

Biocomplexity and fisheries sustainability

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What is biocomplexity

- Biodiversity is the diversity of life forms including species diversity, and diversity of stocks, life histories and morphologies within a species
- Biocomplexity is the “complex chemical, biological and social interactions in our planet’s systems” (Colwell 98)

The Earth is a living, ever-changing planet. Its environment is defined by the interaction of many complex systems that are structured or influenced by living organisms, their components or biological processes. These systems are the source of our sustenance, well being and quality of life. Biocomplexity is the defining property of these systems, resulting in the 'whole being greater than the sum of its parts'. The area of biocomplexity that will come to the forefront in coming years is that of interactions of living organisms with all facets of their external environment. In particular, research on interactions involving multiple levels of biological organization and/or multiple spatial (microns to thousands of kilometres) and temporal (nanoseconds to aeons) scales will be of great importance. (Colwell 2000)

Fisheries Sustainability: The Litany

- “Most of the world's major fisheries are depleted or rapidly deteriorating. Wherever they operate, commercial fishing fleets are exceeding the oceans' ecological limits.”

Greenpeace

Fishing industry

*Plan to ban factory trawlers
addresses issue of overfishing*

**West Coast
fishing faces
huge cutbacks**

Waste and overfishing of one of the last, great resources

Overfishing is
blamed for the
proposed limits



Humans and the sea

*Overfishing is ruining
our once-bountiful oceans*

What is wrong with the litany?

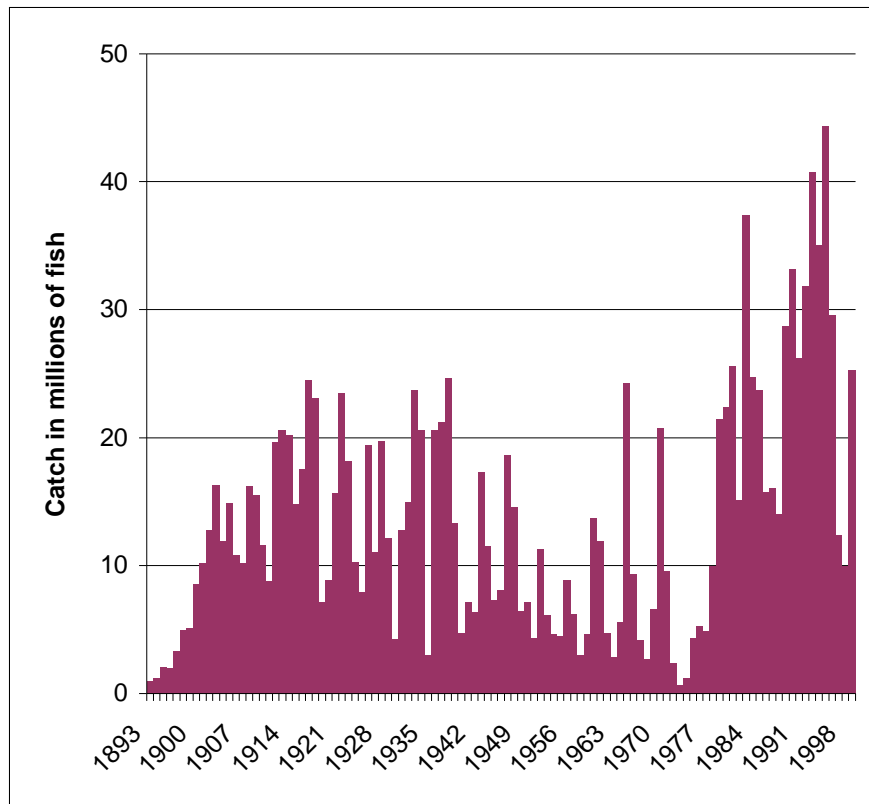
- Most of the worlds fisheries are not collapsed and produce substantial yield
- In the US we are obtaining 85% of the maximum possible yield
- The authors of the Litany argue fisheries management has failed and we need to look for new solutions

We have the solutions in hand

- There are many successful fisheries
- We need to look to the successful examples and learn from them, not look for “new” solutions



Bristol Bay sockeye stand out as a success story in sustainable biological management

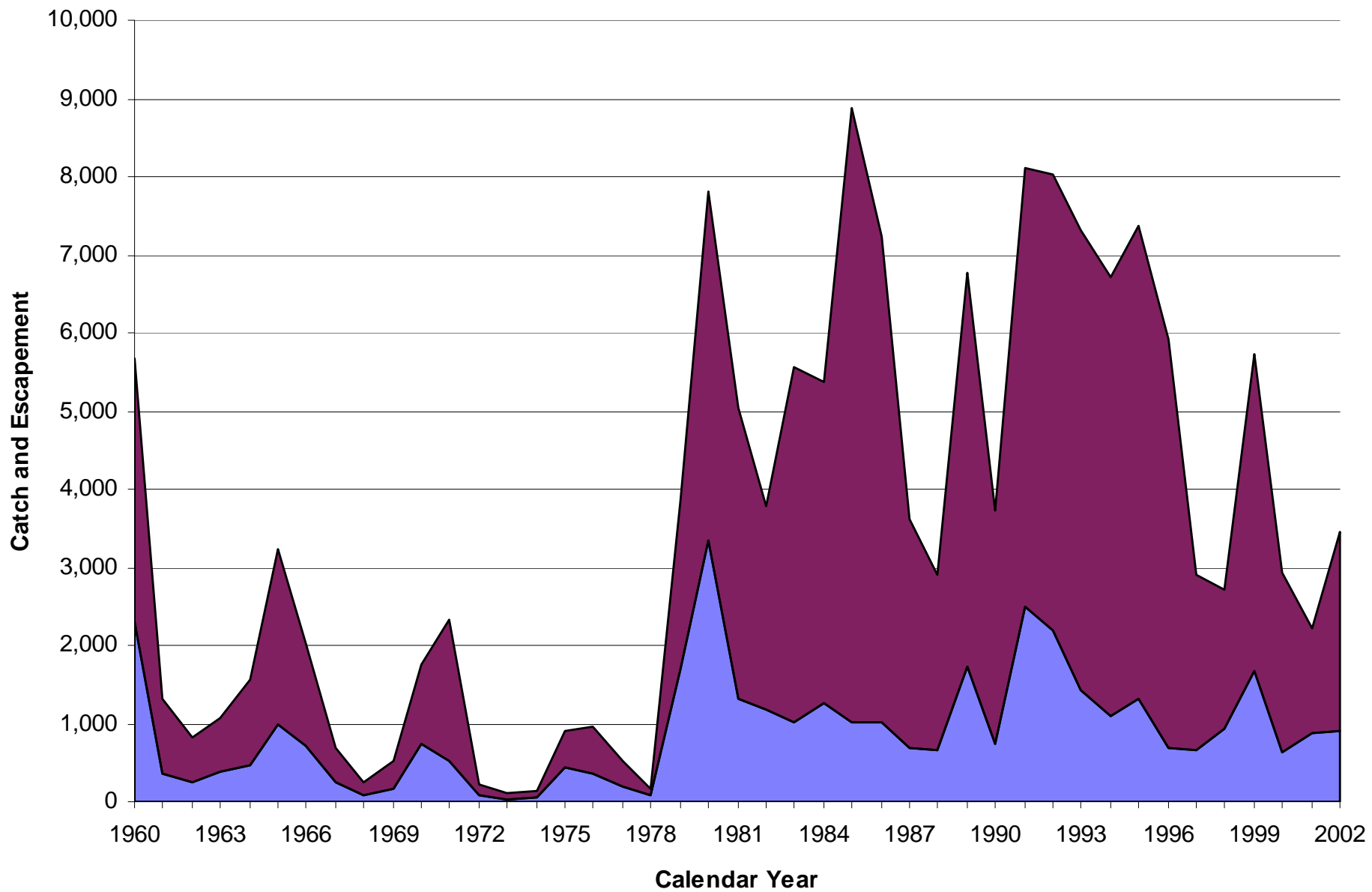


- A single management agency with clear biological objectives
- Good ocean conditions from 1977-1996

A key to this sustainability is management by escapement goal

In escapement goal management the fishery is regulated to assure that a target number of fish “escape” the fishery and reach the spawning grounds, assuring the long term productivity of the stock

Ugashik



Biocomplexity of the stocks is also a key

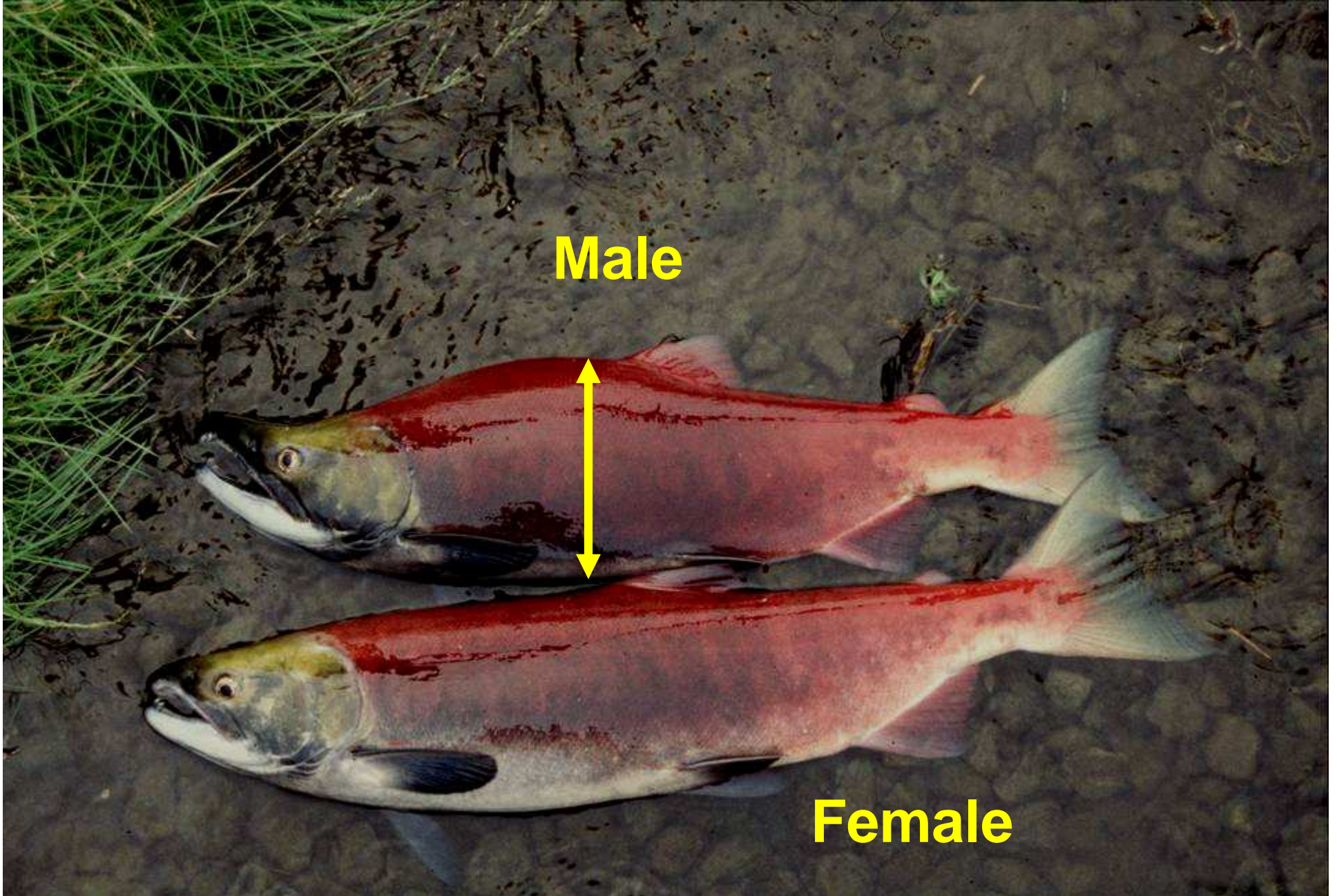
- Diversity in life history
 - Spawning on beaches, in creeks, in rivers
 - Diversity of freshwater life 0, 1 and 2 years
 - Diversity of marine life, 1, 2, 3 and 4 years
- Diversity in morphology

Hansen Creek sockeye salmon

Male



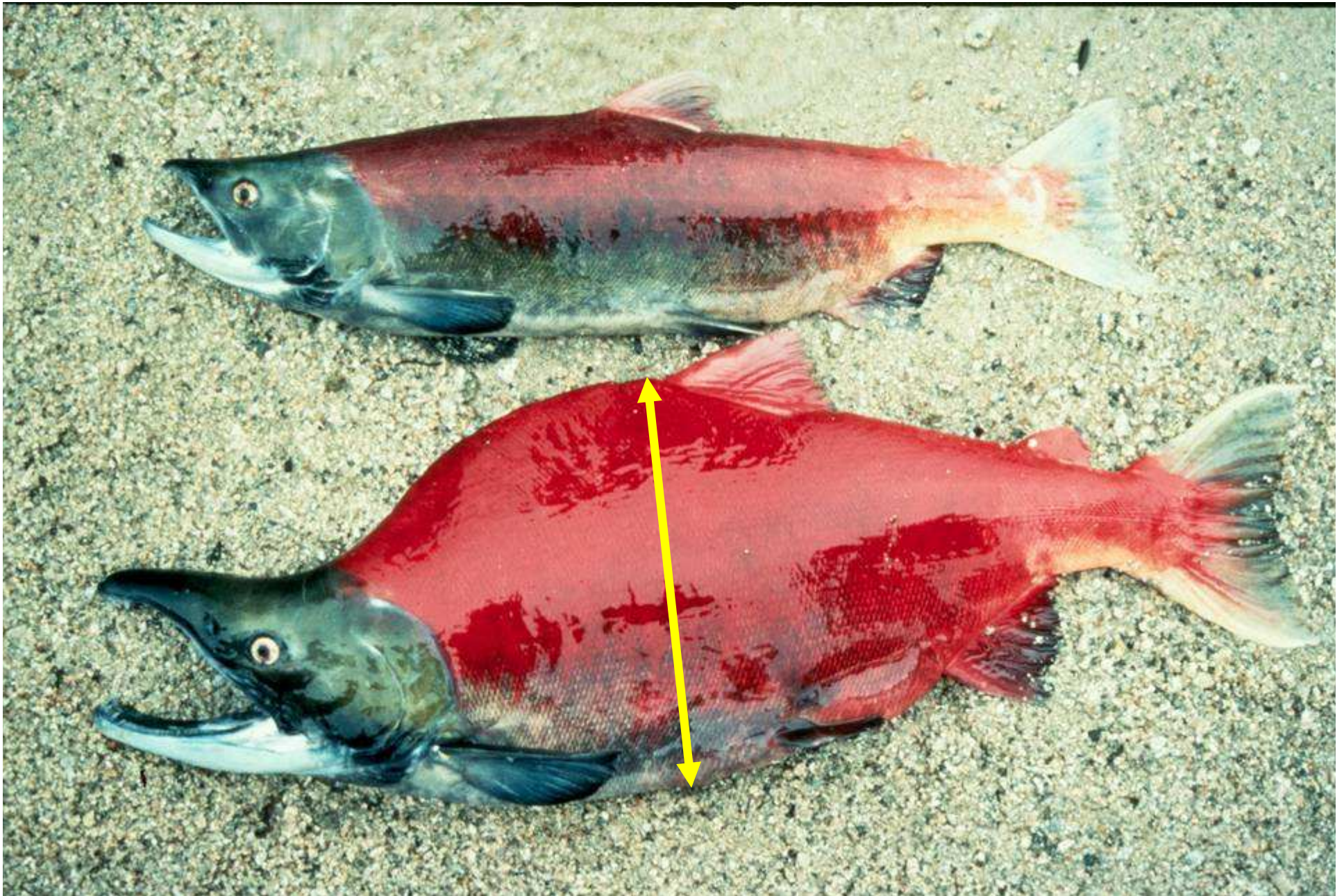
Female



Bear Creek sockeye salmon



Beach spawning sockeye salmon



Diversity of Habitats and Geography

- Many different lake systems
 - different physical regimes
- Different times of smolt and adult migration
- Long term changes associated with Pacific Decadal Oscillation





**Large rivers
between lakes
have stable flows,
no bear
predation**

**Often high
density spawning**

An aerial photograph showing a dense green forest covering a hillside that meets a sandy beach. The ocean is a deep blue, and the water's edge is visible. The text is overlaid on the right side of the image.

**Small streams often have very
high density spawning: also
high bear predation**

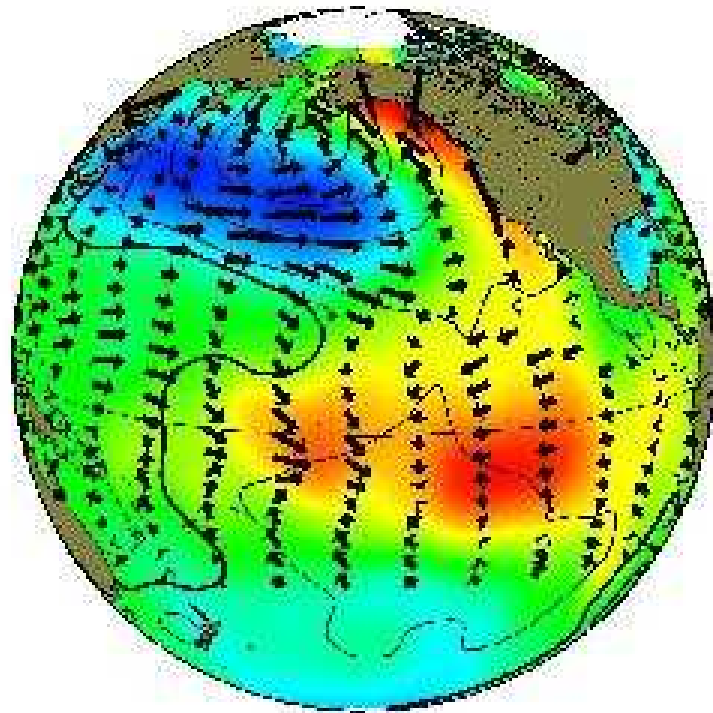
**Beach spawning occurs where
here is upwelling or wind
driven currents**



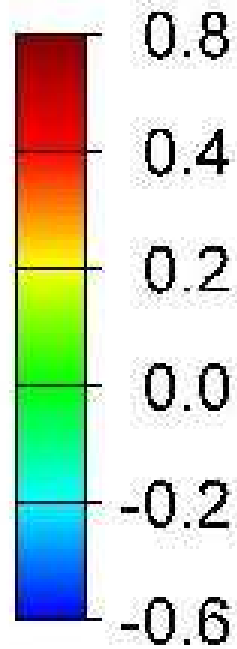
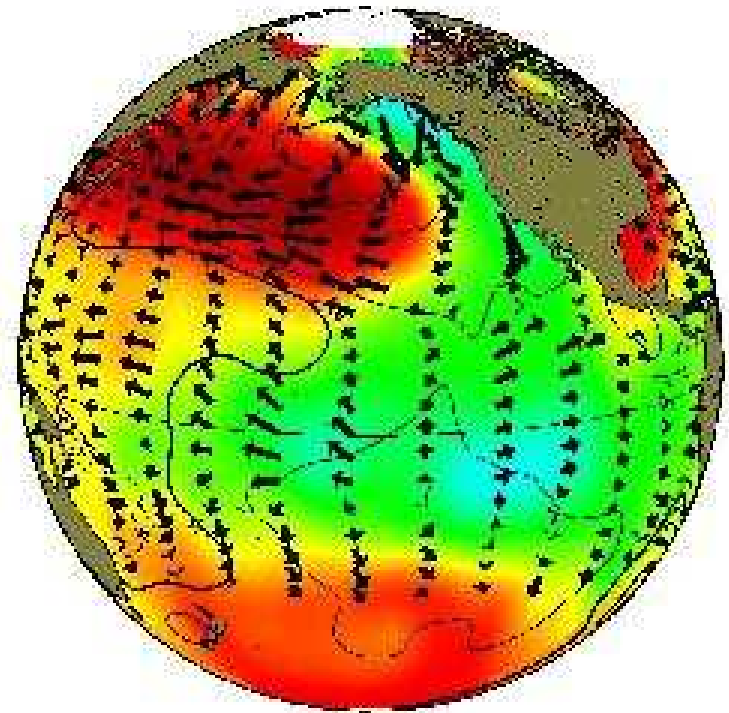
Importance of climate

- The Pacific Decadal Oscillation

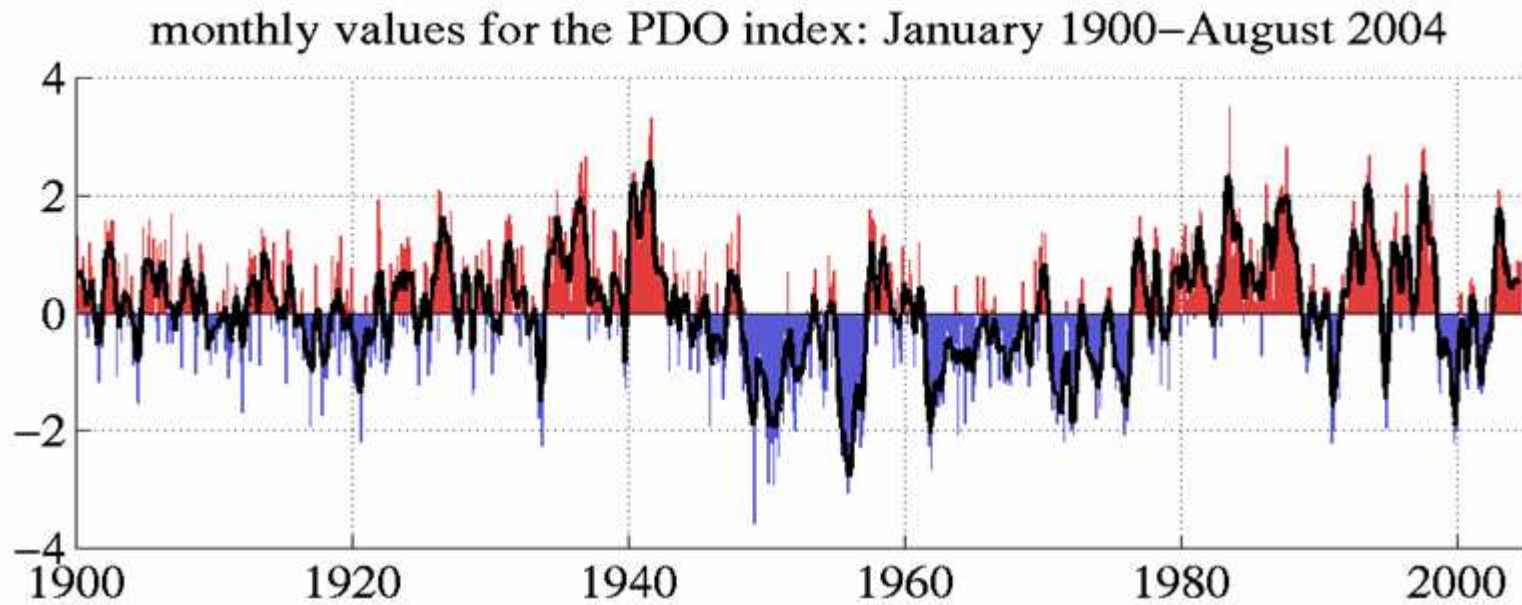
Warm Phase



Cool Phase



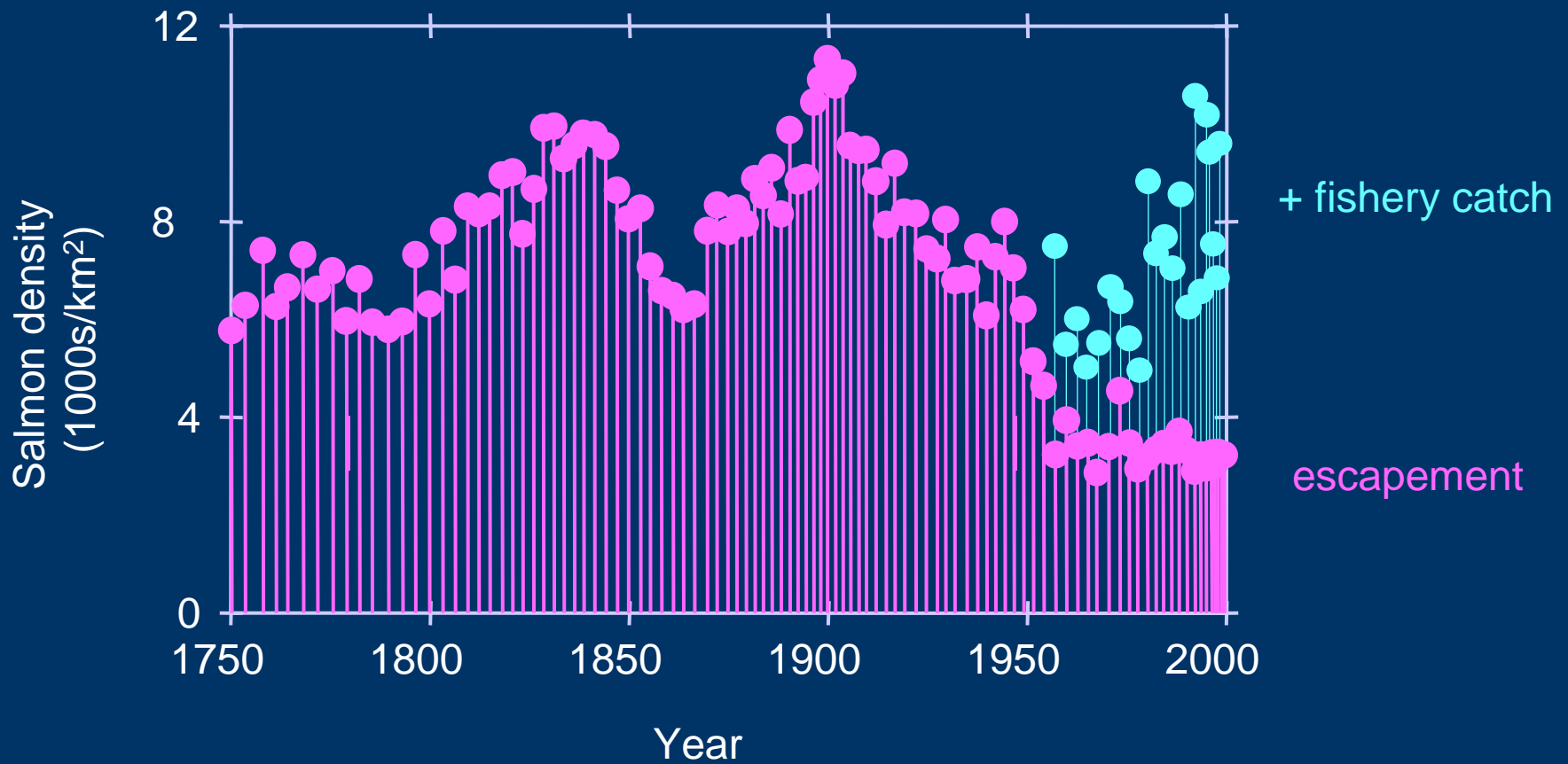
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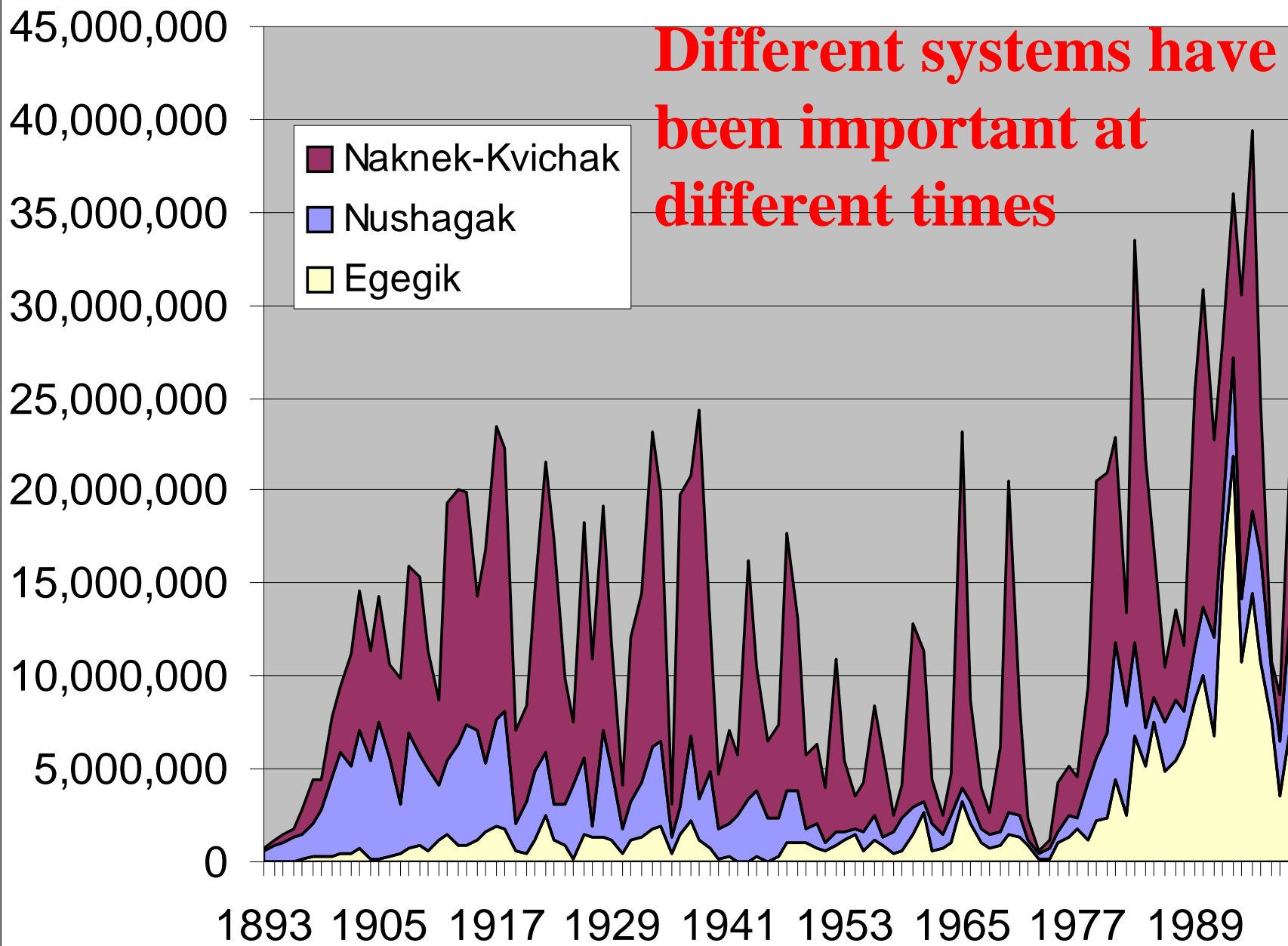
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Historical sockeye population dynamics

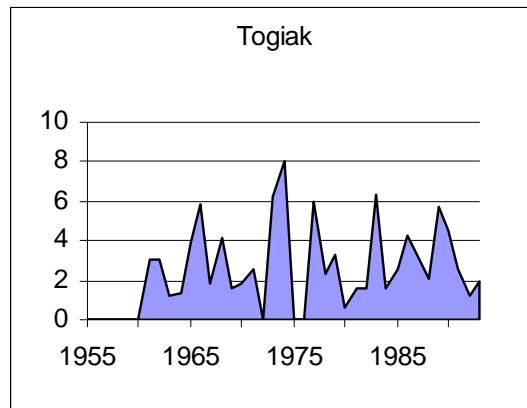
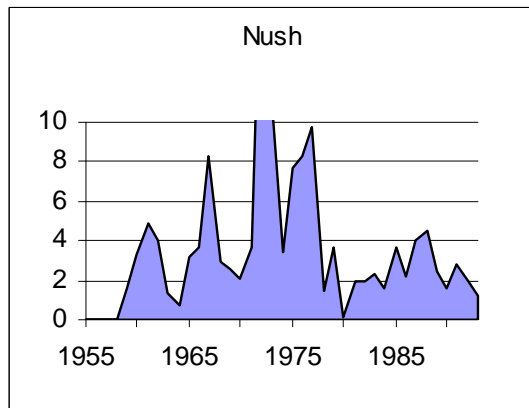
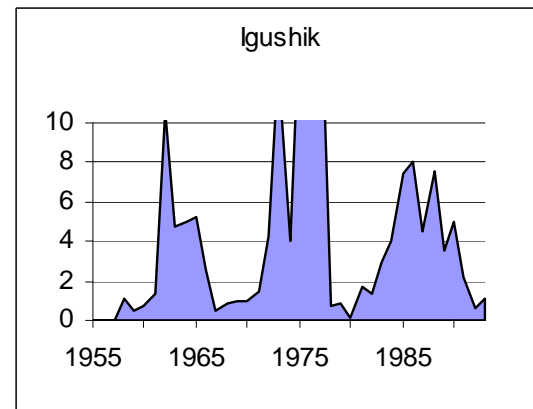
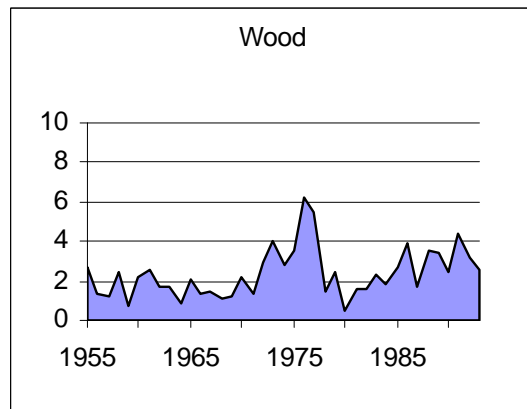
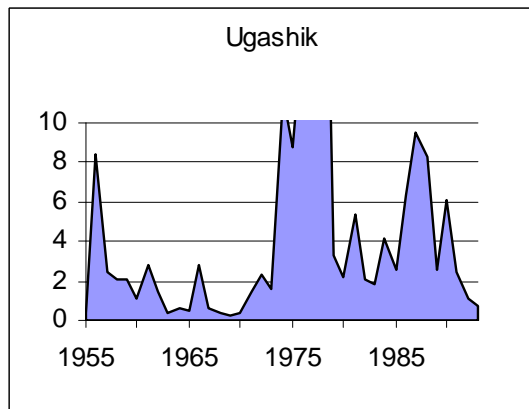
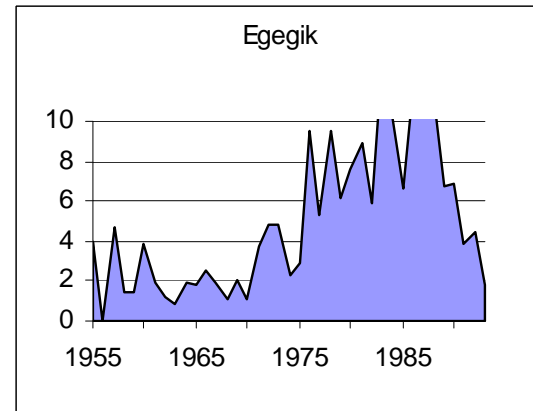
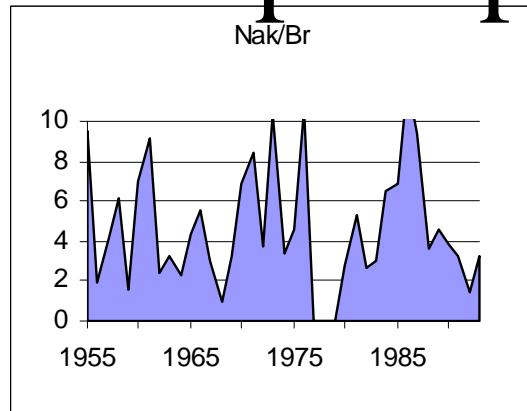
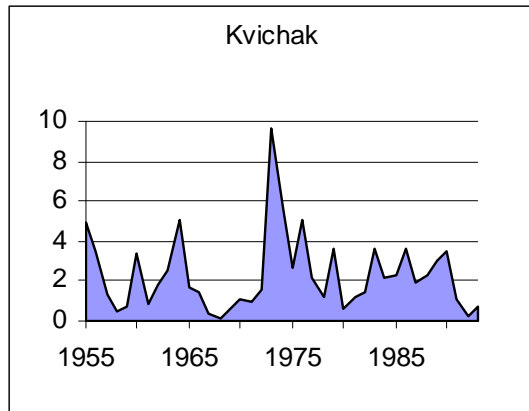
Lake Nerka, SW Alaska



**Different systems have
been important at
different times**



Recruits per spawner

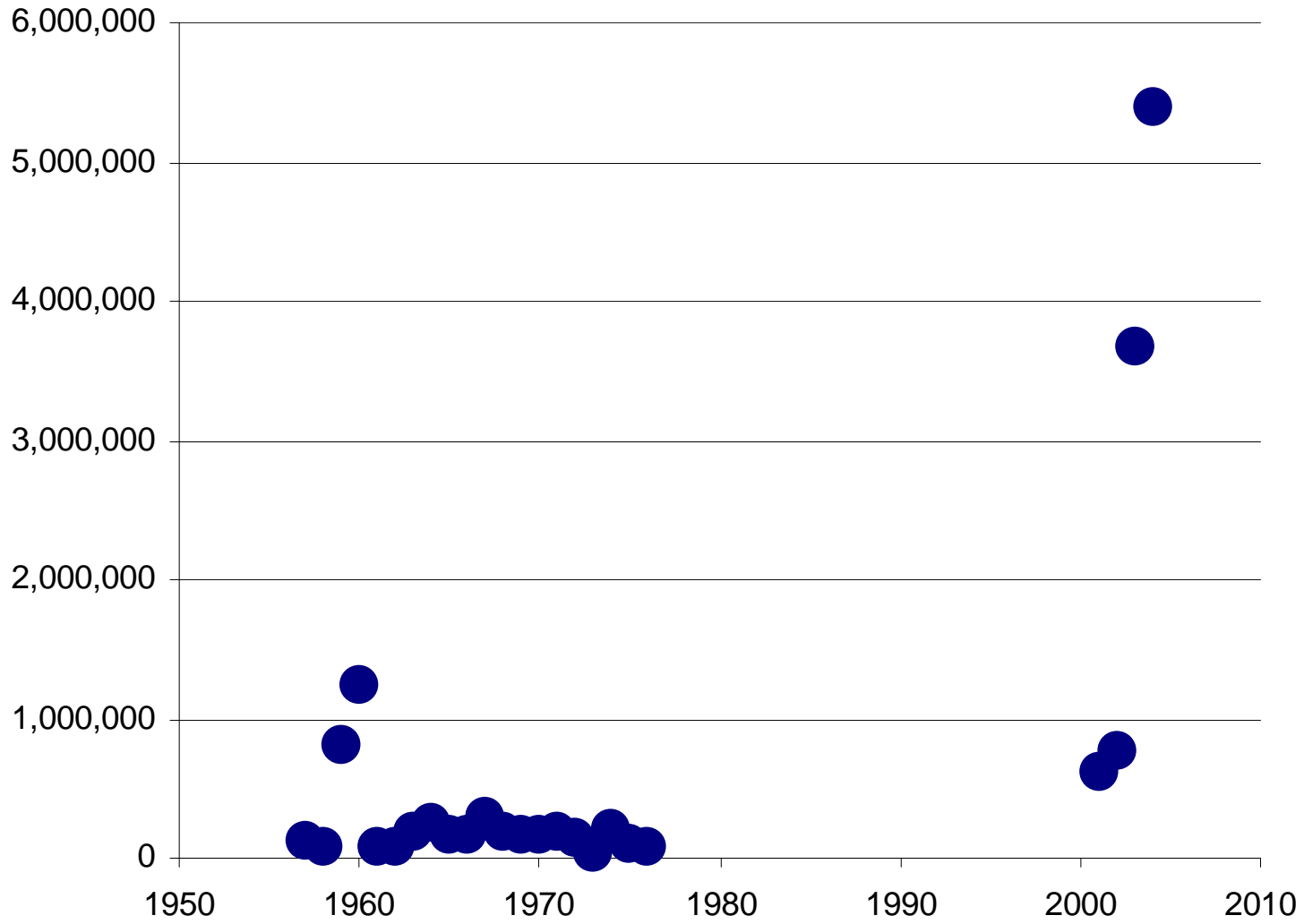


Changing perceptions

- In the 1940s 50s or 60s no one would have ever expected Egegik to be the most important system in Bristol Bay
- In the 1970s no one would have expected the Nushagak to be the most important system in the bay
- Many had never heard of the Alagnak!
- Not on many maps

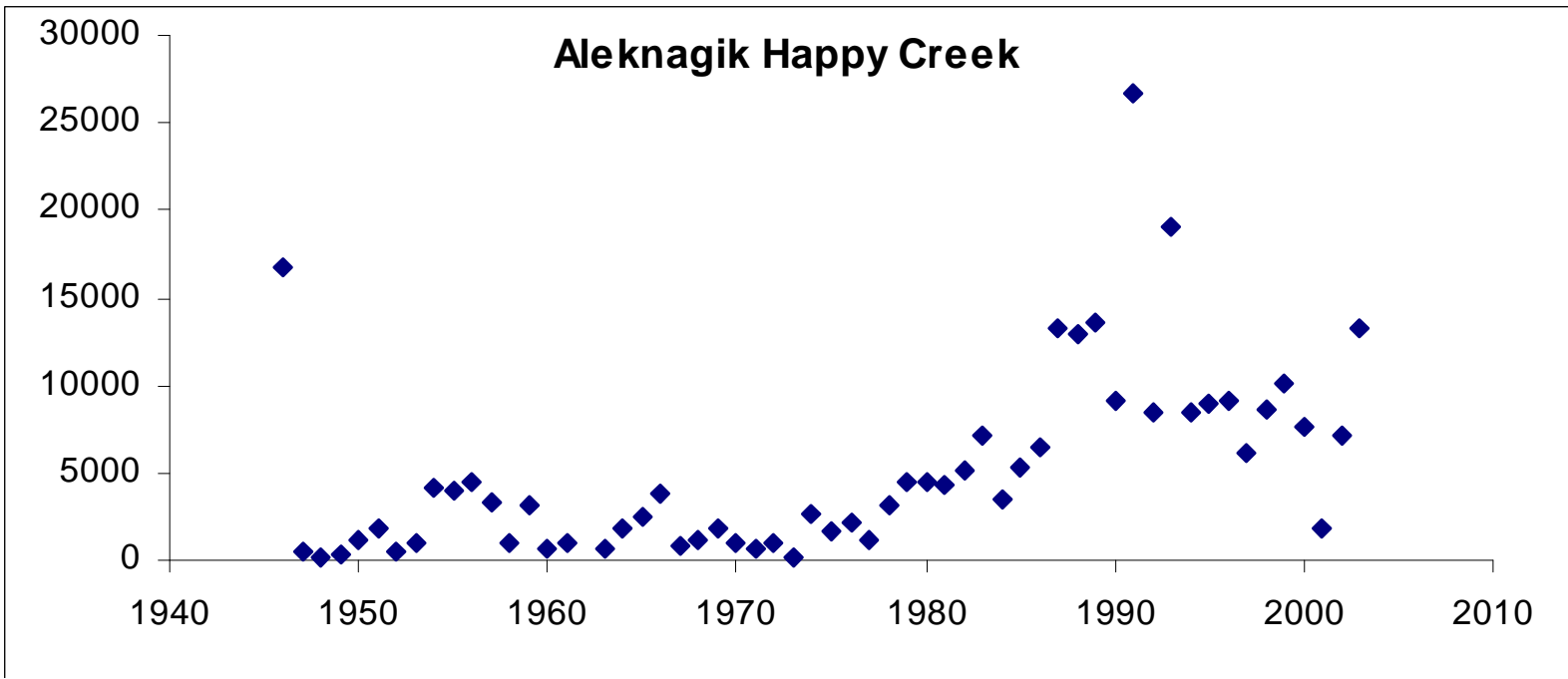
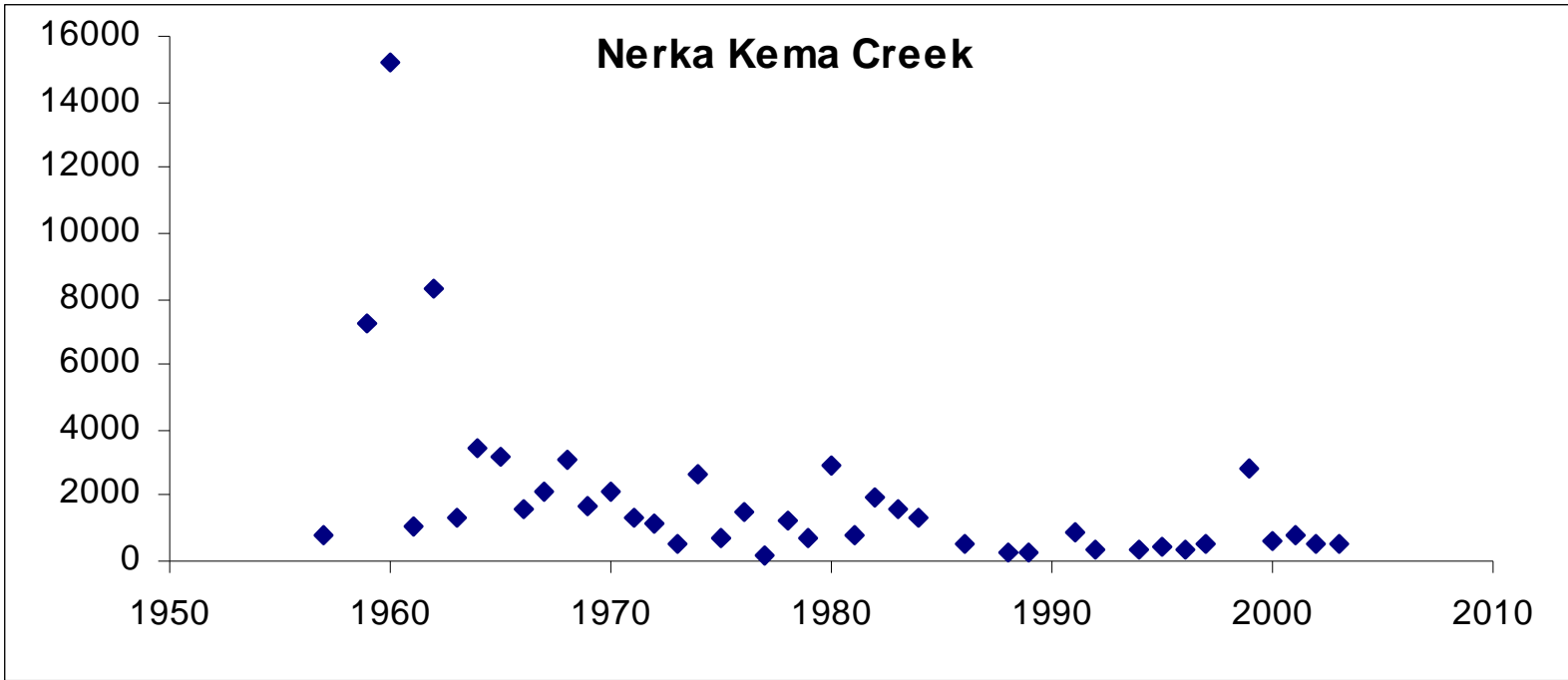


Alagnak river escapements



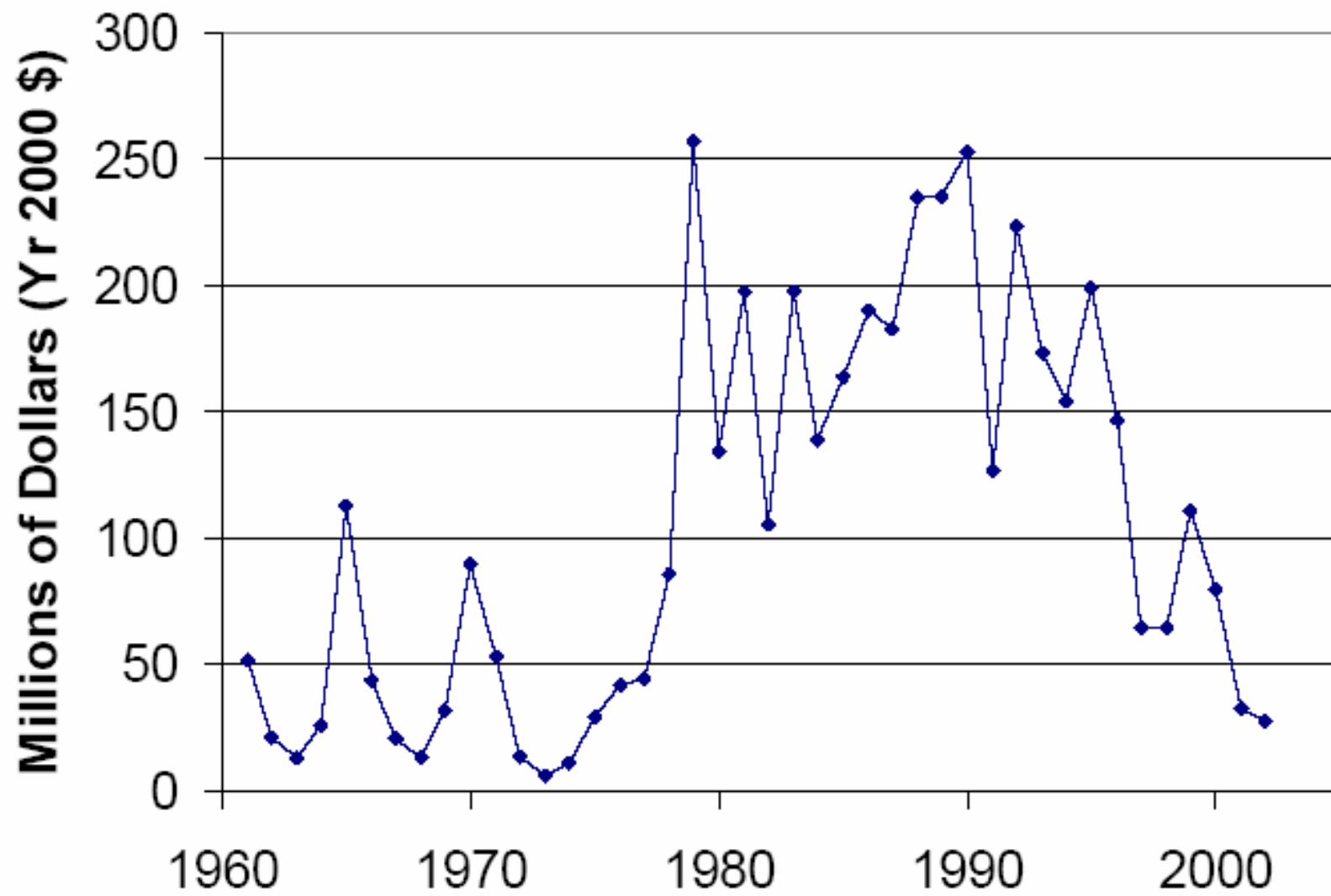
Spatial scale hypotheses

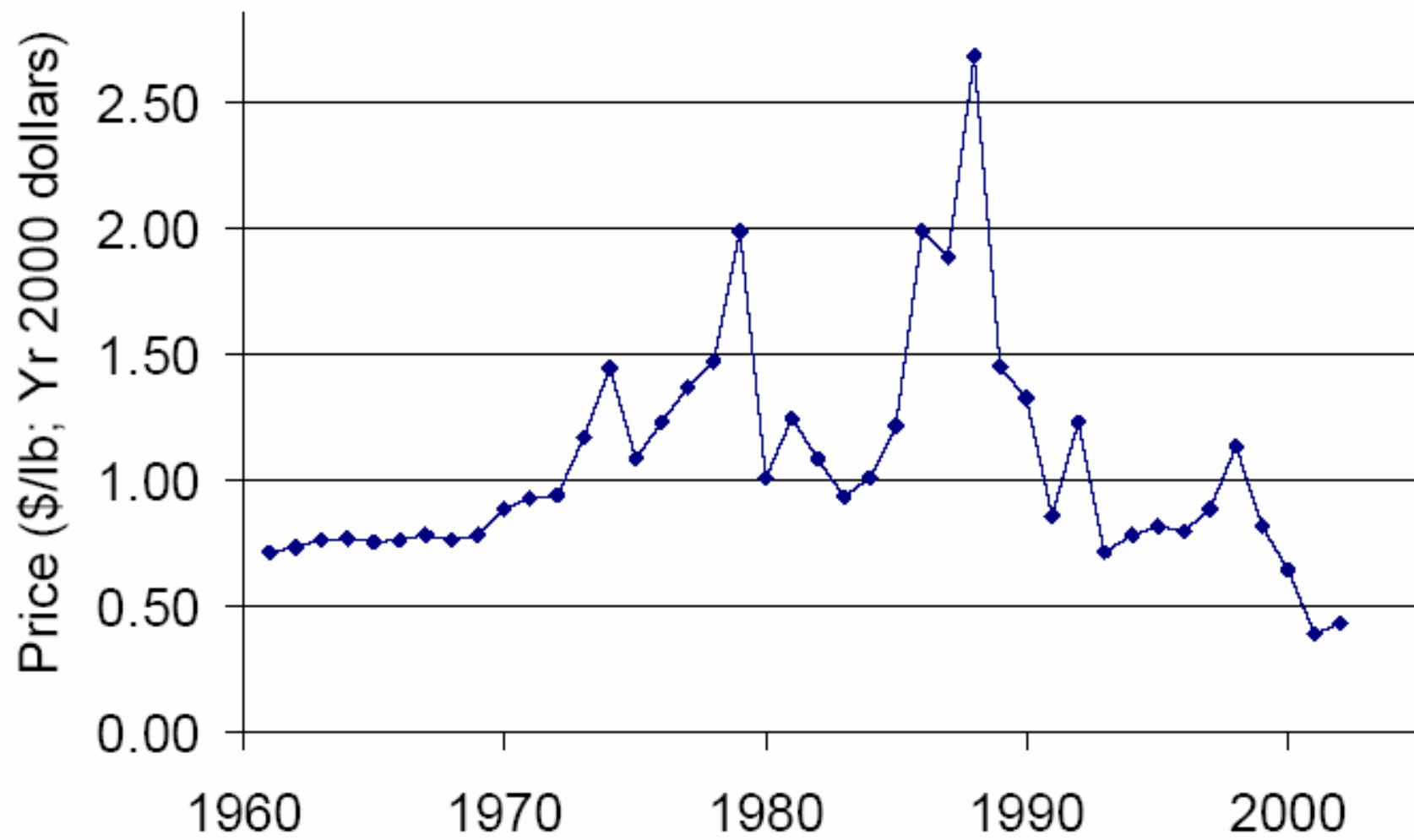
- The role of biocomplexity and response to climate extends to all spatial scales
 - We know it occurs on Pacific wide scales
 - Documented negative correlation between lower 48 and Alaskan salmon productivity
 - We see it at smaller scales
 - At different spawning sites in a stream
 - Even within sections of a stream



The human side of the story

- For all of the excitement over the biological success, the social and economic success has faded
- It was once possible to clear \$50,000 in a 6 week season





SAY NO
TO 40¢ FISH
ORGANIZE

CONTACT BUZZ OTTEM PH.
BX 42 503-738-3075
SEASIDE OR 97136

The human biocomplexity

- The fishing fleet and processing industry is as diverse as the fish
- Diversity of fishing gears
- Diversity of strategies – mobile, stationary, resident non resident, high capital input, low capital input

The fishery

- 2000 drift gillnet boats and 1000 shore based “set net” gill nets
- Fishery from 25 June to 15 July
- Product is both canned and frozen
- Canned market UK and Europe, Frozen Japan









Photo Robert Kope



Photo Robert Kope



Photo Robert Kope





The race for fish

- Is widely recognized as the primary economic problem in worlds fisheries
- In the 1930's 30 million salmon were caught in Bristol Bay by 2000 sail powered boats
- We don't need 2000 high powered vessels
- State policy is to spread the wealth to as many as possible

The Management System

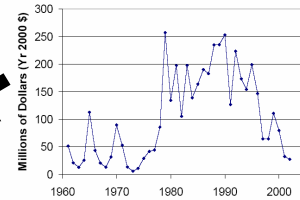


The biocomplexity of Bristol Bay

The fleet



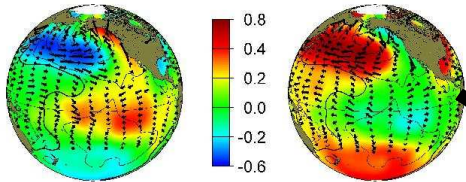
Price and Revenue



The managers



Climate



The fish



The potential adaptation of the human system is restricted by regulation

- Regulations determine how many and what type of fishing takes place
- There is very limited ability to adapt
- We expect that “the struggle for existence” will by default take place within existing regulations
- We are modelling alternatives to the current regulatory structure including cooperative fishing programs as seen at Chignik



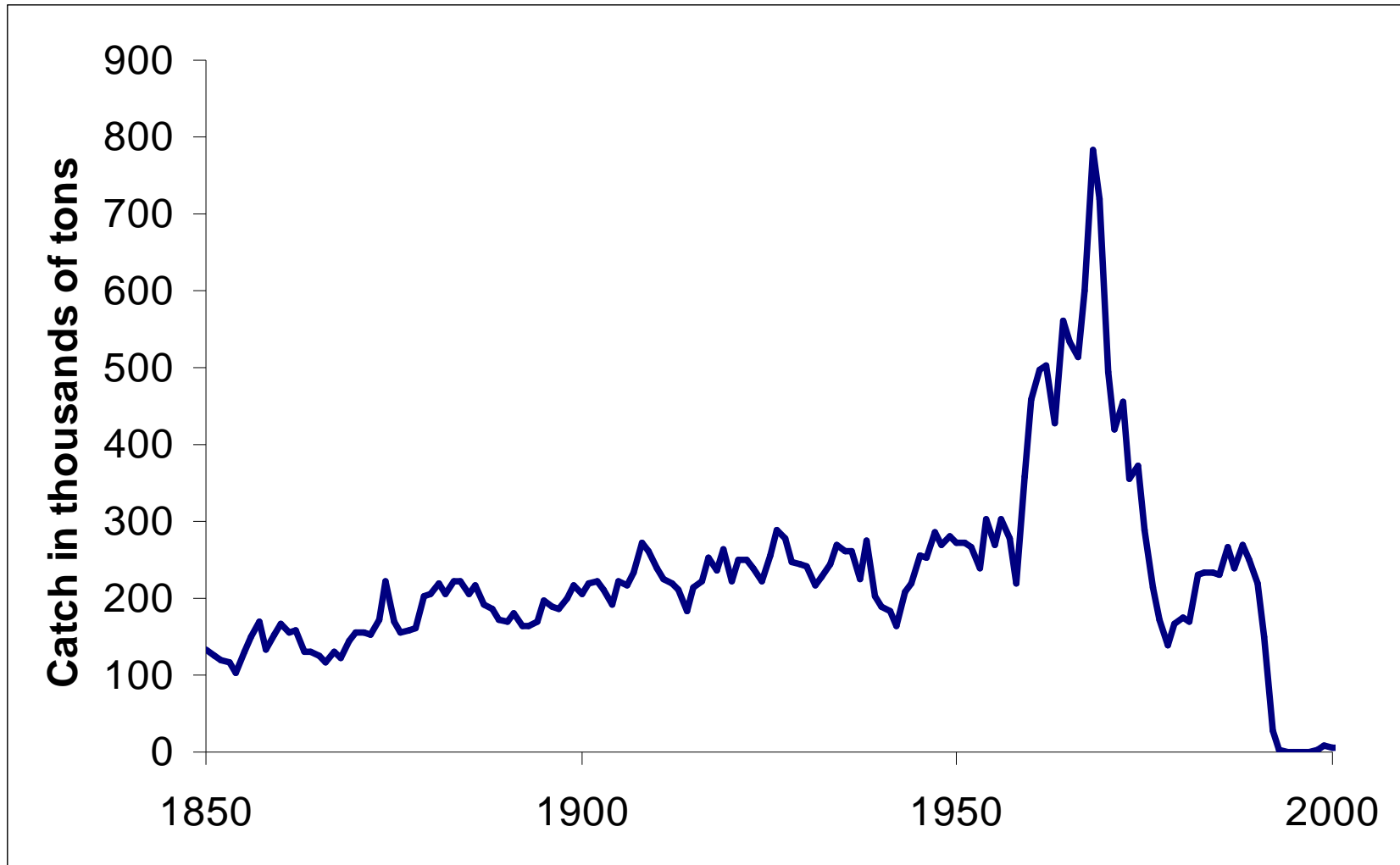
General Lessons

- Biocomplexity appears to be important in stabilizing total productivity over a range of spatial scales in both fish and human systems
- Systems that are productive in one epoch are much less productive in other epochs
 - The lesson is maintain the stock structure
 - what seems unimportant now may be very important later
- The regulatory structure imposed threatens the ability of the human system to adapt

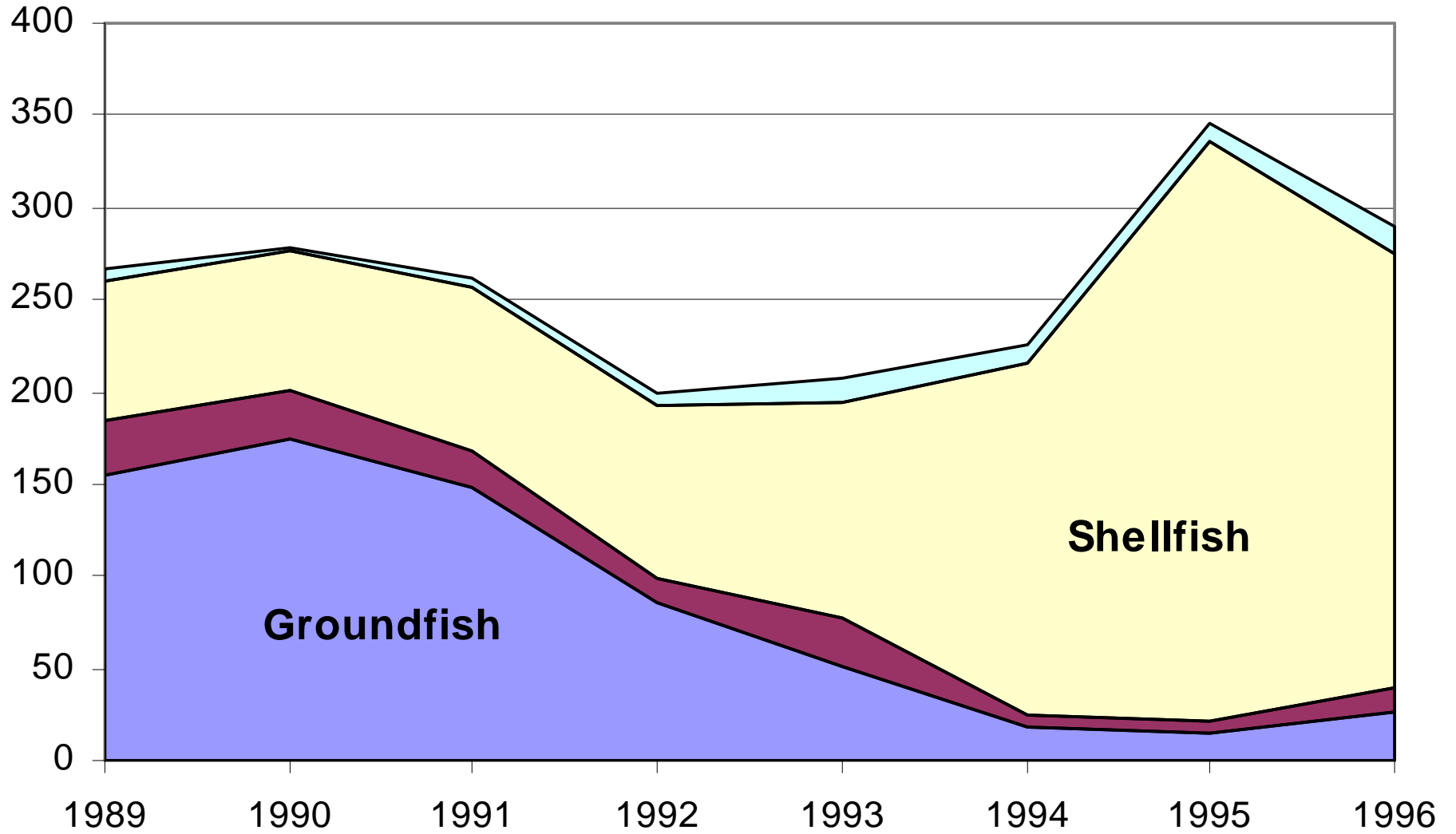
Some other examples

- Ecosystems change
- The productivity of different species changes

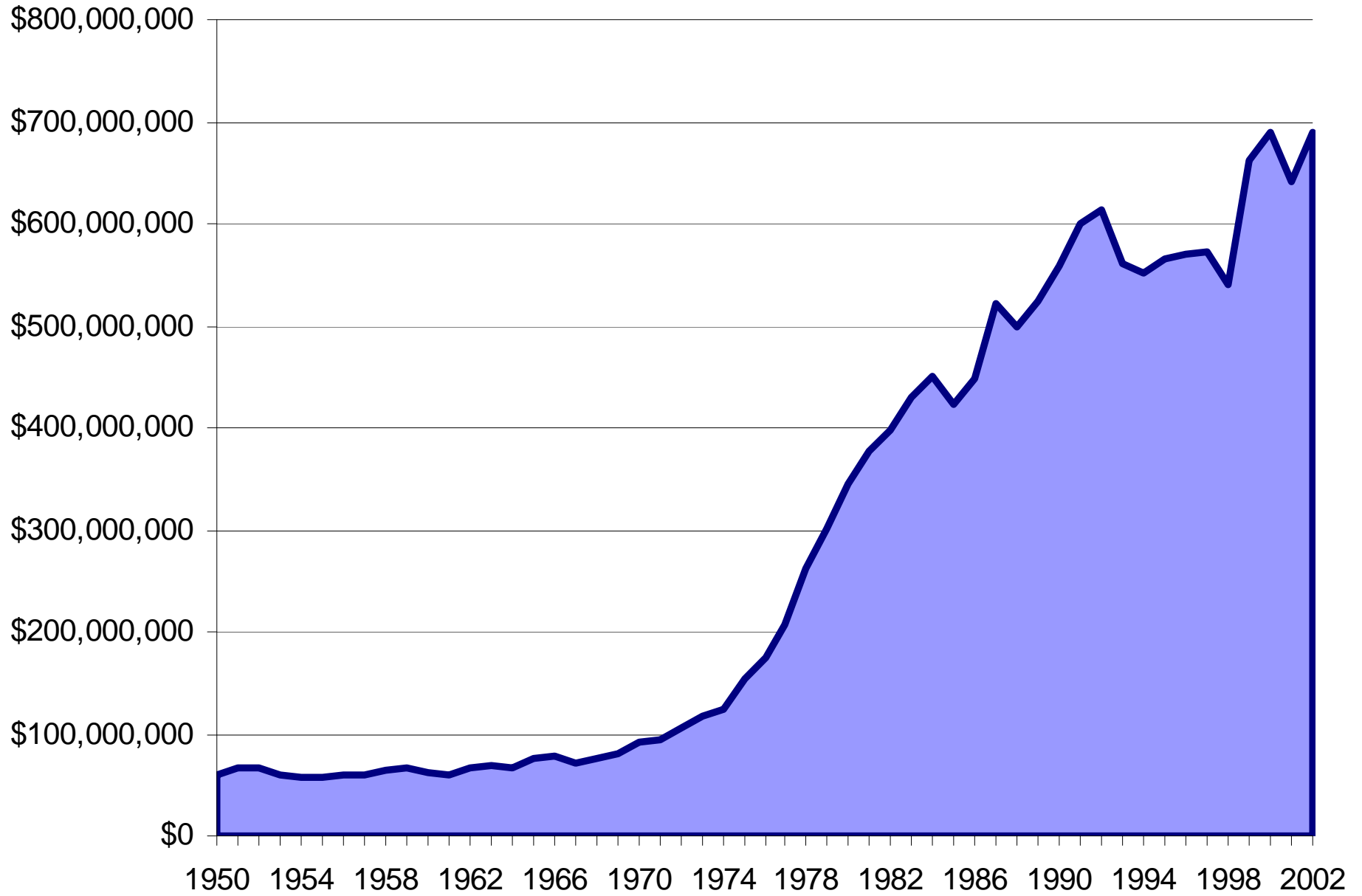
The “worst” fisheries disaster of the last 20 years
Collapse of the Northern Cod fishery in
Newfoundland



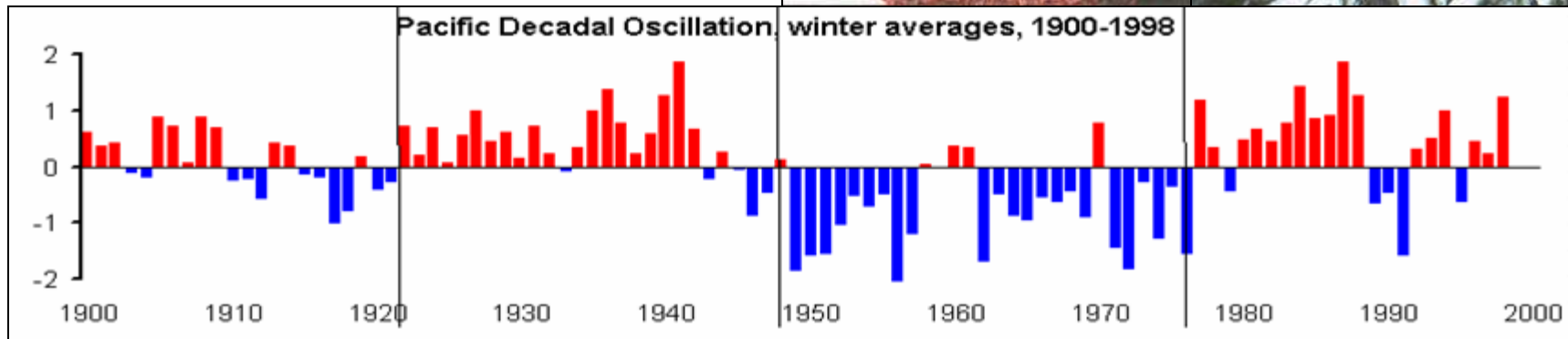
Value of fish products landed in Newfoundland



Landed value in New England



Gulf of Alaska – Small set of structuring variables operating at different speeds - Whammo!



Conclusions

“If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.”

Aldo Leopold Round River

Final Lessons

- Maintain flexible social institutions: fishing communities need to adapt
- This issue has not been on the legislative agenda
- The fisheries crisis is one of governance
- We know what to do: solutions are available

Acknowledgements

- The FRI pioneers who started and maintained 57 years of continuous data
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