12:50:31 CEST 2006.
Available via FIGIS from:
http://www.fao.org/figis/servlet/static?dom=area&xml=Area18.xml

Index of Red-List MARINE species - adjusted by area (listed species per million km²)



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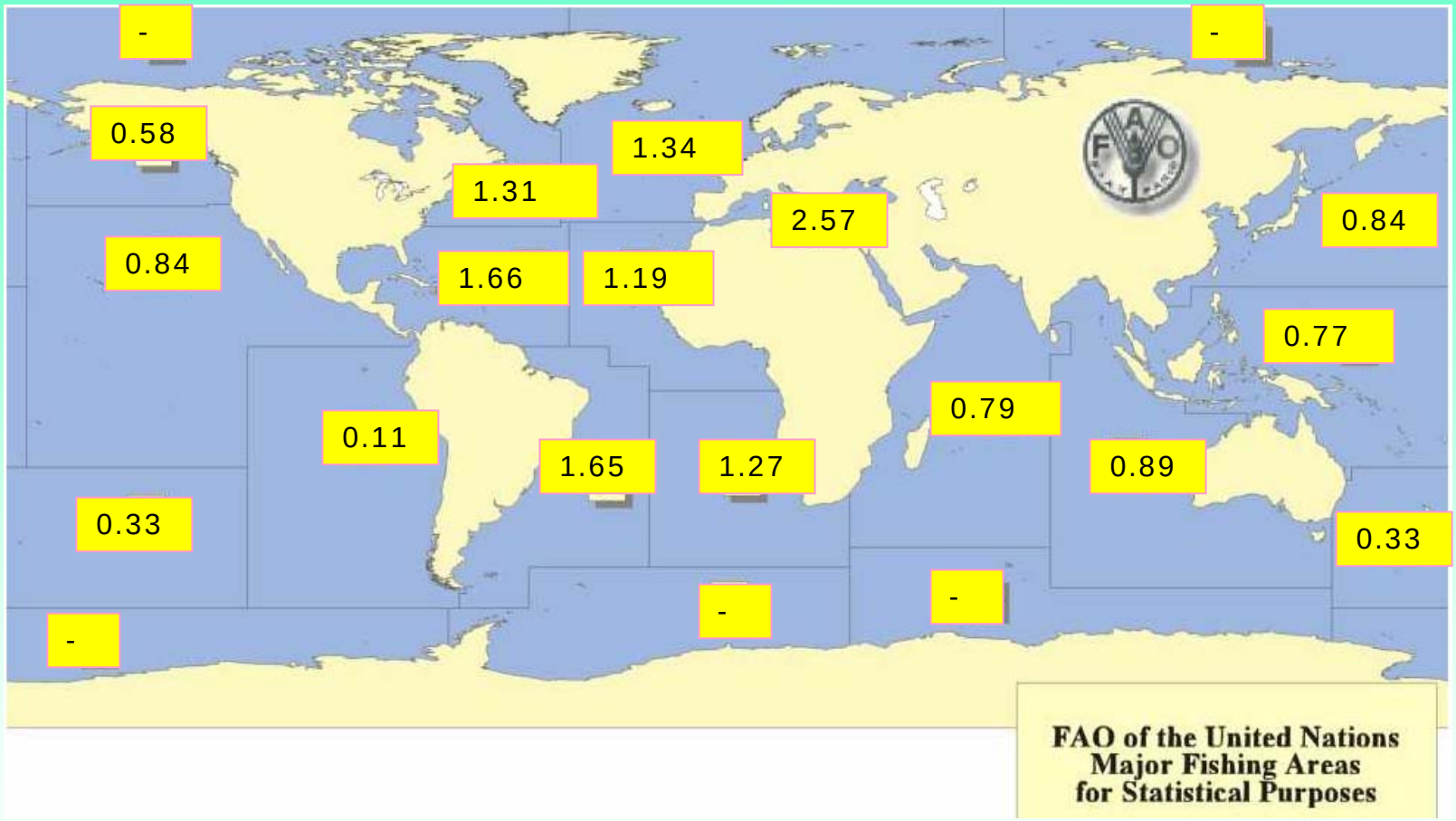
Available via FIGIS from:
http://www.fao.org/figis/servlet/static?dom=area&xml=Area18.xml

Index of Red-List MARINE species – (percent of listed species/all species)



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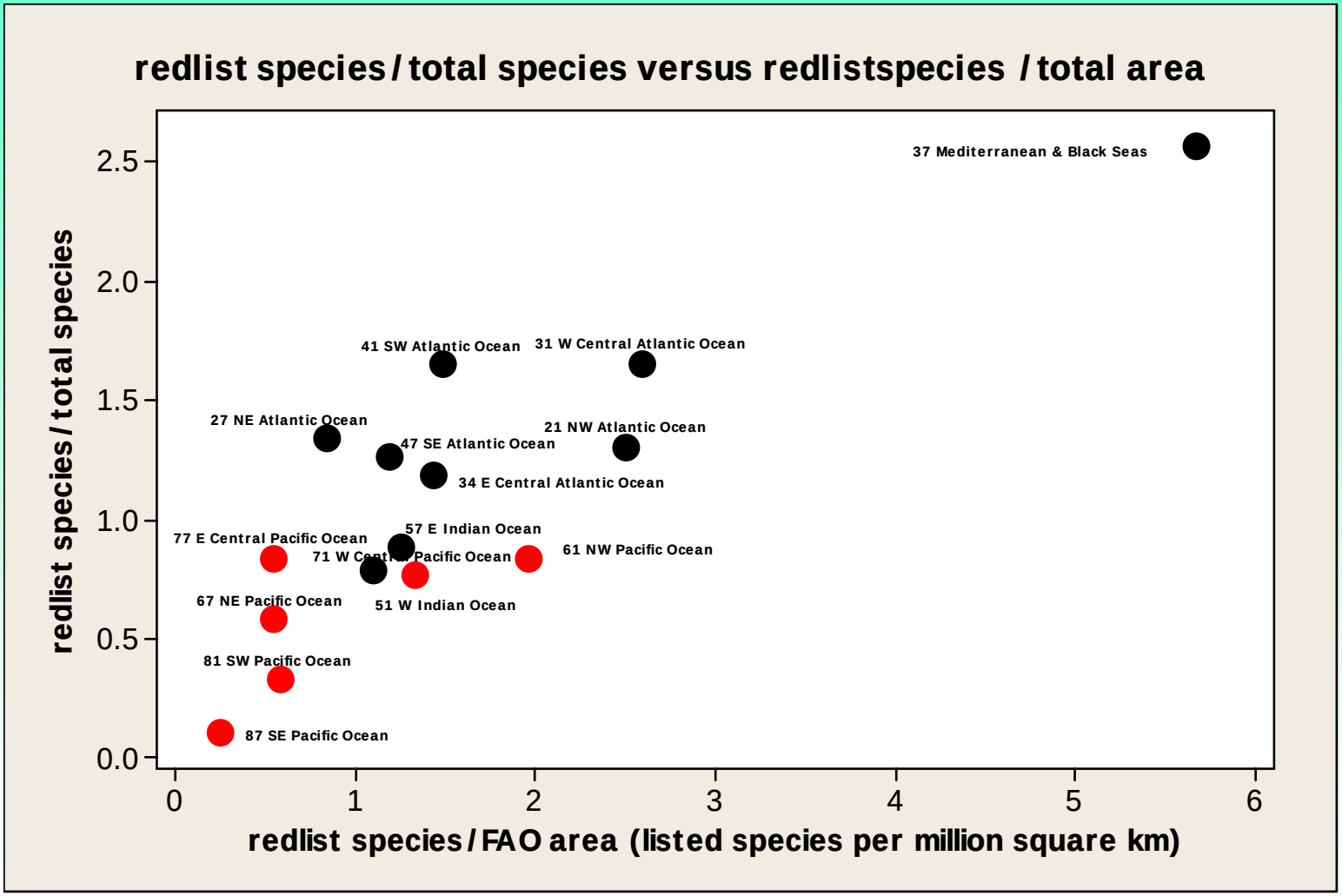
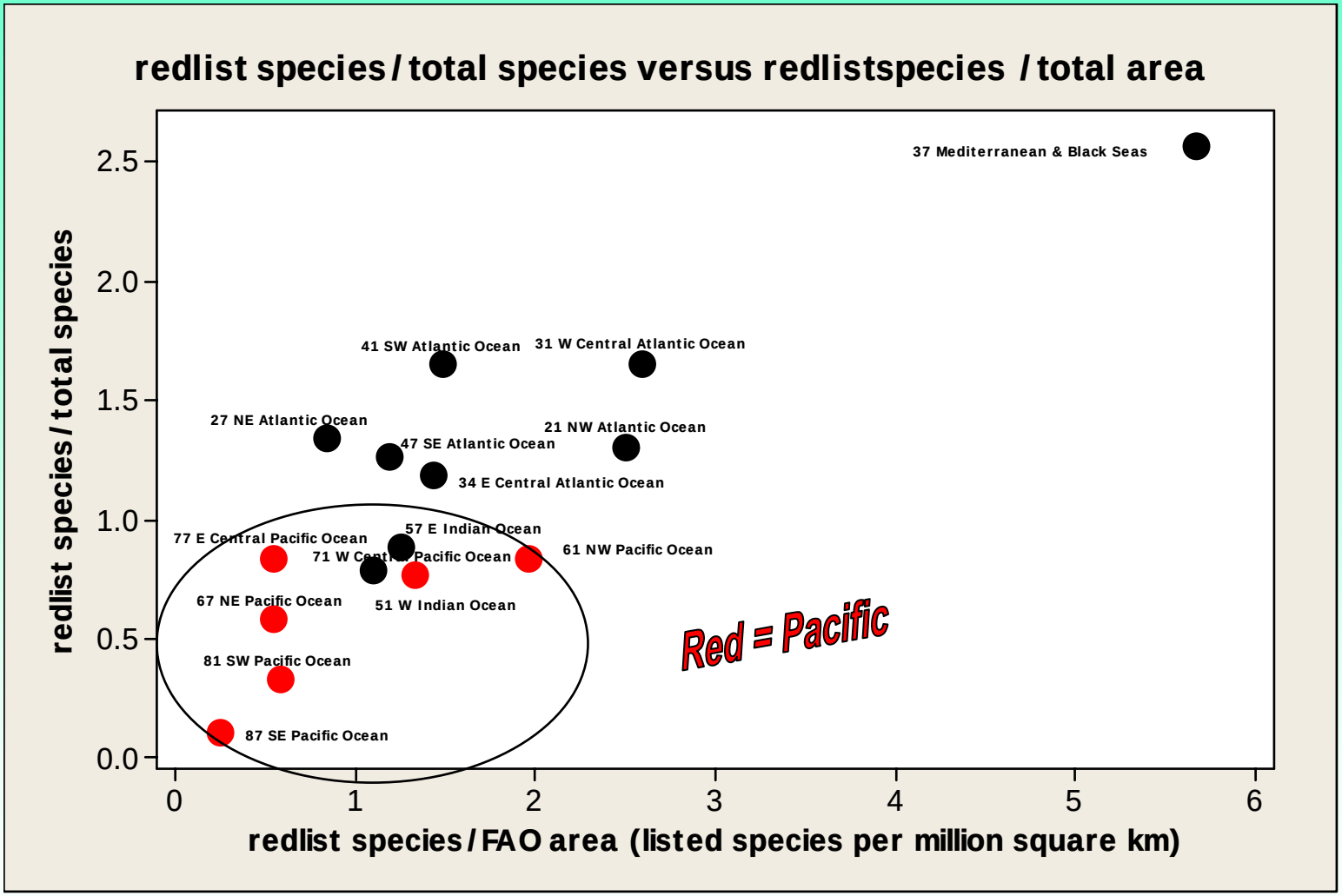

redlist species / total species versus redlistspecies / total area
redlist species / total species
redlist species / FAO area (listed species per million square km)
0.0
0.5
1.0
1.5
2.0
2.5
0
1
2
3
4
5
6
37 Mediterranean & Black Seas
41 SW Atlantic Ocean
31 W Central Atlantic Ocean
27 NE Atlantic Ocean
21 NW Atlantic Ocean
47 SE Atlantic Ocean
34 E Central Atlantic Ocean
57 E Indian Ocean
77 E Central Pacific Ocean
61 NW Pacific Ocean
67 NE Pacific Ocean
51 W Indian Ocean
81 SW Pacific Ocean
87 SE Pacific Ocean


redlist species / total species versus redlistspecies / total area
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0.0
0.5
1.0
1.5
2.0
2.5
0
1
2
3
4
5
6
37 Mediterranean & Black Seas
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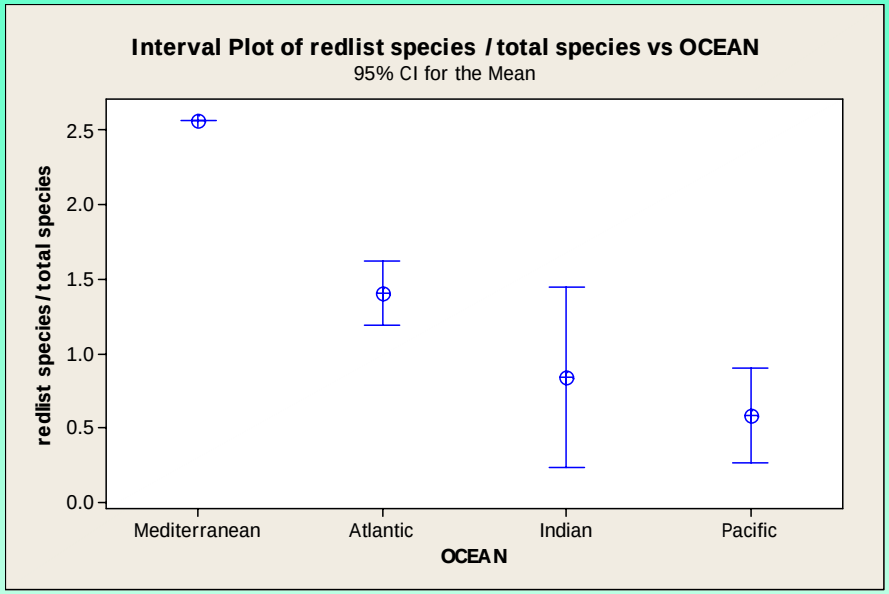
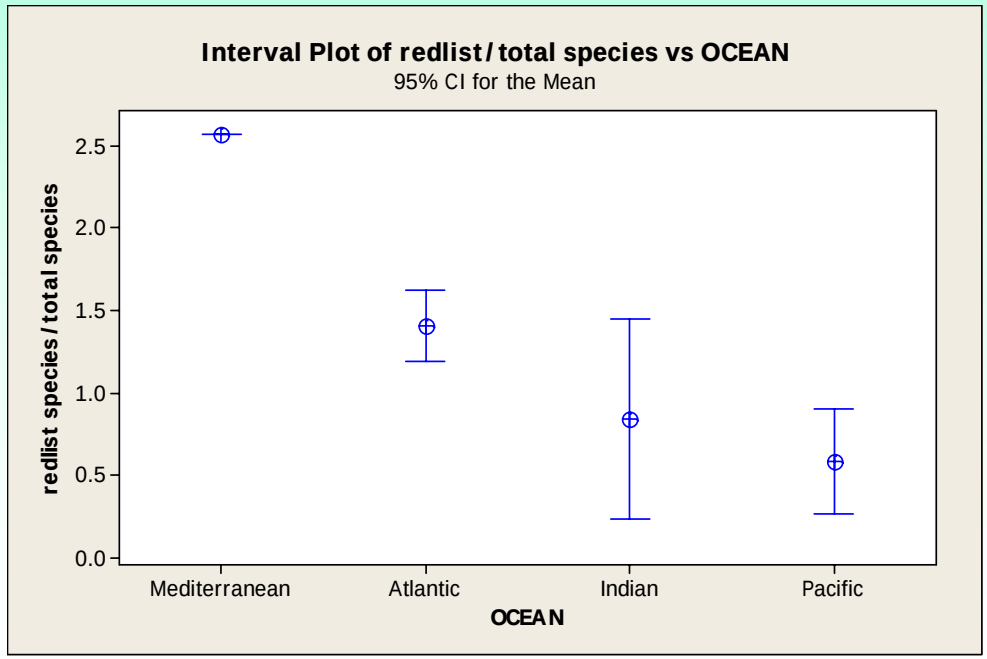
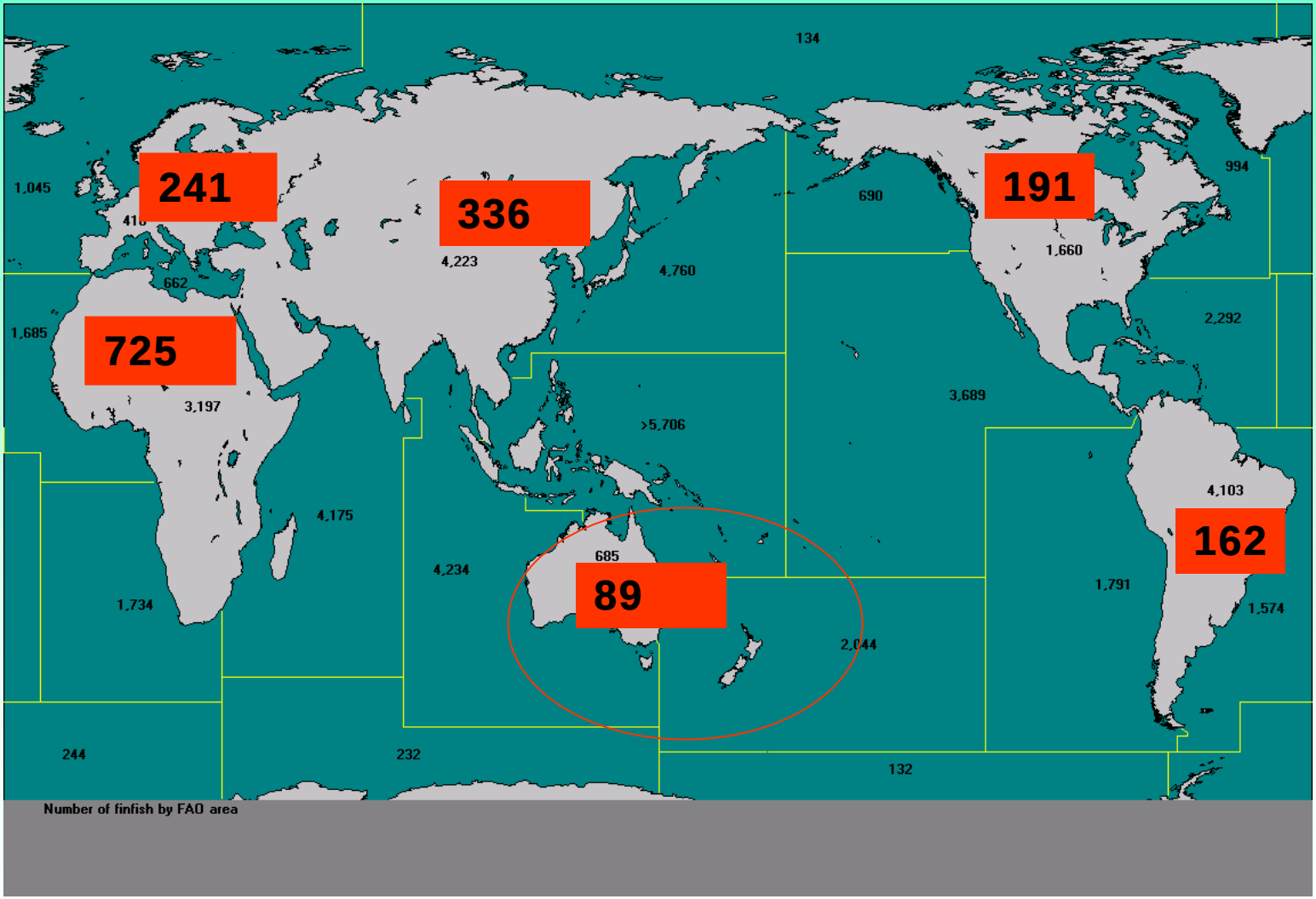
61 NW Pacific Ocean
67 NE Pacific Ocean
51 W Indian Ocean
81 SW Pacific Ocean
87 SE Pacific Ocean
Red = Pacific


Interval Plot of redlist species / total species vs OCEAN
95% CI for the Mean
redlist species / total species
2.5
2.0
1.5
1.0
0.5
0.0
Mediterranean
Atlantic
Indian
Pacific
OCEAN

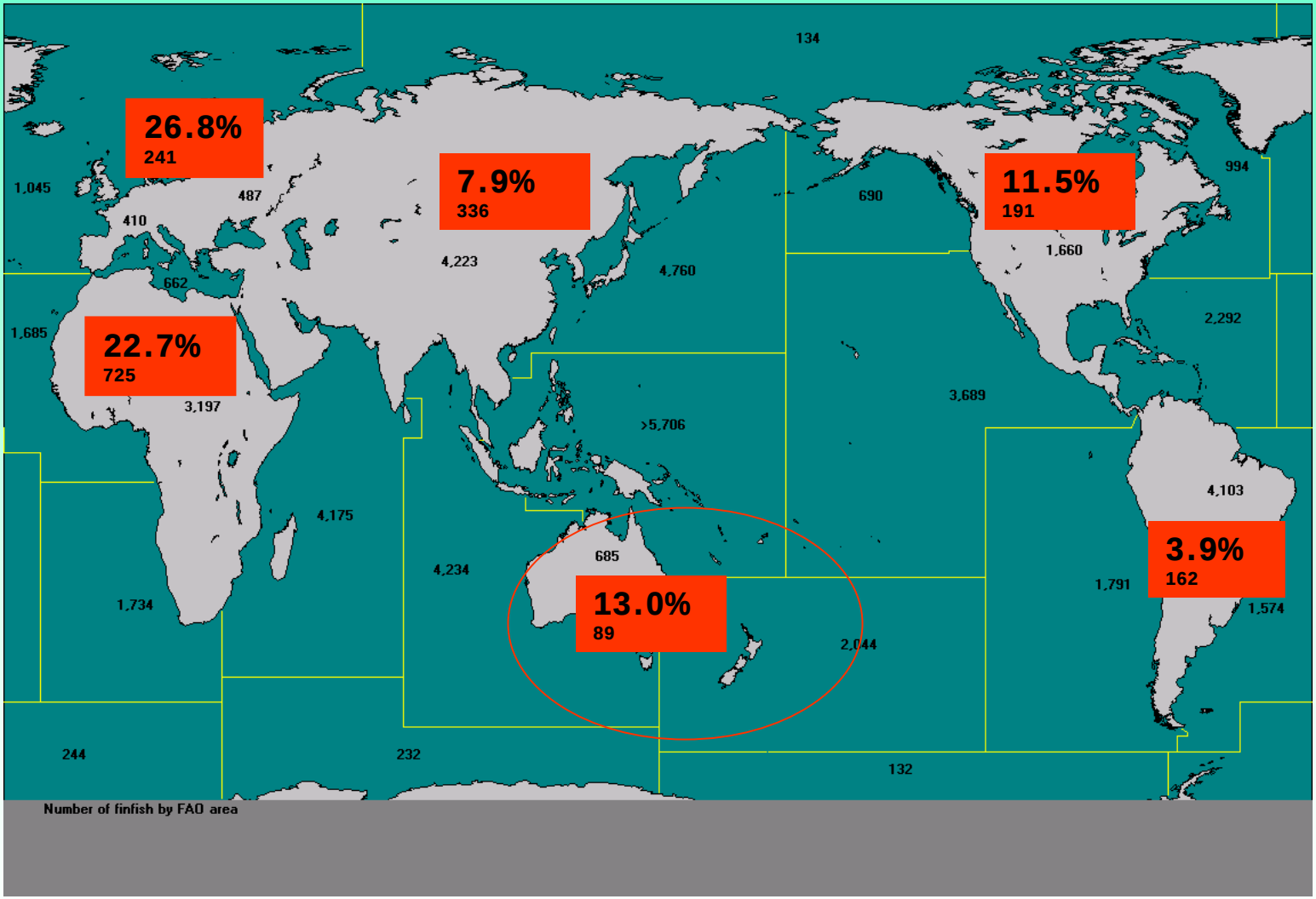

Interval Plot of redlist / total species vs OCEAN
95% CI for the Mean
redlist species / total species
2.5
2.0
1.5
1.0
0.5
0.0
Mediterranean
Atlantic
Indian
Pacific
OCEAN

Red-listed species in freshwater

Approximate number of red-listed freshwater species



Approximate PERCENTAGE of red-listed freshwater species – relative to total spec



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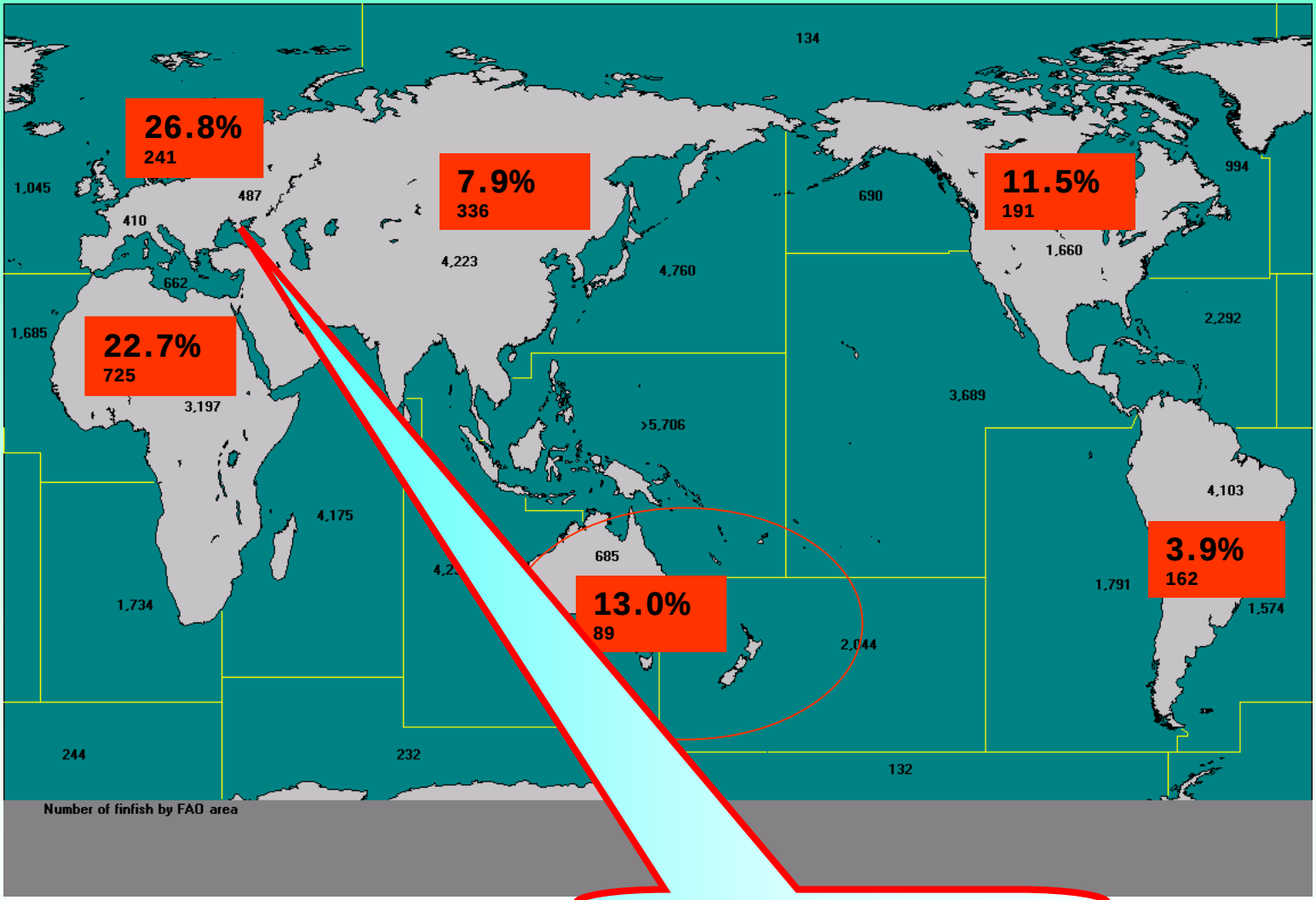
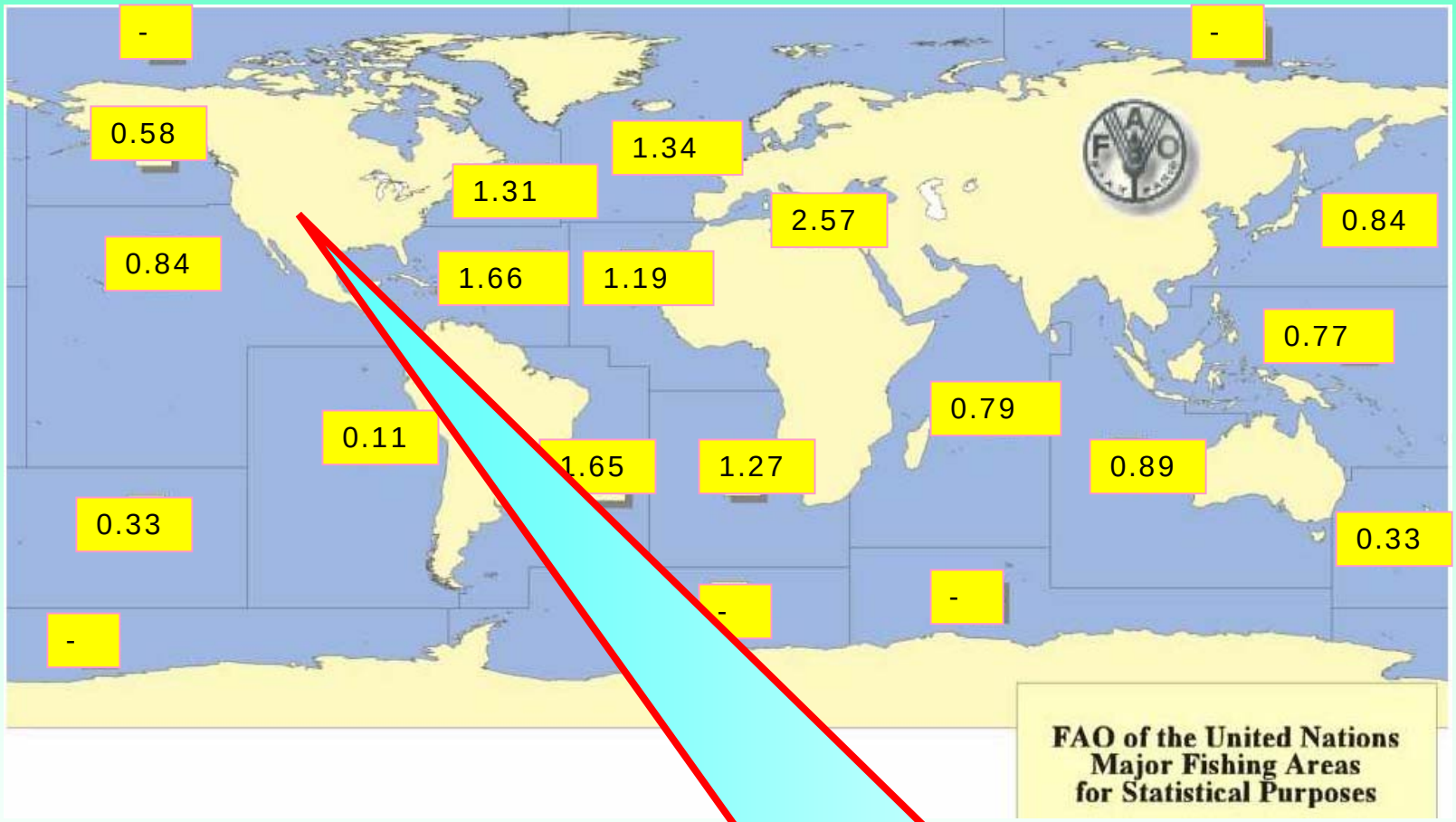


Index of Red-List MARINE species – (percent of listed species/all species)



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Percent of listed marine fish is much lower than FW

Several simple conclusions are clear relative to Red-listing:

FW >> marine

(1) There are many more endangered and extinct freshwater species than marine species

Several simple conclusions are clear relative to Red-listing:

FW >> marine
South >> north

(1) There are many more endangered and extinct freshwater species than marine species

(2) There more species endangered and extinct in the south parts of their ranges than in the north

Several simple conclusions are clear relative to Red-listing:

FW >> marine
South >> north
Atlantic >> Pacific

(1) There are many more endangered and extinct freshwater species than marine species

(2) There more species endangered and extinct in the south parts of their ranges than in the north

(3) There also seems to be more species marine listed in the Atlantic than the Pacific! **Why is that?**

anadromous fish (and estuarine species) may be more at risk
than marine

so, if **FW >> marine,** then

FW >> ANADROMOUS >> marine**

… in other words, all marine fish are not at equal risk…

…fully marine species like anchovy and sardine – in spite of their notorious population fluctuations seem to be at low risk, but shelf-based species like herring *(Clupea)* are at greater risk, and estuarine and anadromous species like the smelts are at high risk…..

**

P. Moyle (UC Davis) has reported on this for California fishes)

- So: are Pacific-Atlantic differences in listings of marine species real or are they an artifact?

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- This difference may simply reflect higher density of conservation biologists in the Atlantic?

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…If so, perhaps we should be doing more to protect Pacific species that are most vulnerable…..

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…If so, perhaps we should be doing more to protect Pacific species that are most vulnerable…..

And also, by recognizing such vulnerability we also may also help to appreciate and understand that climate change also affects many ‘non-commercial’ and ‘unimportant’ species.

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…If so, perhaps we should be doing more to protect Pacific species that are most vulnerable…..

And also, by recognizing such vulnerability we also may also help to appreciate and understand that climate change also affects many 'non-commercial' and 'unimportant' species.

Maybe climate change impacts are bigger than we think!

….end….