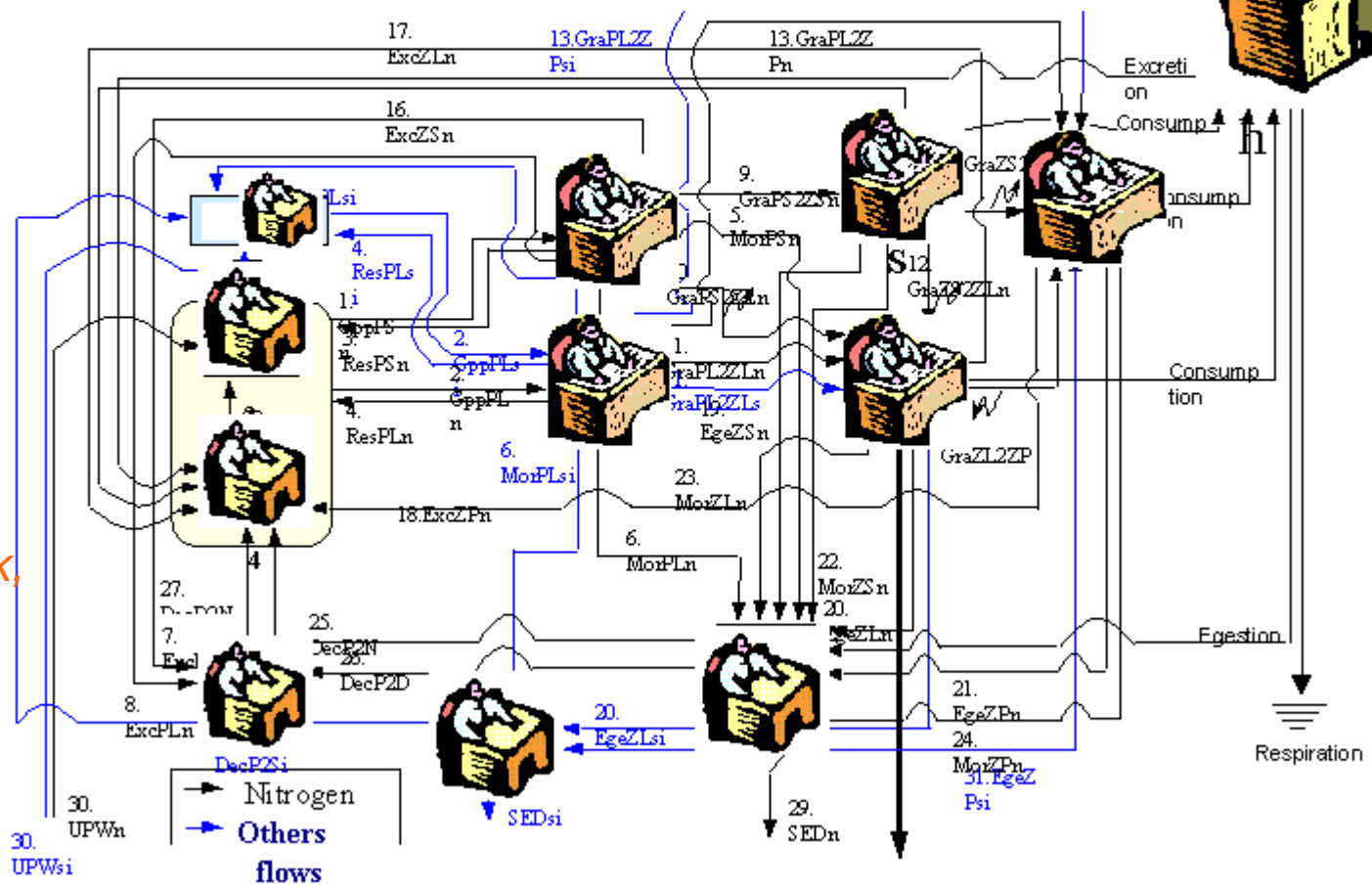
Ecosystem-based management of marine biological resources:

illusion and the reality

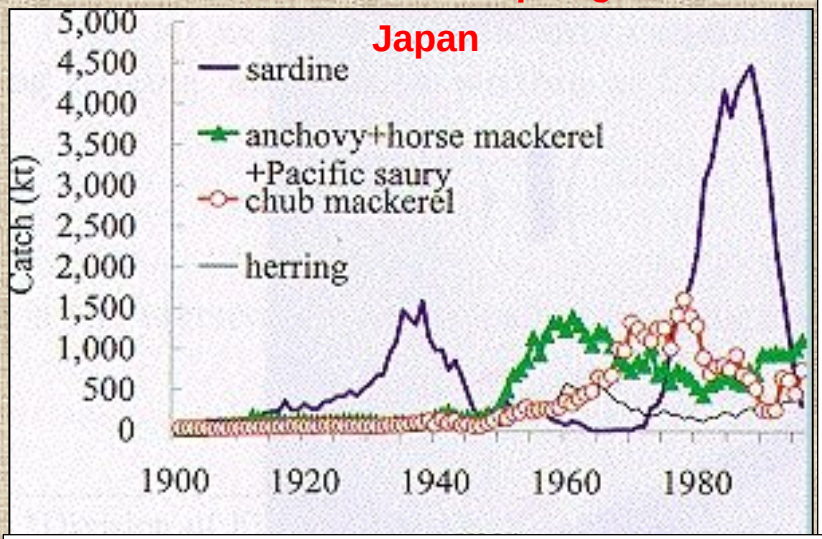
Shuntov, V.P.[1], and Radchenko, V.I.[2]

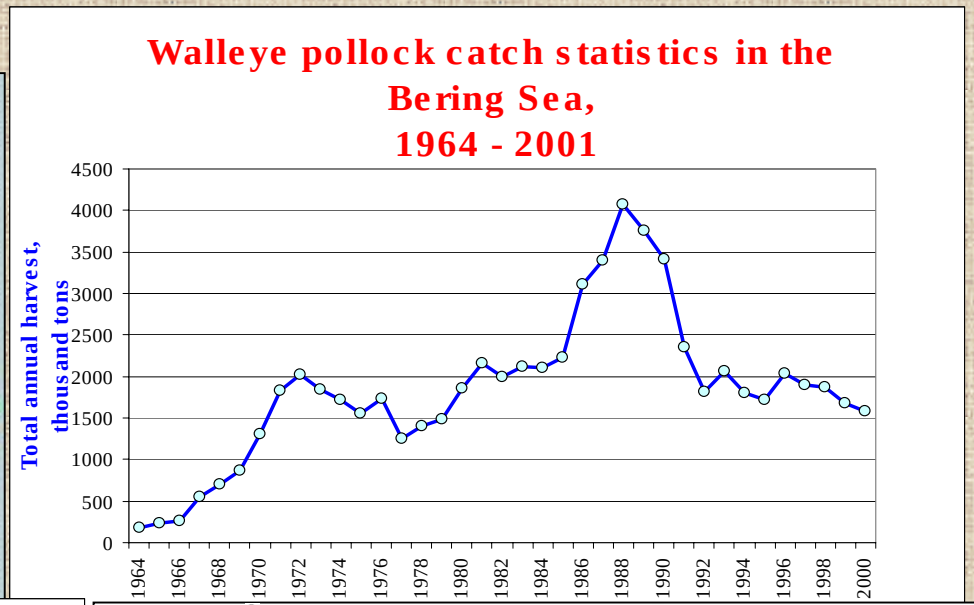
[1] – TINRO-Center, Vladivostok, 690600, Russia

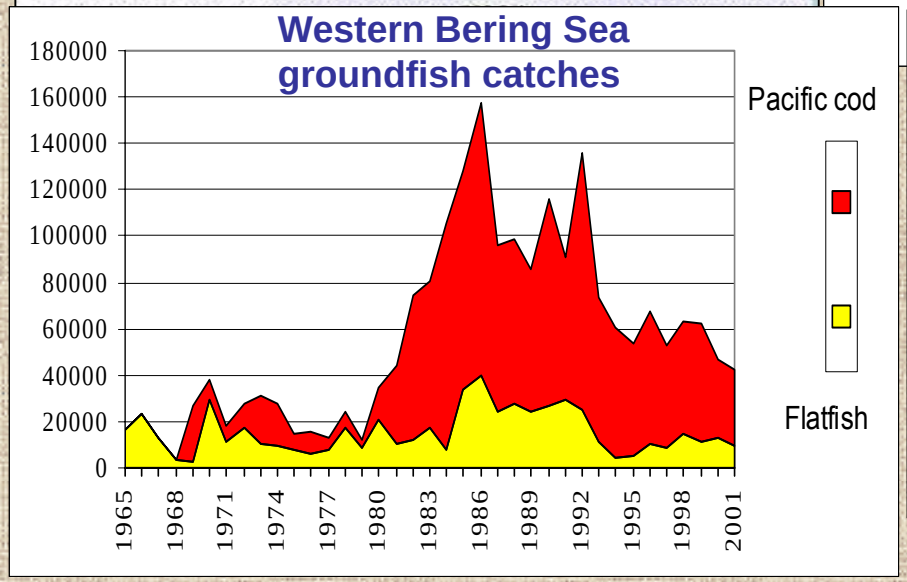
[2] – SakhNIRO, Yuzhno-Sakhalinsk, 693023, Russia
vlrad@sakhniro.ru



Catch statistic of some important commercial fish species in the North Pacific







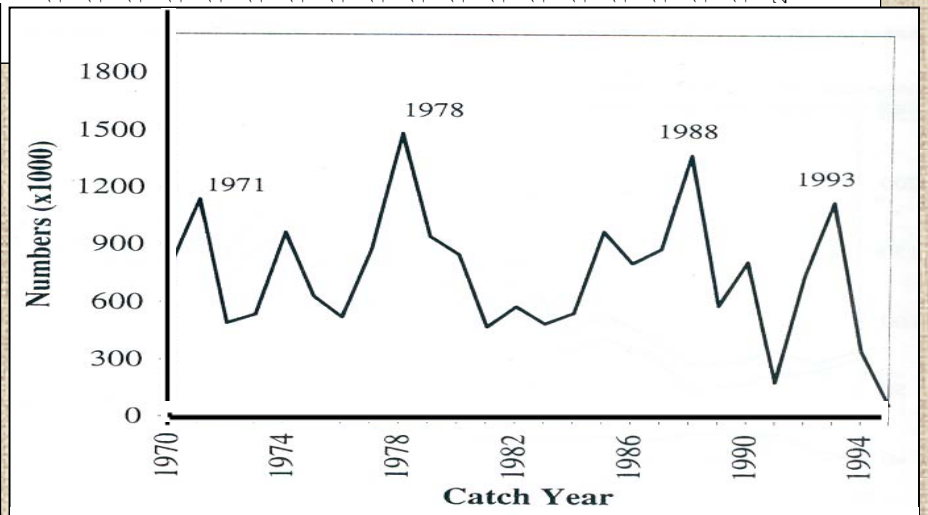
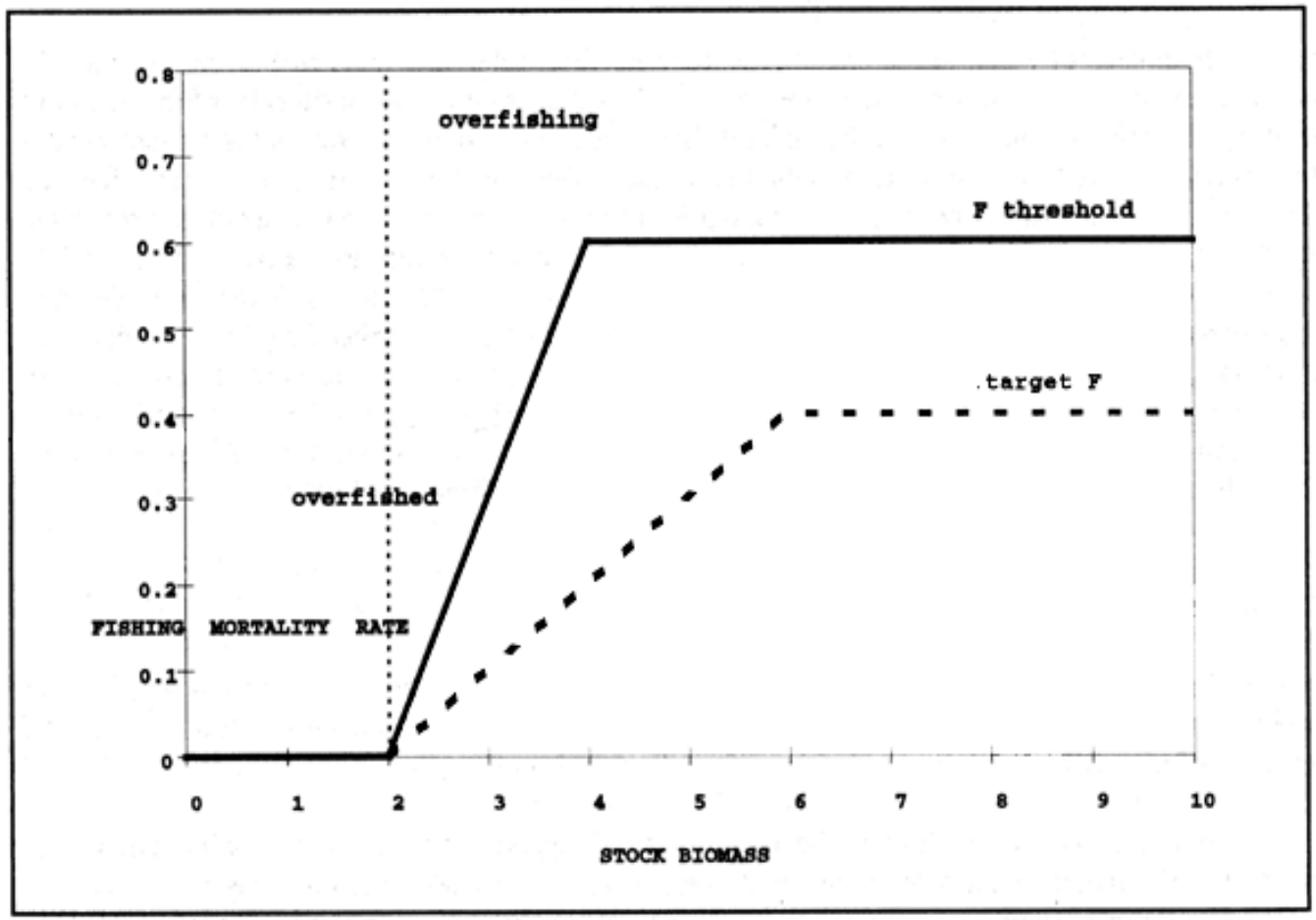


Fig. 6 Commercial & sport catch of coho salmon in the Strait of Georgia.

A schematic harvest control law

In this example, the dashed line represents a target fishing mortality rate which may vary as a function of stock size. A stock biomass value of 2 corresponds to an absolute biomass threshold. Biomass levels below this value indicate that the stock is overfished. The solid line represents a threshold fishing mortality, or the maximum allowable F. F values above this line indicate overfishing. A stock biomass value of 4 corresponds to a precautionary biomass level below which the maximum allowable F is reduced.

Precautionary

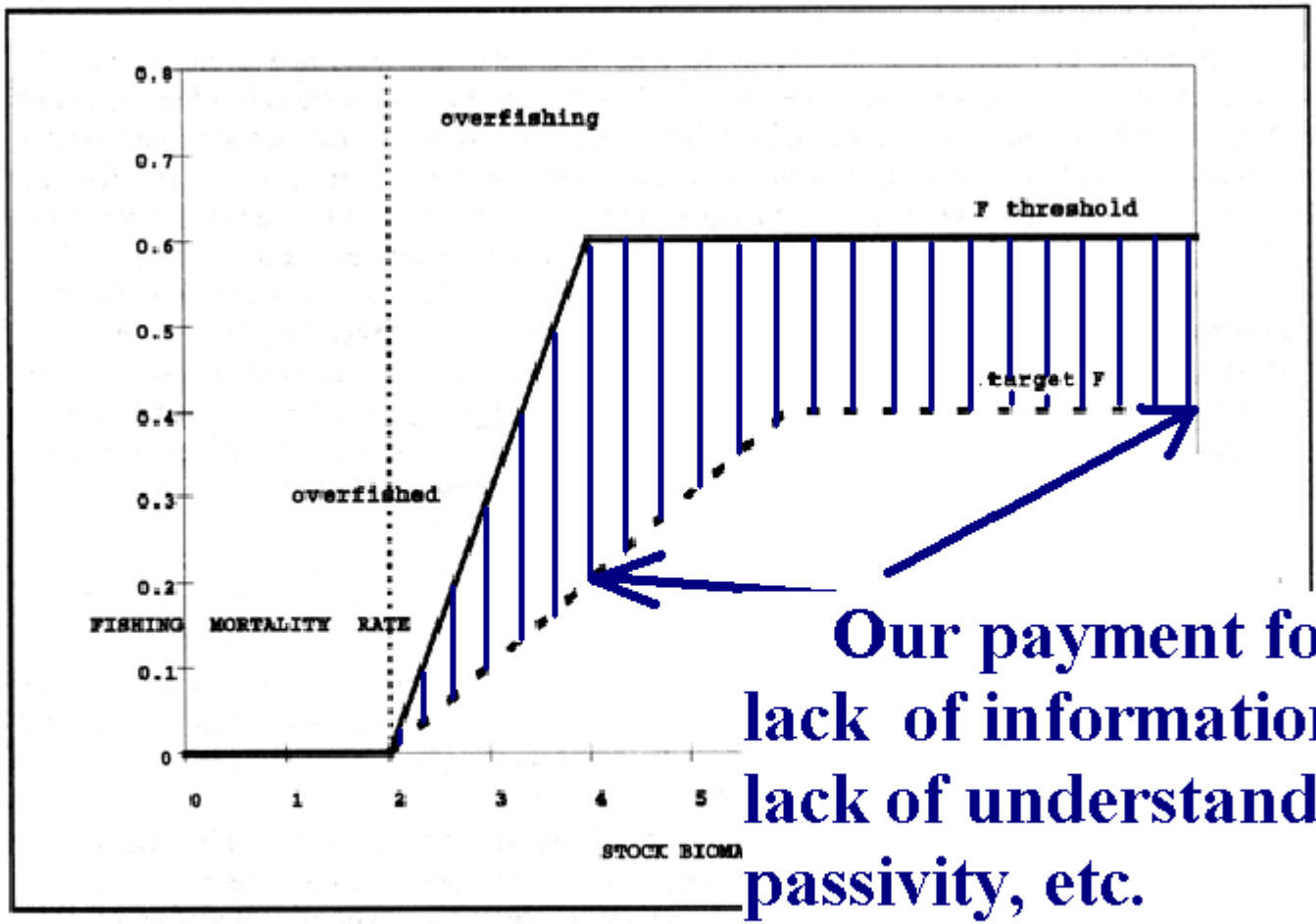


approach

A schematic harvest control law

In this example, the dashed line represents a target fishing mortality rate which may vary as a function of stock size. A stock biomass value of 2 corresponds to an absolute biomass threshold. Biomass levels below this value indicate that the stock is overfished. The solid line represents a threshold fishing mortality, or the maximum allowable F. F values above this line indicate overfishing. A stock biomass value of 4 corresponds to a precautionary biomass level below which the maximum allowable F is reduced.

Precautionary



Our payment for lack of information, lack of understandings, passivity, etc.

approach

- The Google search gives 4 references on the word-combination «precautionary approach» (in Russian) and 514 references on the word-combination «Ecosystem-based approach» (in Russian)[1]. However, fishery regulation in Russia is conducted basing on the precautionary principles in much more degree, than on the ecosystem-based theory

[1] In English, the search results ratio (by Google) differs significantly: 219,000 versus 13,300 references.

- Ecosystem-based approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Thus, the application of the ecosystem approach will help to reach a balance of the three objectives of the Convention: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

5th Conference of Convention on biodiversity, 2000, Decision V/6
http://www.biodiv.org/decisions/default.asp?lg=0&m=cop-05&d=06

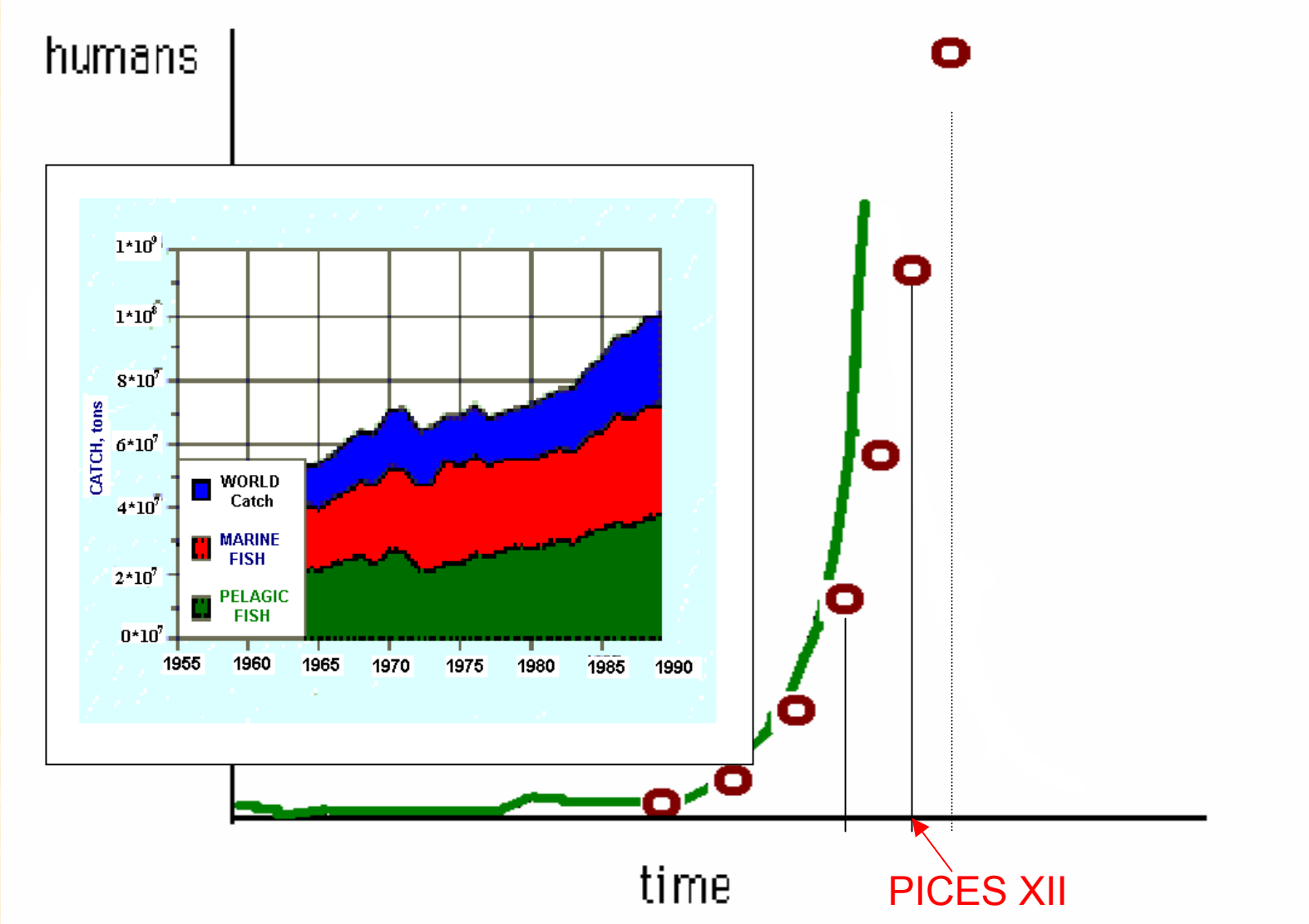
Some definitions of the Ecosystem-based Management

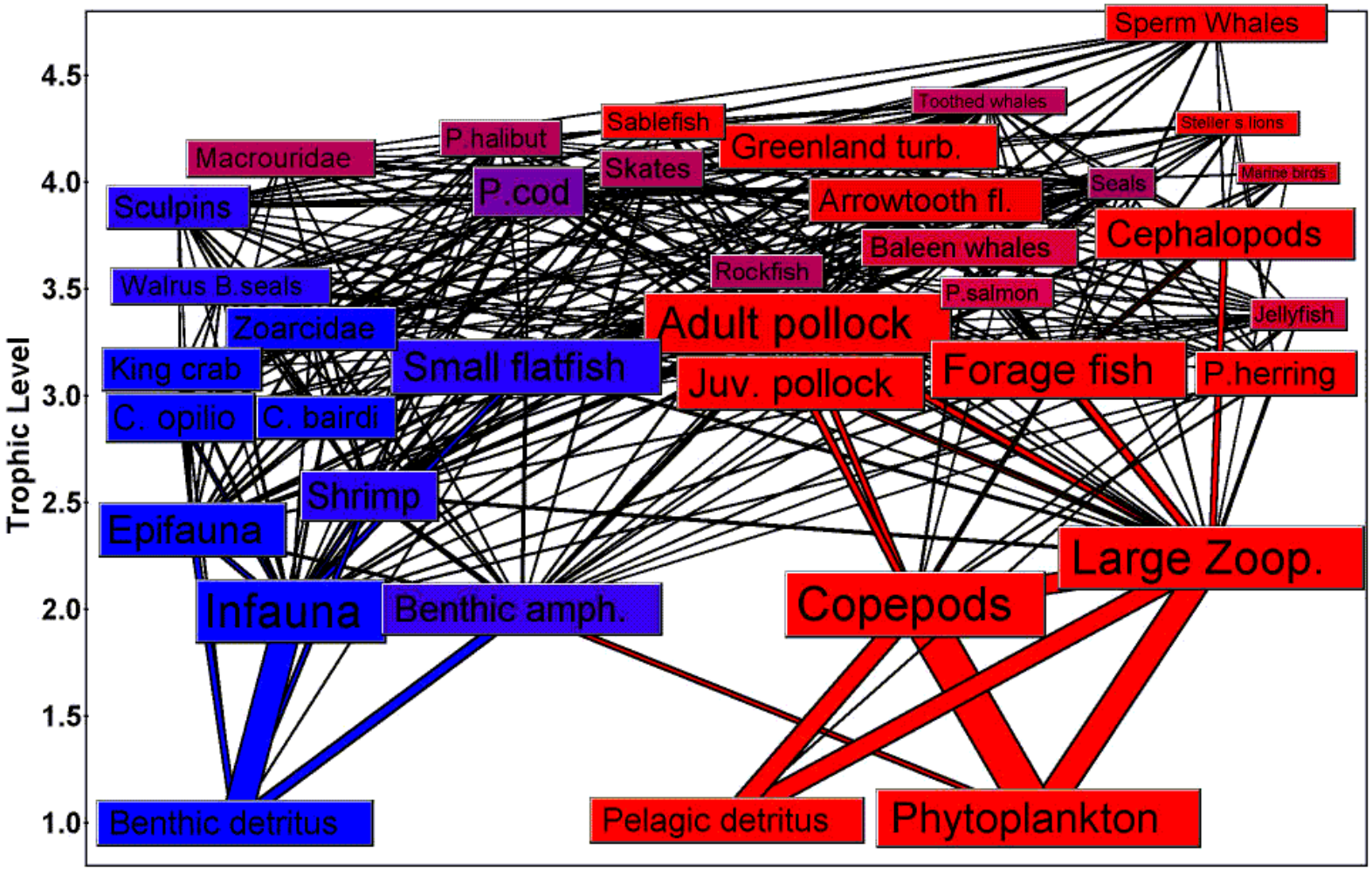
- Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term (Holt 2001)

- Ecosystem-based management integrates scientific knowledge of ecological relationships with sociopolitical values to maintain long-term system viability through collaborative stewardship of ecosystem components; including their functions, processes, interactions, and intrinsic value. Ecosystem-based Management Strategy - Conserve, restore, and enhance ecosystems (including their functions, processes, constituent species, and productive capacities) by integrating ecological, social, and economic factors (O'Neil, Ecological Analysis Center, Oregon Department of Fish and Wildlife, Corvallis, Oregon)

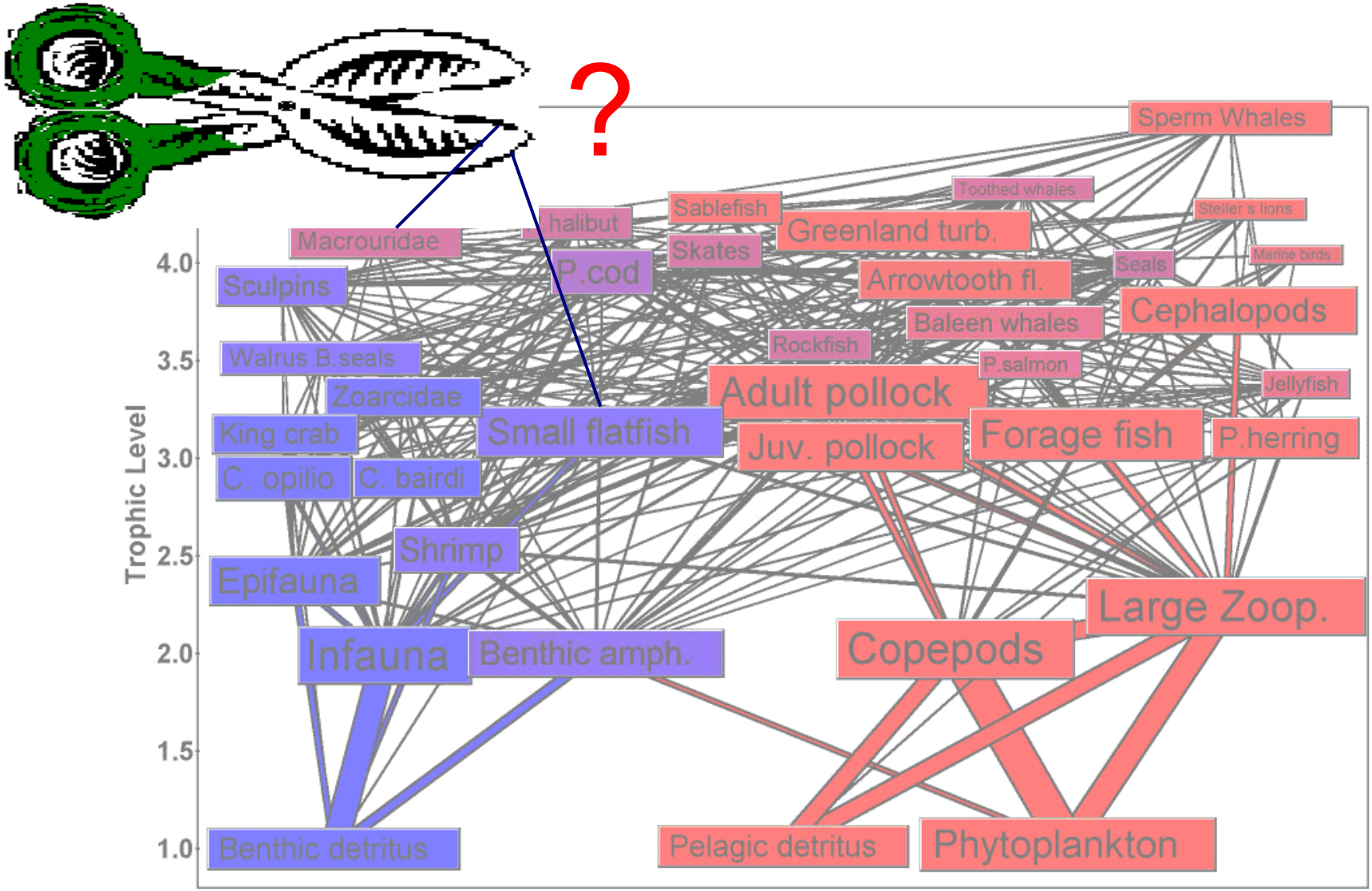
- Ecosystem-based management is development and implementation of comprehensive information, training and marketing strategies that foster ecosystem-based assistance implementation of broad-based interdisciplinary activities to help farm, ranch, and urban customers maintain the long-term productivity of the resource base and the quality of the environment (NRCS, US Department of Agriculture).

Currently we have roughly 6.2 billion people on the earth. The world population has more than doubled in the past 49 years. From 2.5 billion in 1950 to 6.2 billion today. Every 12 years we add a billion to the population. Unless death rates rise, it may reach 8 billion by 2025





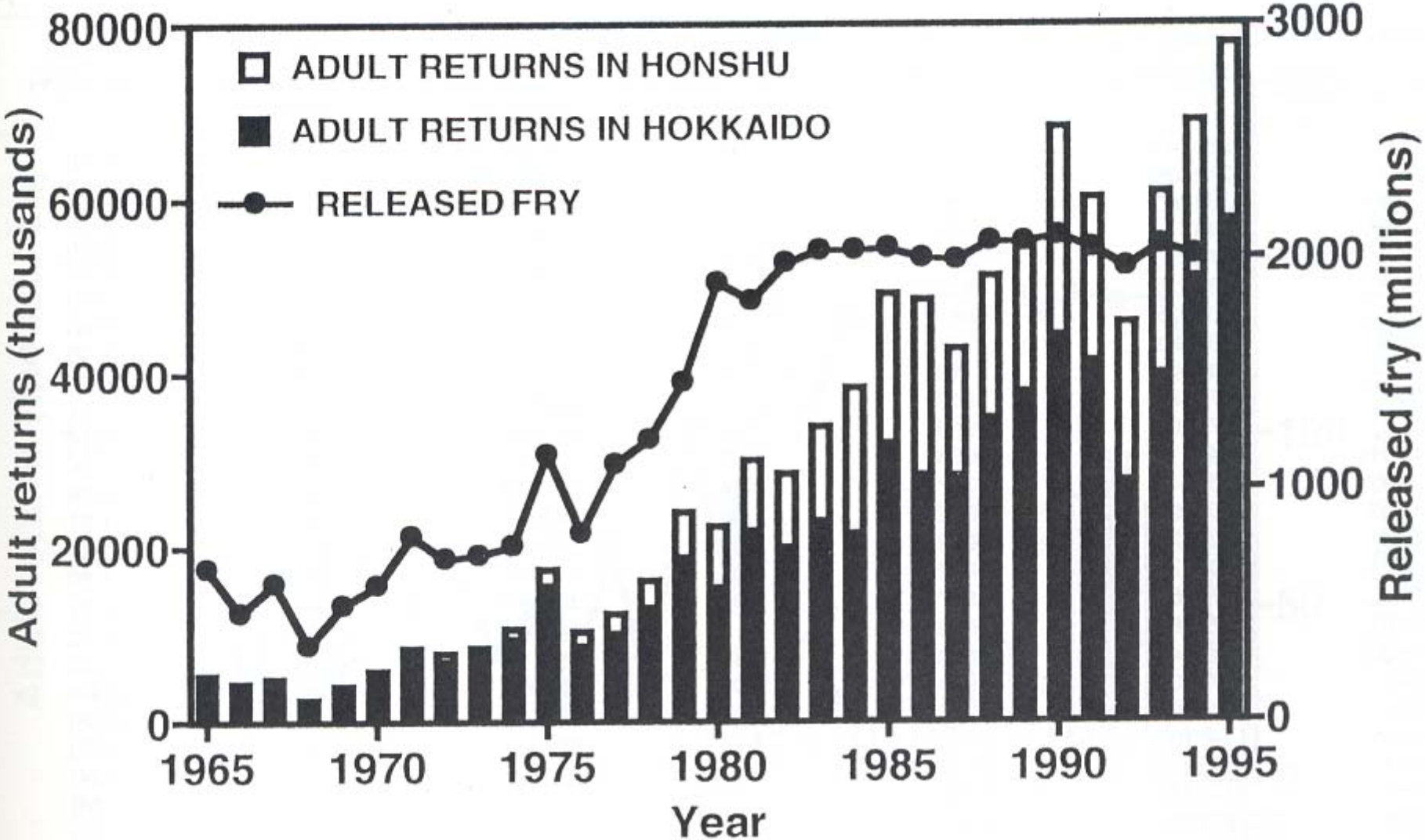
The trophic webs of the Eastern Bering Sea model. Trophic level is shown on the Y-Axis; box size is not proportional to biomass. All predator prey flows are shown; the width of each predator/prey flow is proportional to the square root of the volume of the flow (t/km^2/year), from Audin et al. 2002.



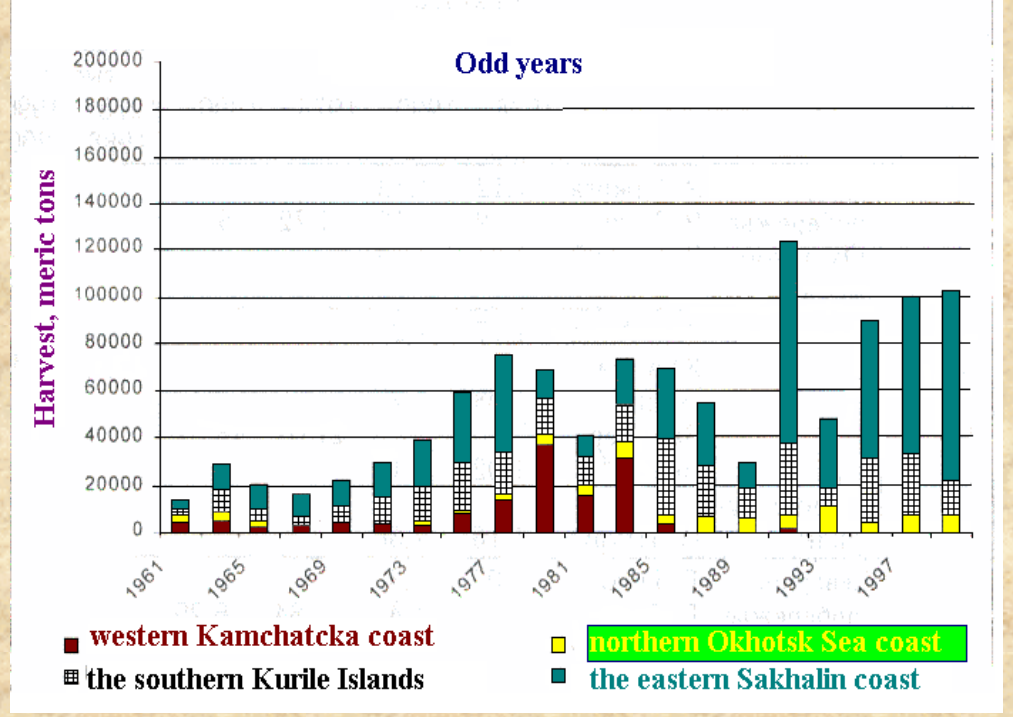
Which cut ?

(i.e. which link must be effected ?)

Fig. 1 Annual changes in adult returns and released fry for chum salmon from Japan, 1965-1995.

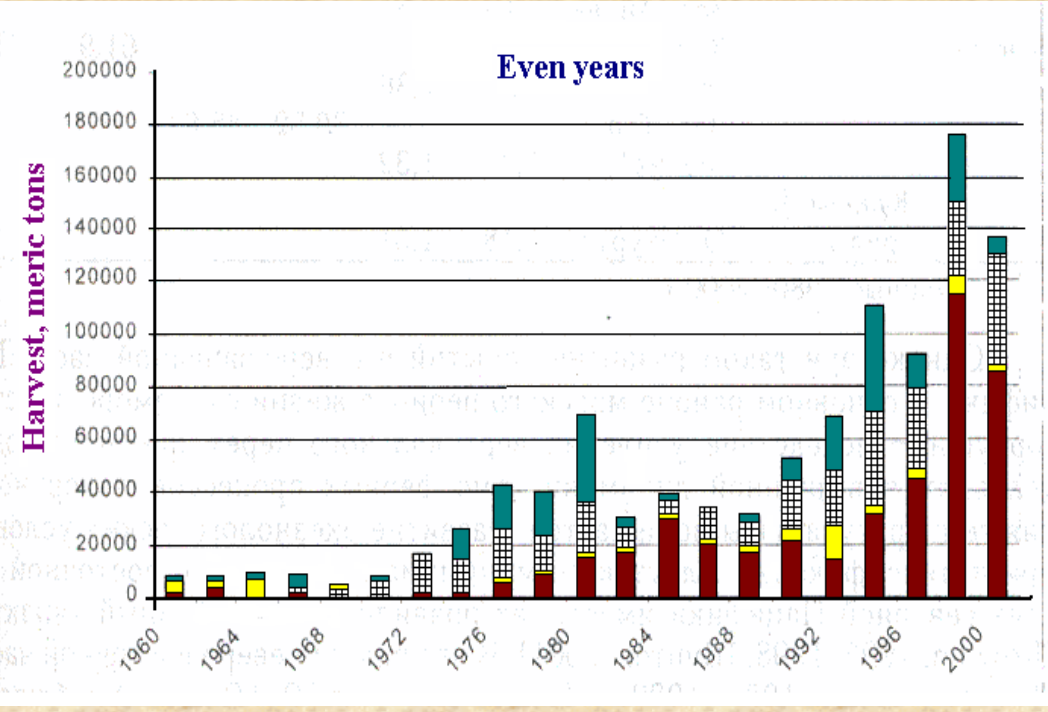


Hiroi 1998

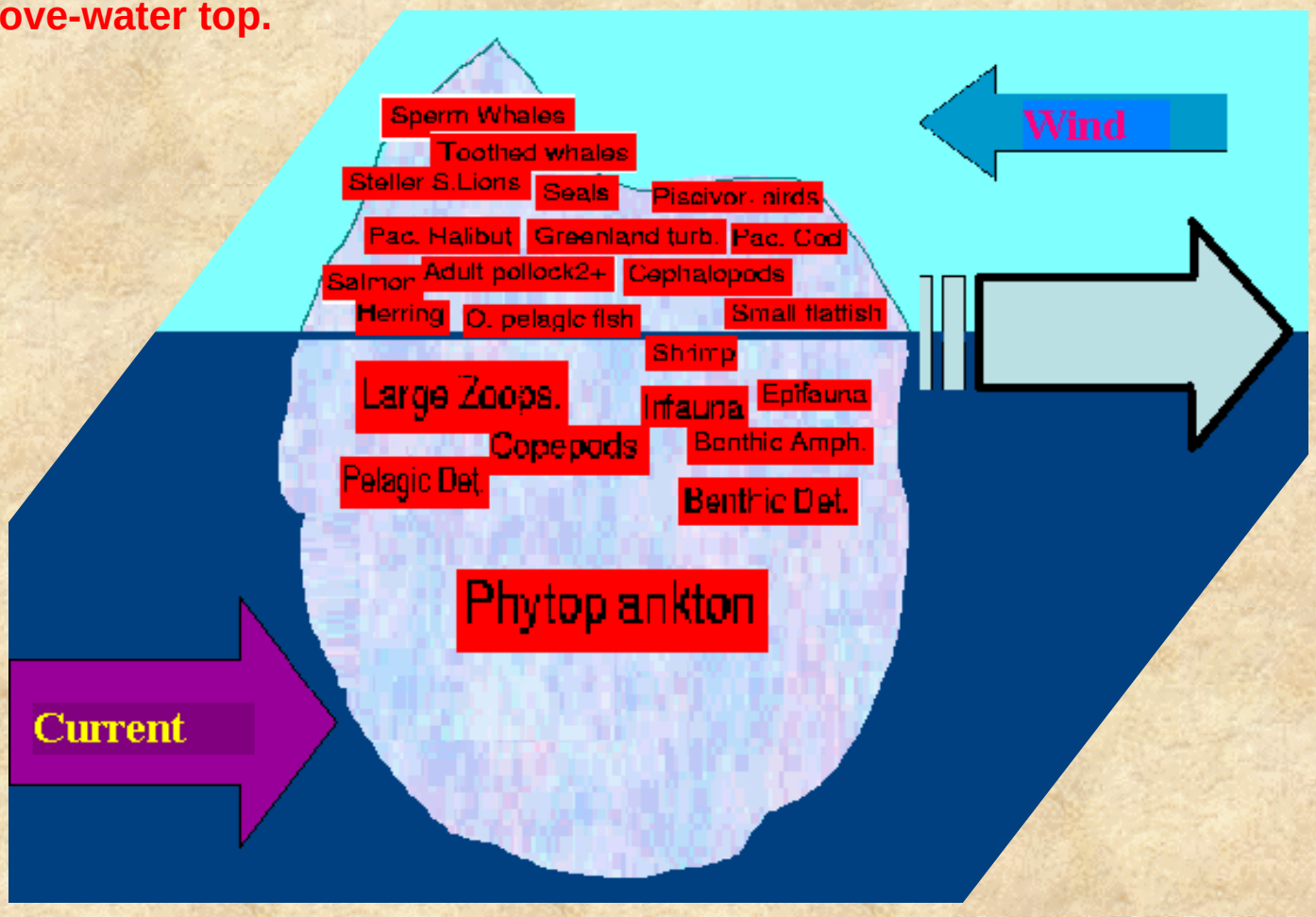


Pink salmon coastal catch dynamics in the main commercial fishery regions in the Sea of Okhotsk,

after Temnykh et al. 2002



Even deep autoecological understandings on the common fish species – commercial fishery objects are like an above-water top part of iceberg, and linkages in the community and ecosystem are like the under-water part. In this figurative example, iceberg is moved at sea by currents effecting on its under-water part but in less degree by wind effecting on its above-water top.



Like that, processes in fish communities and ecosystems at times influence biological species, which are a part of them, in the more degree than direct fishery stress.

Customary formula of fish biomass calculations basing on the trawl survey data, after Shuntov et al. 1988, Borets 1997

$$B = \frac{Sq}{sk}$$

where B - fish biomass, S - investigated area, s - swept area during the trawl haul, k - gear catchability factor

In the ecosystem studies, k varied from 0.01 to 0.5 for different species and groups

Biomass of the main animal groups (g/m^2) in the Bering and Okhotsk Seas

After Shuntov and Dulepova 1995	Bering Sea	Okhotsk Sea
Euryphagous zooplankton		
summer	136.0	205.0
fall	74.0	131.0
Predatory zooplankton		
summer	37.0	39.0
fall	56.0	60.0
Euryphagous benthos	83.0	125.0
Predatory benthos	5.4	12.7
Pelagic fish	16.8	15.8
Demersal fish	5.0	3.2
Total nekton	18.5	16.4
Total nektobenthos	6.0	4.1
Marine mammals and birds	0.6	0.1

Minke whale abundance and seasonal diet ration, after T.Tamura & H. Kato, this PICES meeting

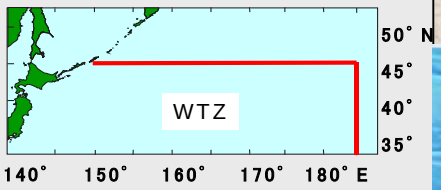
PICES region WTZ (Western Tropical Zone)

Common minke whale :

about **12,000** animals

Daily prey consumption :

about **2,300** tonnes

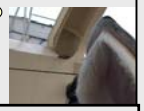


Seasonal prey consumption (180 days)

: about **414,000** tonnes

Prey switching ?

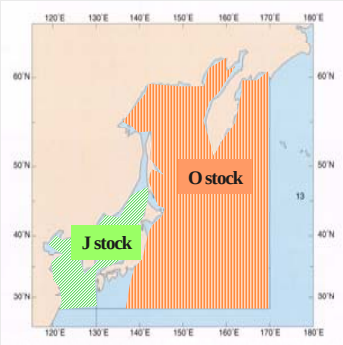
Regime shifts



Major prey species of common minke whales in western North Pacific

Krill (*Euphausia pacifica*)	Japanese anchovy (*Engraulis japonicus*)	Pacific saury (*Colorabis saira*)
160kg	300kg	300kg
Body length 2 – 3cm	Body length 12 – 13cm	Body length 20 – 30cm

Stock structure

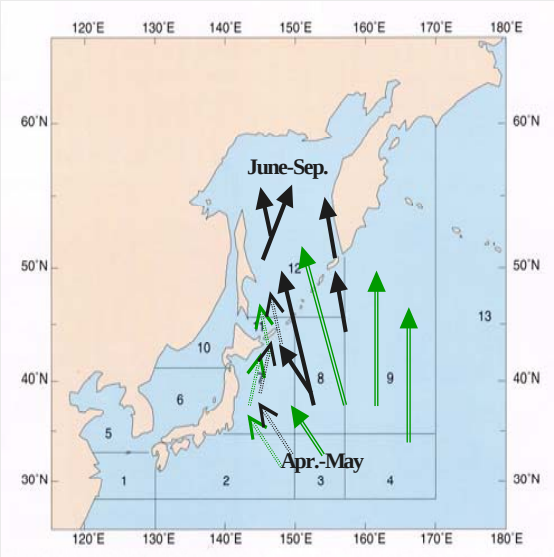


Abundance (O stock)

25,000 animals

IWC1 1992

Migration pattern of common minke whale (O stock)



Immature ⇐ Mature Male ← Mature Female

Fishing Down Marine Food Webs

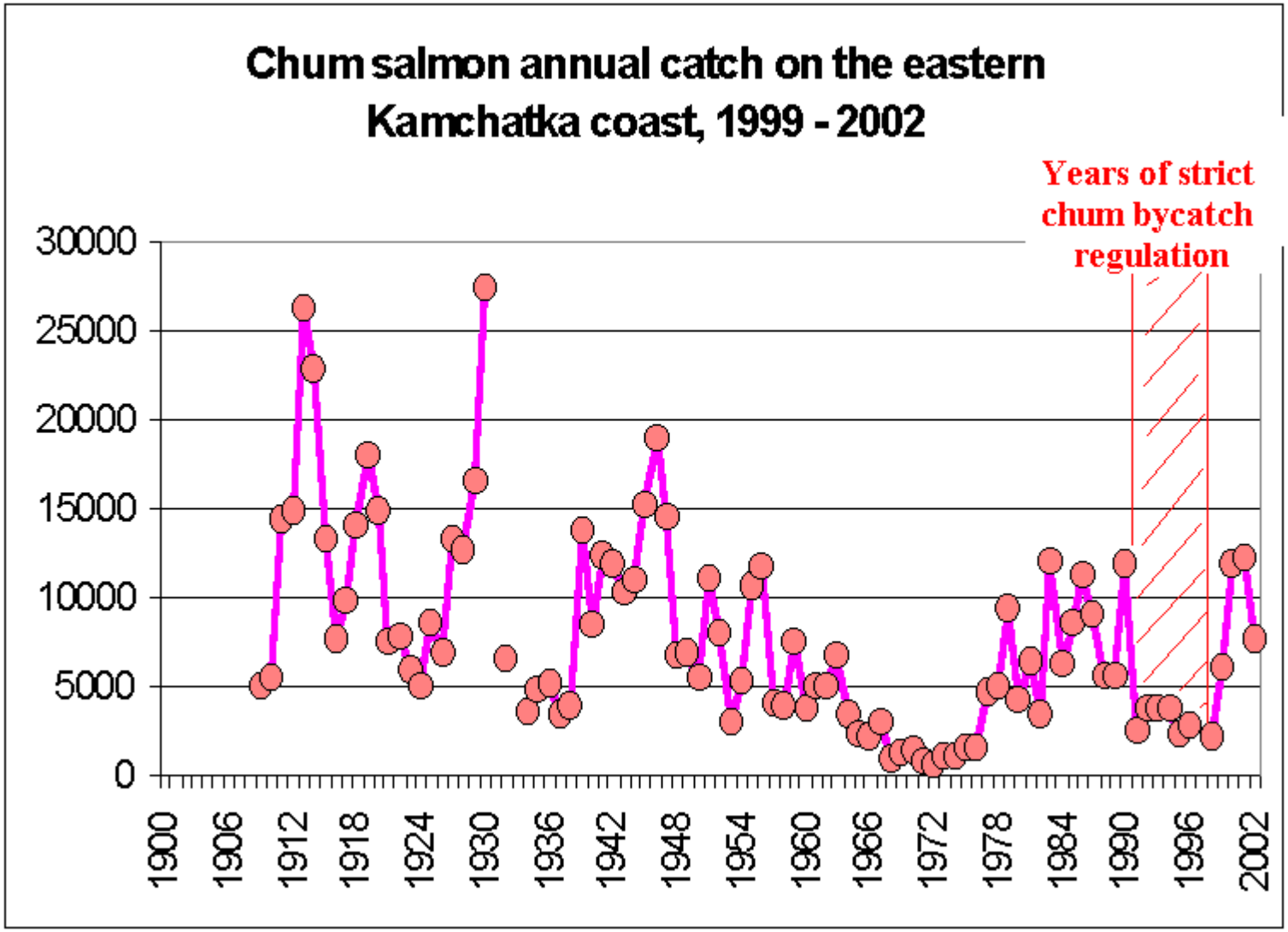
Daniel Pauly,* Villy Christensen, Johanne Dalsgaard,
Rainer Froese, Francisco Torres Jr.

The mean trophic level of the species groups reported in Food and Agricultural Organization global fisheries statistics declined from 1950 to 1994. This reflects a gradual transition in landings from long-lived, high trophic level, piscivorous bottom fish toward short-lived, low trophic level invertebrates and planktivorous pelagic fish. This effect, also found to be occurring in inland fisheries, is most pronounced in the Northern Hemisphere. Fishing down food webs (that is, at lower trophic levels) leads at first to increasing catches, then to a phase transition associated with stagnating or declining catches. These results indicate that present exploitation patterns are unsustainable.

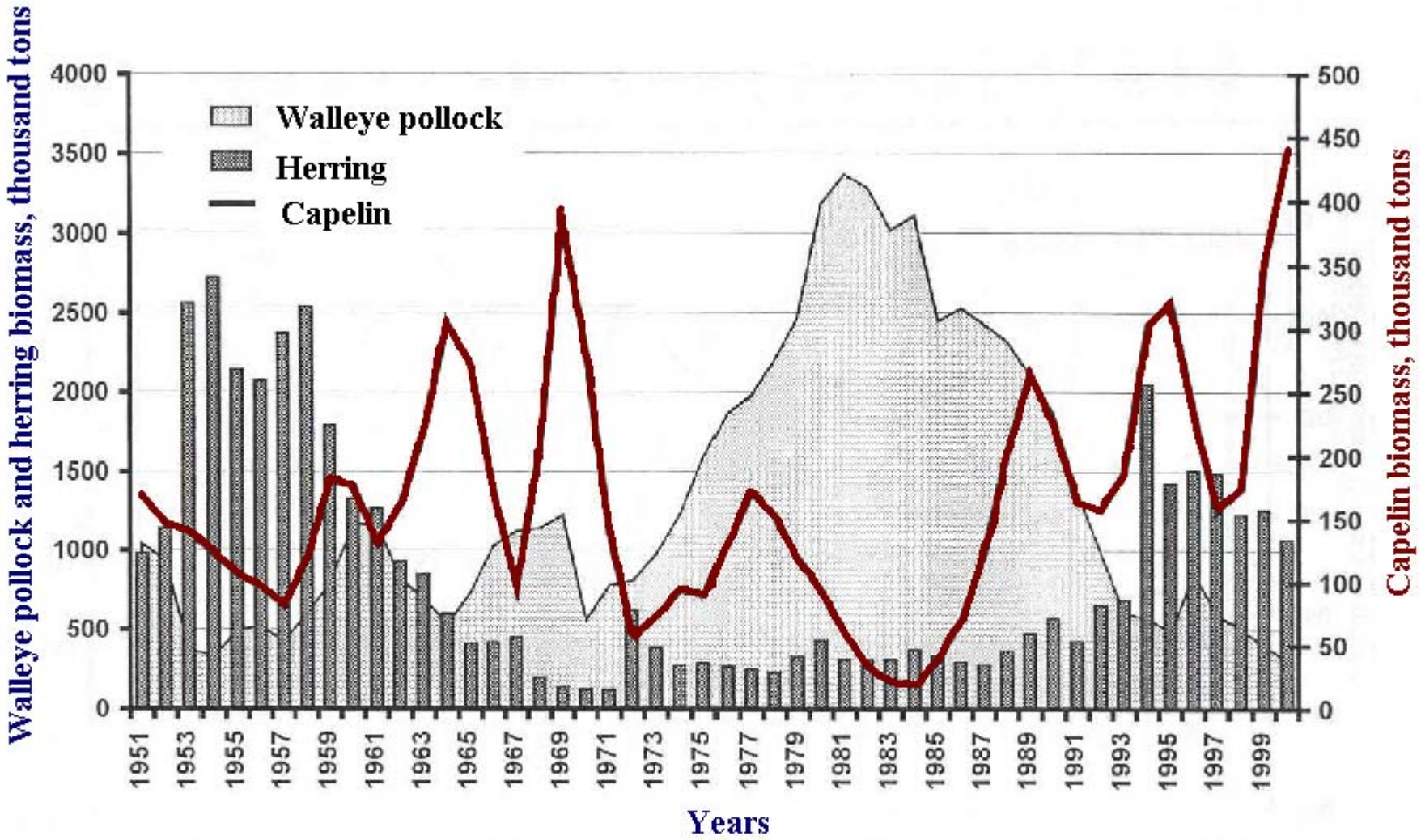
Annual consumption of the walleye pollock in the Bering Sea and the Sea of Okhotsk in 1980s, million metric tons (Shuntov and Dulepova 1993)

Mortality sources	Sea of Okhotsk	Bering Sea
Larger pollock (Cannibalism)	0.6	0.9
Other predatory fish species	2.2	4.5
Marine mammals and birds	0.4	1.5
All predators	**3.2**	**6.0**
Commercial fishery harvest	1.8	2.0*
Walleye pollock production	5.0 – 7.5	10.0 – 12.5

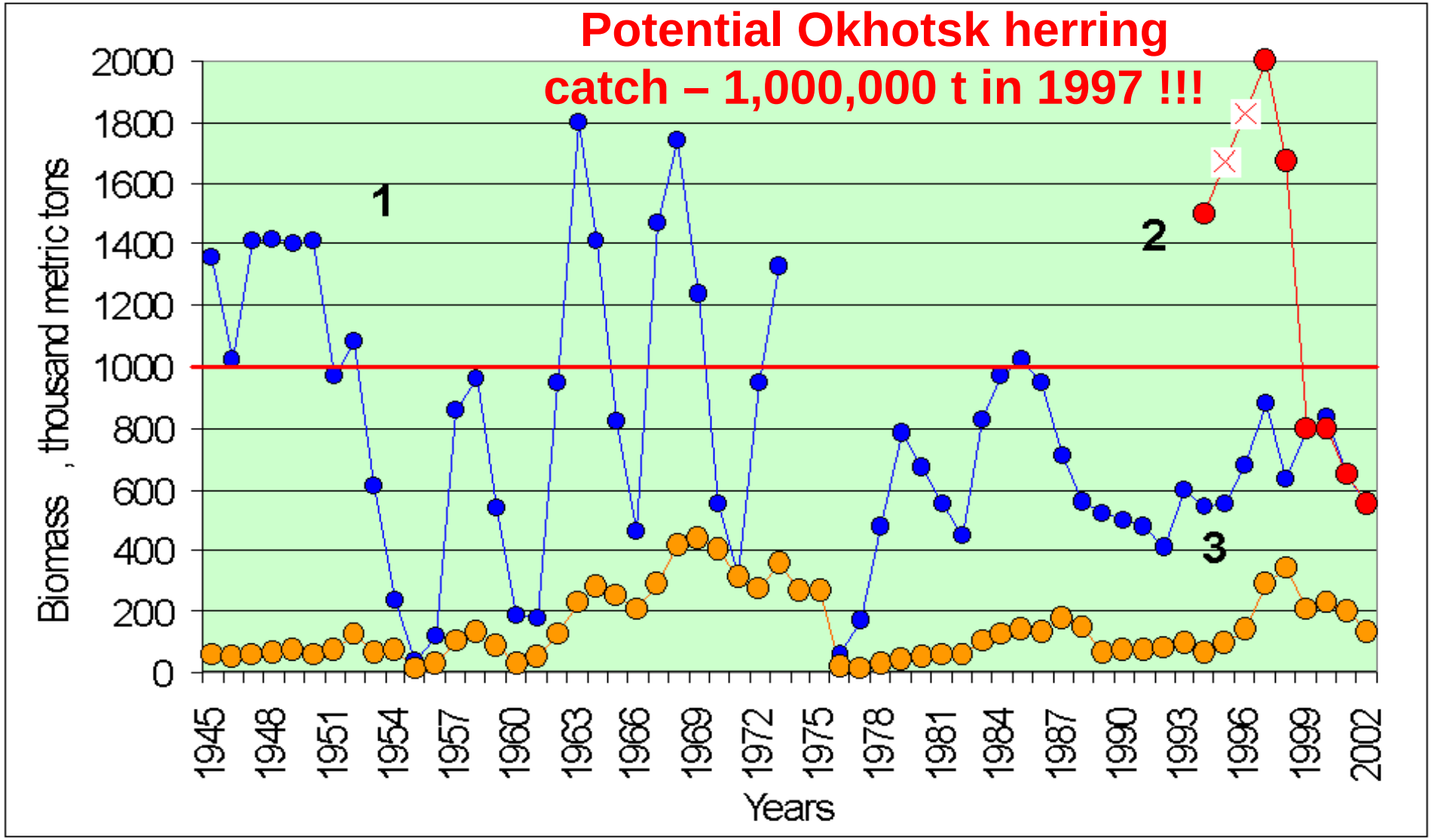
Remark: Catch data of 1988 (3.8 million tons) are not included



After 1997, chum bycatch in the coastal Pacific salmon fishery has not been strictly limited. This measure led to the average pink salmon catch increase from 32,200 to 43,200 tons, sockeye salmon - from 3,950 to 5,820 tons.



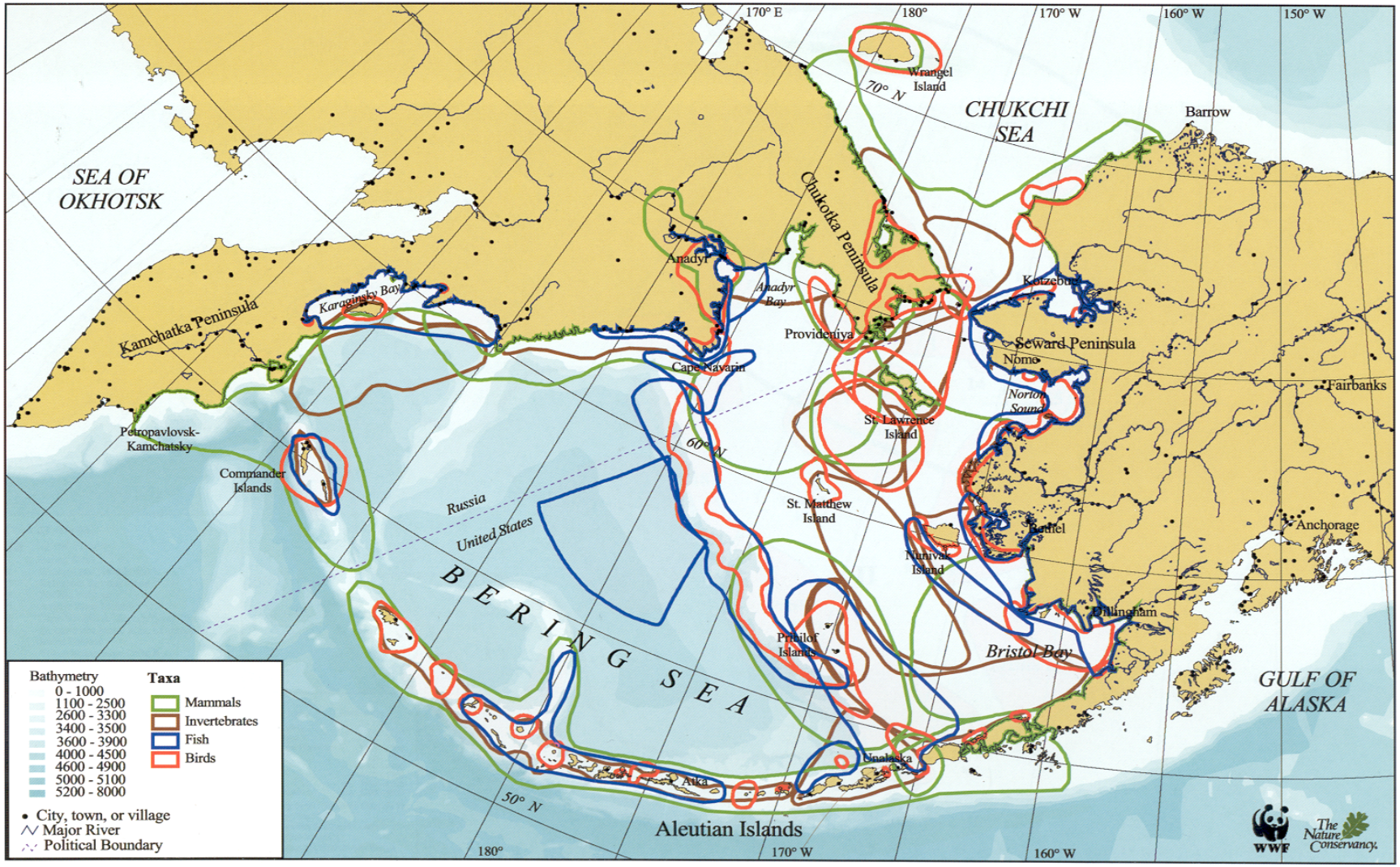
Dynamics of the biomass estimations of common pelagic fish in the western Bering Sea, 1951 – 2000 гг., after Naumenko 2001



Spawning stock fluctuations and catch dynamics of the Okhotsk herring population, 1945-2002. 1 - spawning stock estimations from the MagadanNIRO; 2 - corrections made by the TINRO-Center basing on pelagic trawl survey data (crosses present an assumed level for years between autumnal integrated surveys); 3 - total annual catch.

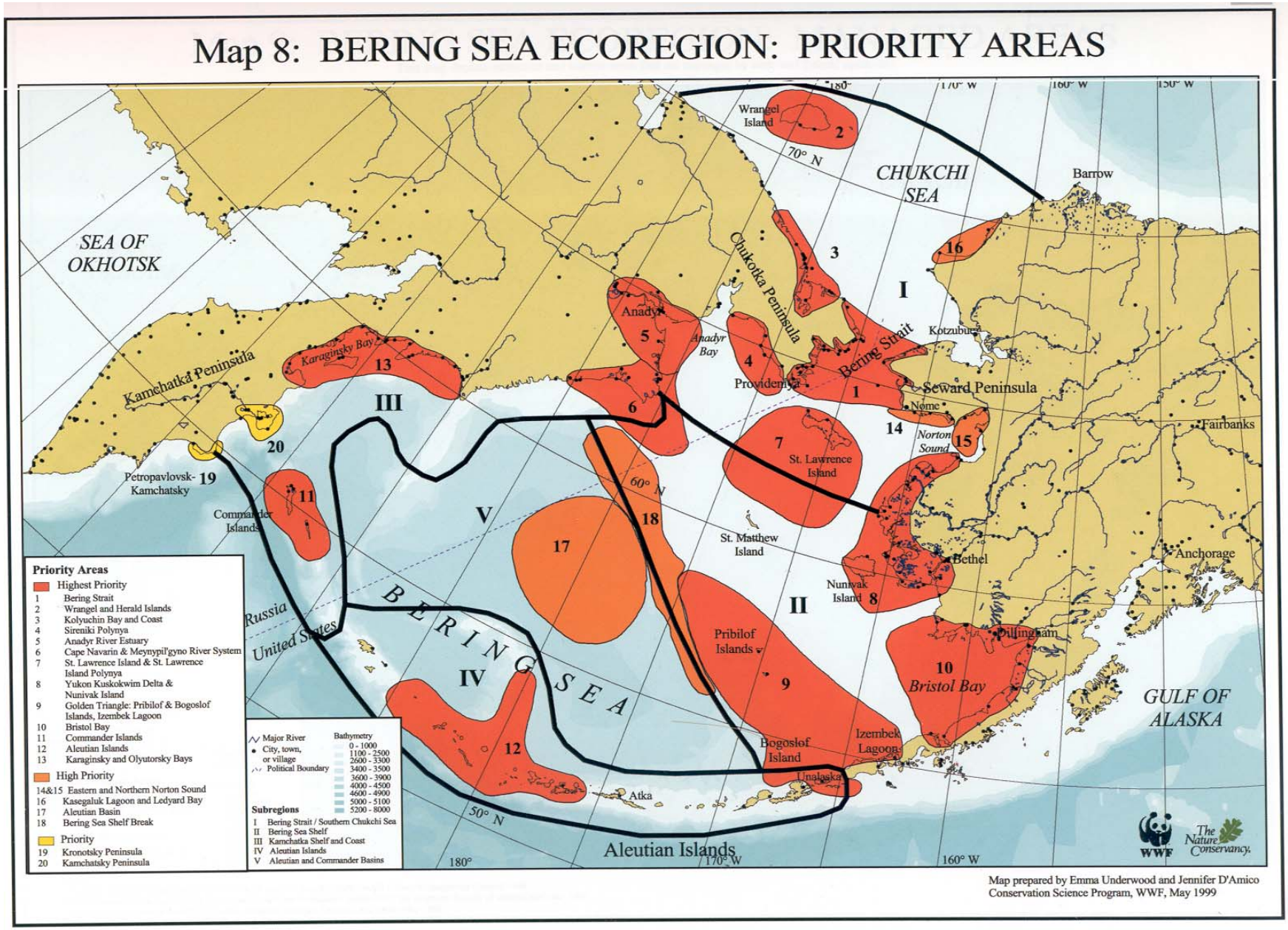
WWF. 1999. Ecoregion-based management in the Bering Sea

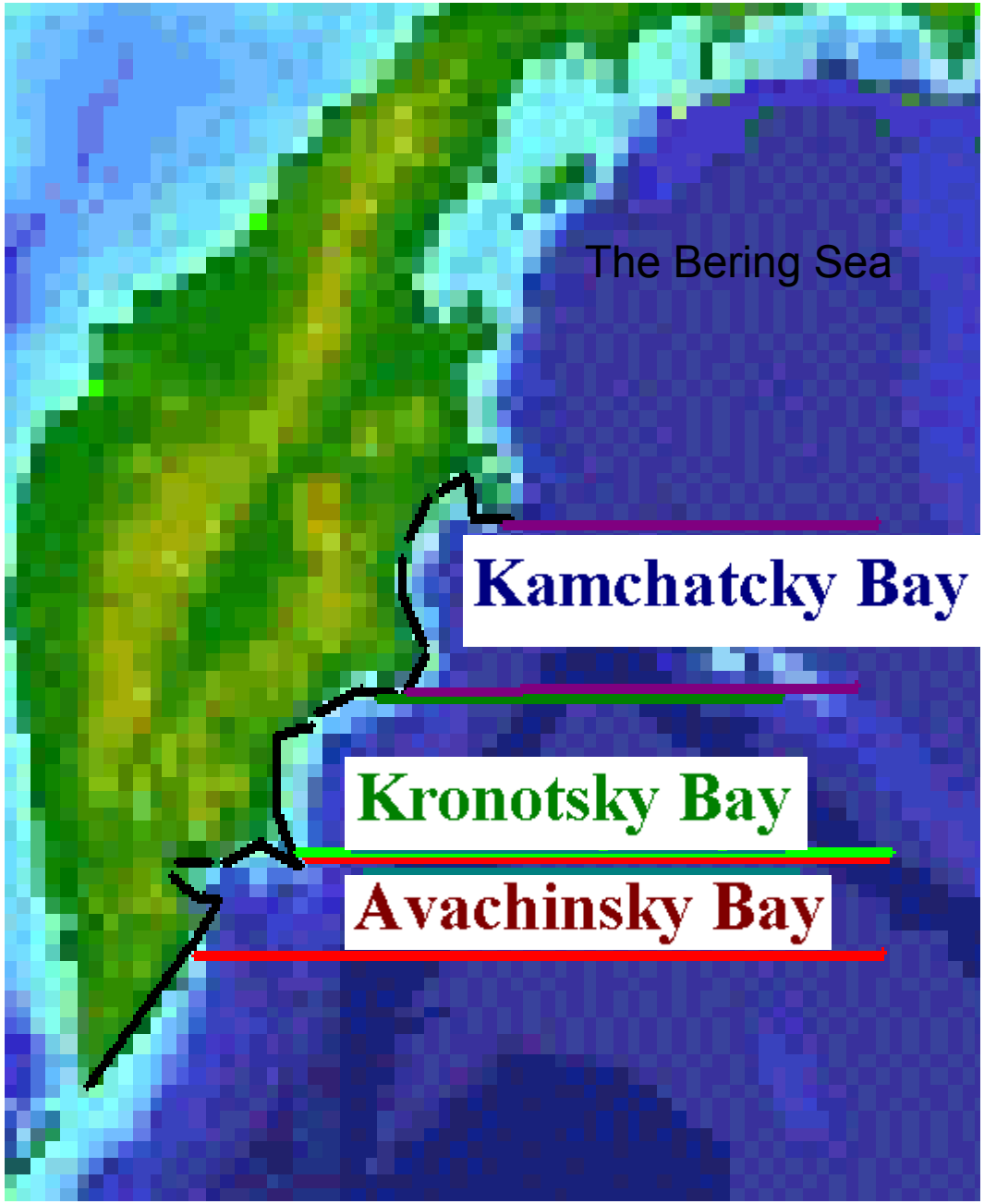
Map 7: BERING SEA ECOREGION: OVERLAPPING PRIORITY AREAS



Map prepared by Emma Underwood and Jennifer D'Amico
Conservation Science Program, WWF, May 1999

WWF. 1999. Ecoregion-based management in the Bering Sea





Different management tactics could be applied on the local areas to receive comparable results from study of human activity effect on fish communities and ecosystem overall.

In Russian EEZ, it can be the eastern Kamchatka bays, which are characterized by close physical conditions and fauna composition: the Kamchatsky Bay, the Kronotsky Bay, and the Avachynsky Bay.

One from them could be an area of the strict fishery management from the point of view of present understandings and regulations,

second bay – area of complete fishery prohibition,

and third one – an area of maximum intensive fishery on the evident over-fishing level.


Thank you for
your attention