

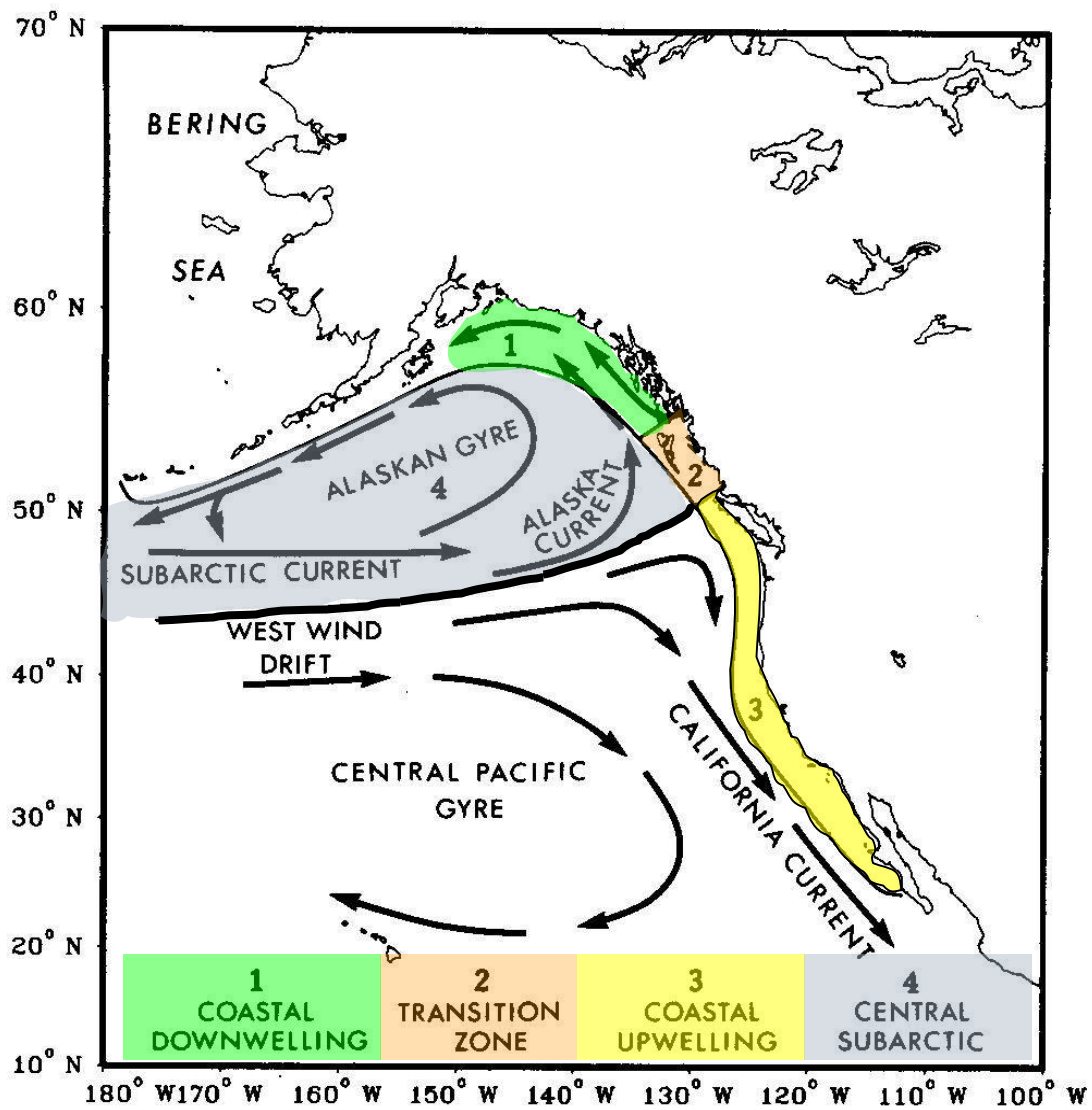
Linkages between open and coastal ecosystems on the Pacific coast of North America

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Fisheries and Oceans Canada,

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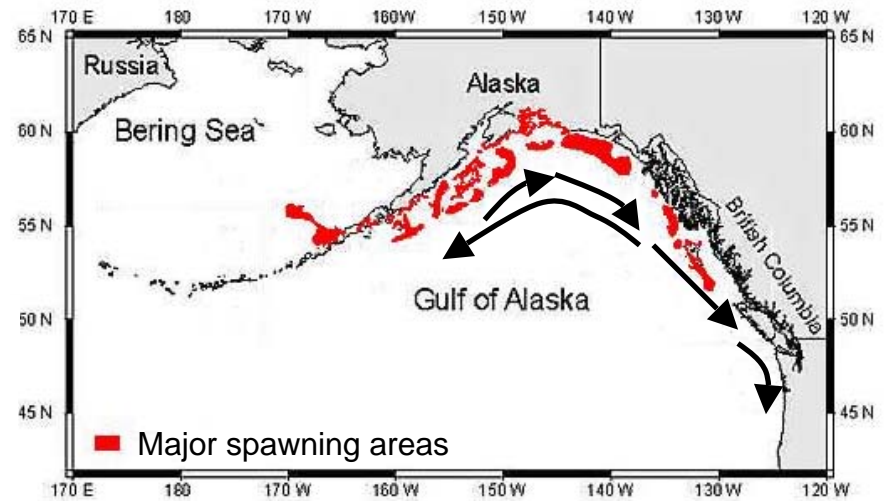
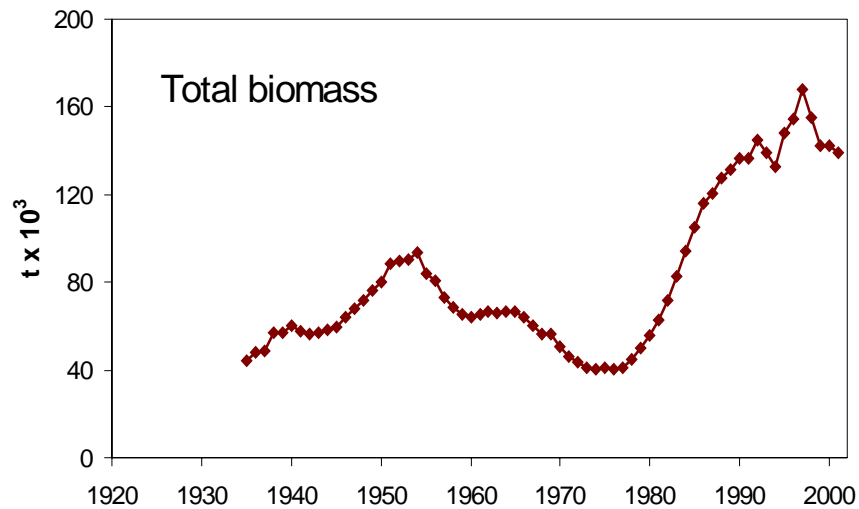


□ Major fisheries are coastal and major migrations are typically north and south.

■ Examples:

- Pacific halibut
 - Pacific hake
 - Pacific sardine
-

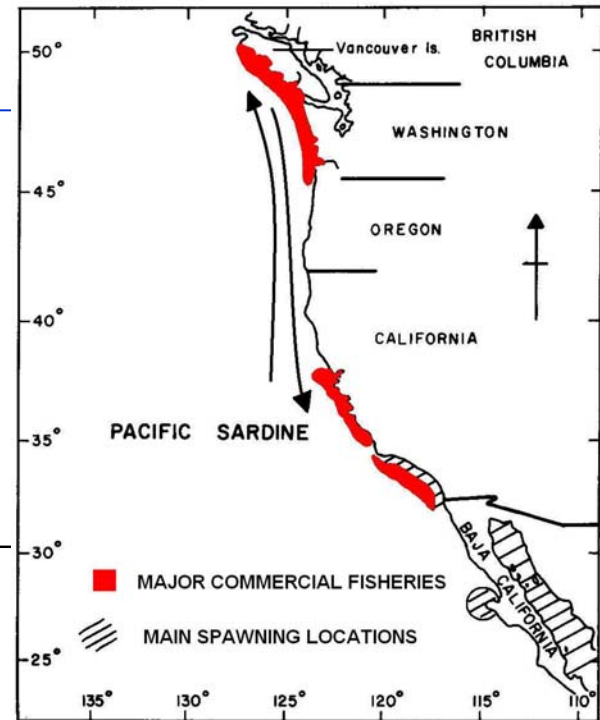
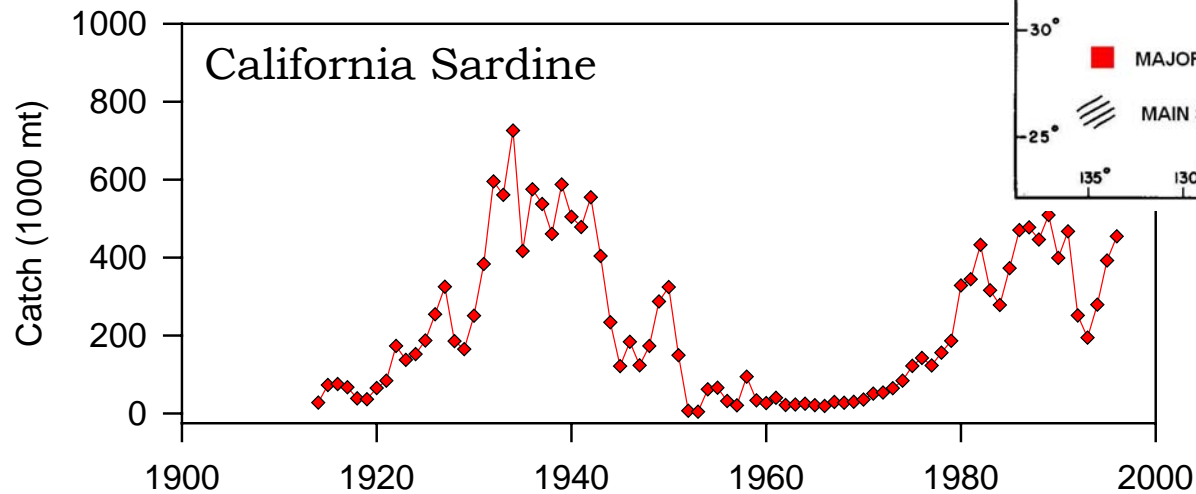
Pacific Halibut



Pacific Hake



California Sardine



Surface Trawl Catches

<input type="checkbox"/>	Sockeye	265	
<input type="checkbox"/>	Chum	2,671	
<input type="checkbox"/>	Pink	1,380	
<input type="checkbox"/>	Coho	153	
<input type="checkbox"/>	Chinook	69	
	Total salmon		4,538
<input type="checkbox"/>	Myctophids	15,107	
<input type="checkbox"/>	Anchovy	19,874	
<input type="checkbox"/>	Squid	23,160	
<input type="checkbox"/>	Other	530	
<input type="checkbox"/>	Tuna	13	

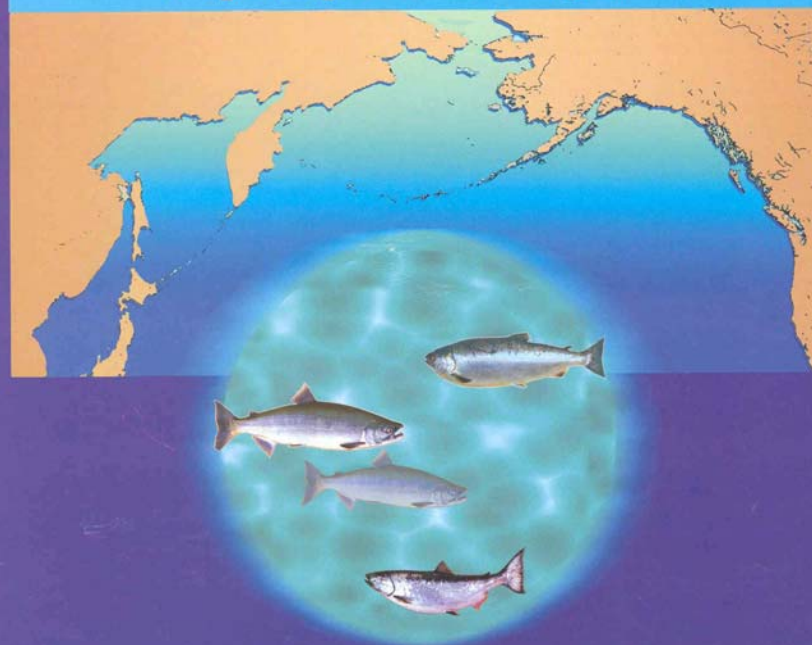
Three cruises, 70 sets, with 11-13mm codend (winter catches; Nov-March 1992, 1996, 1998) Surface to 50m, 5 knots.

АТЛАС

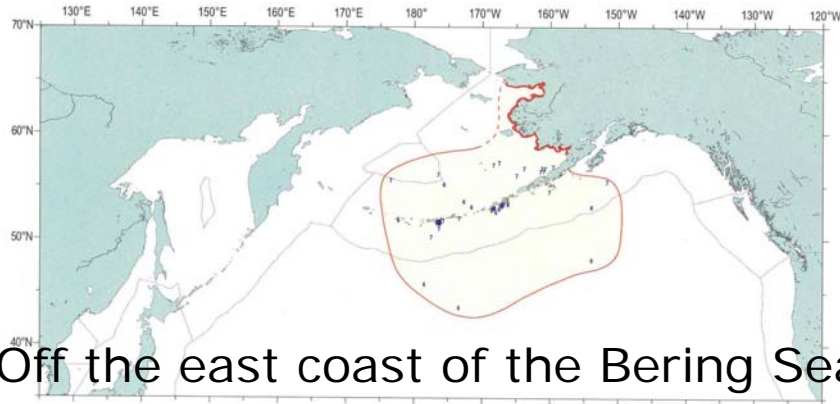
распространения в море
различных стад

ТИХООКЕАНСКИХ ЛОСОСЕЙ

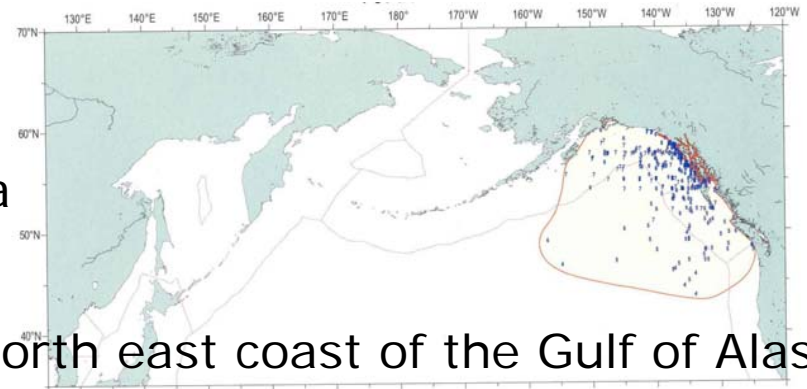
в период весенне-летнего нагула
и преднерестовых миграции



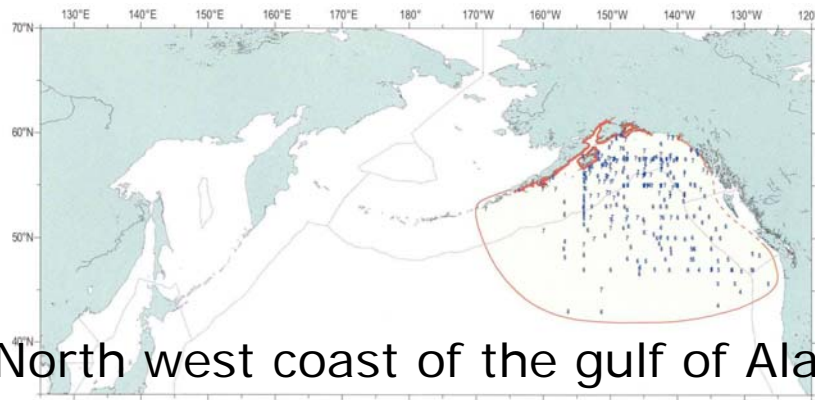
Pink Salmon



Off the east coast of the Bering Sea



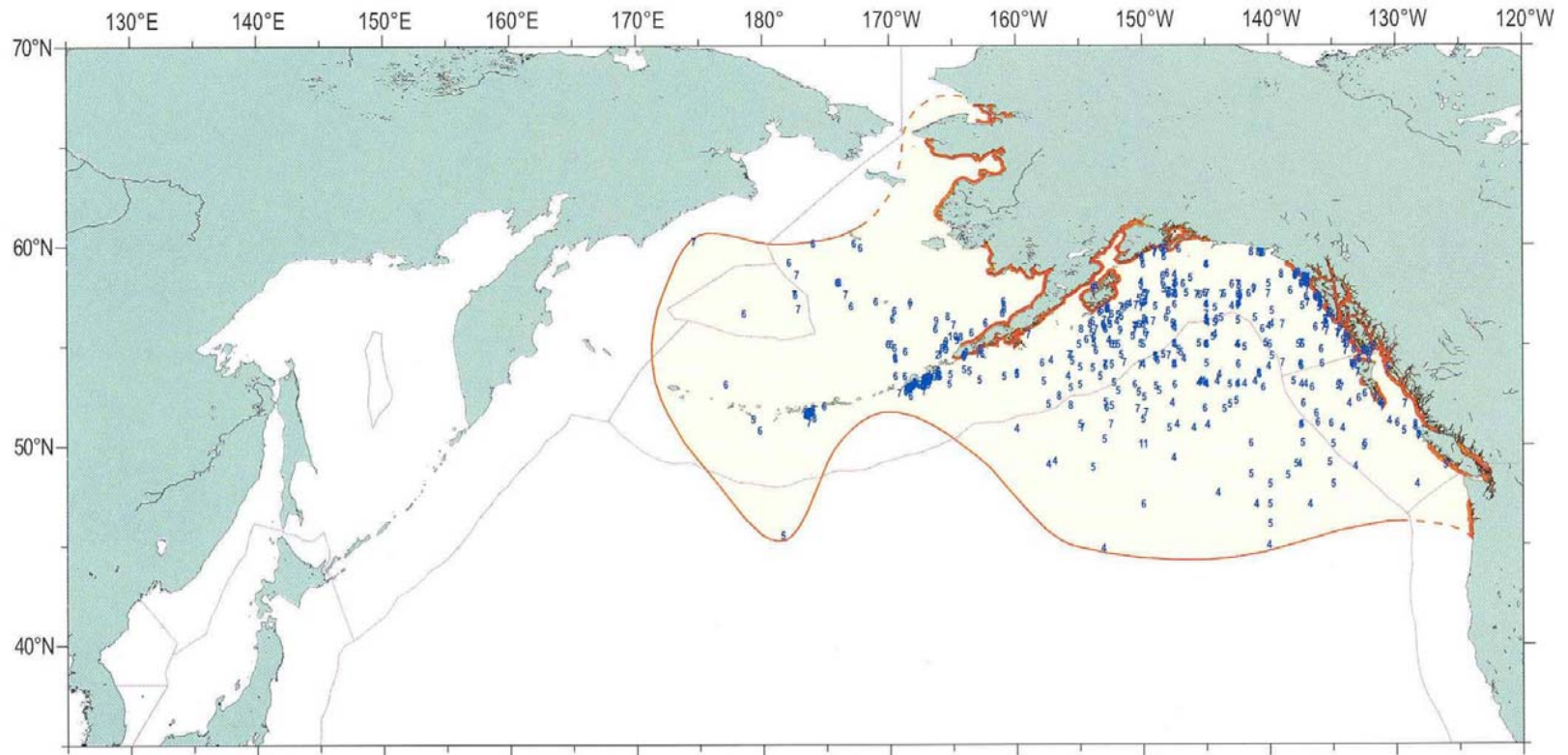
North east coast of the Gulf of Alaska



North west coast of the gulf of Alaska

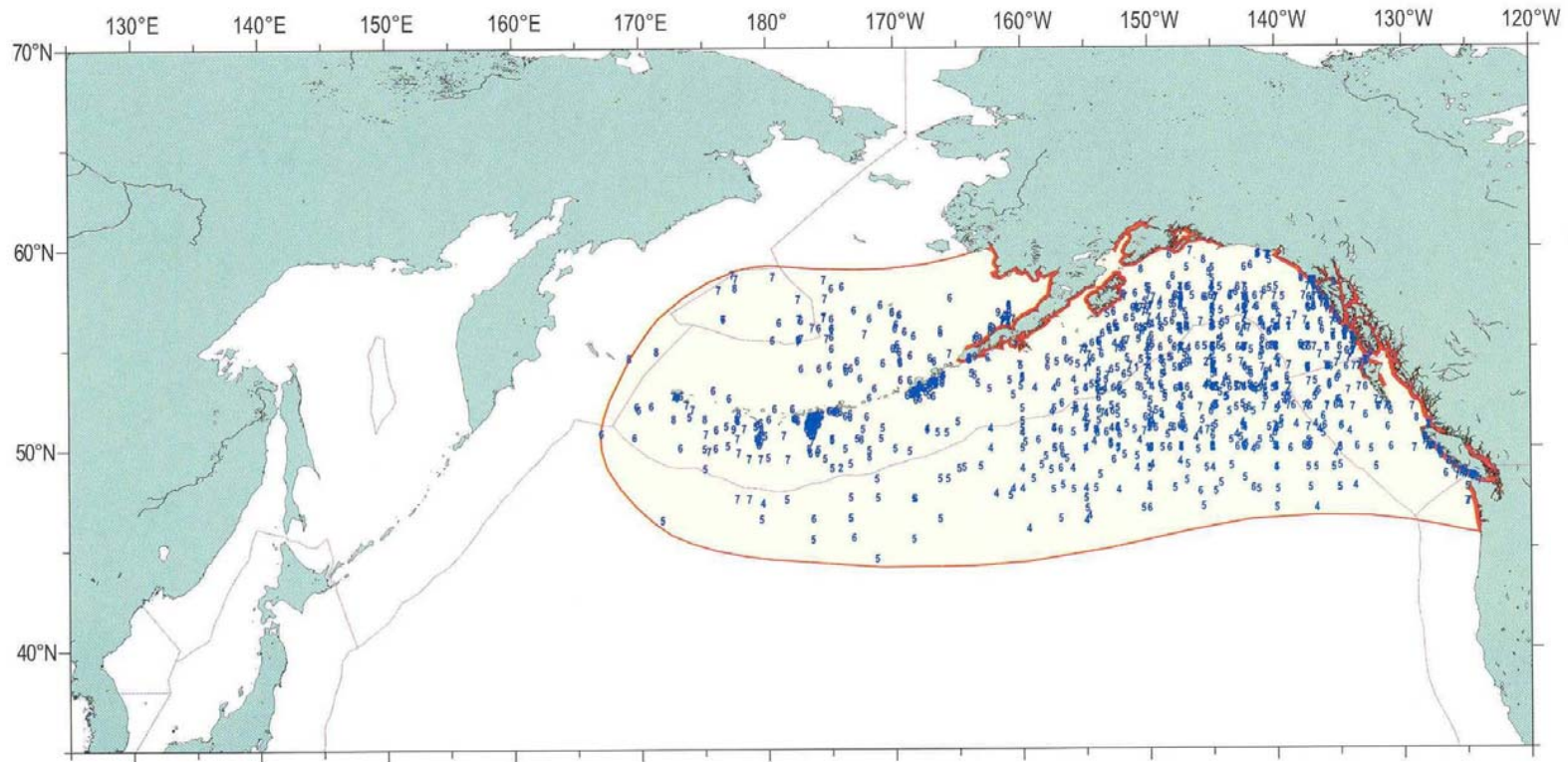
Chum Salmon

West coast of North America



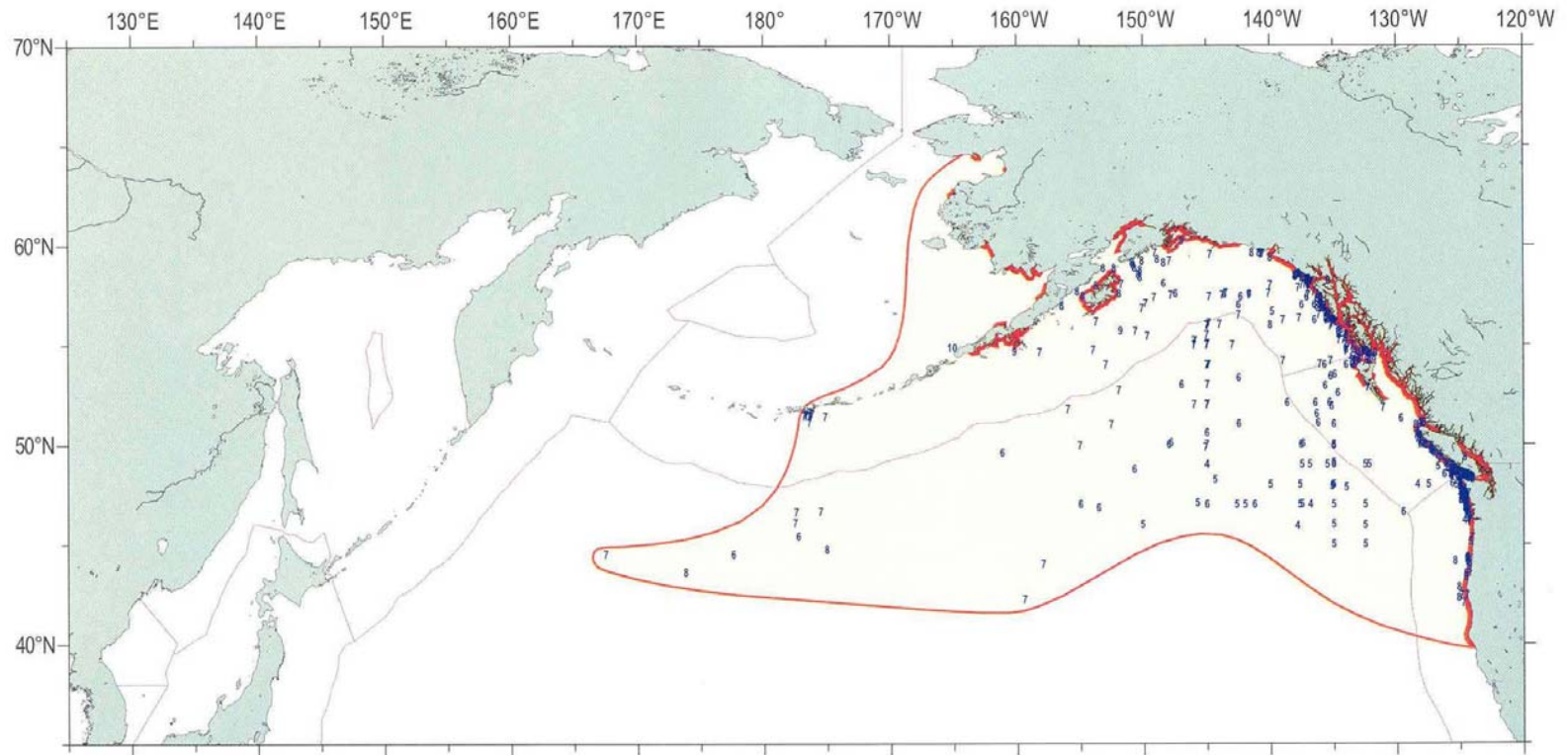
Sockeye Salmon

North America



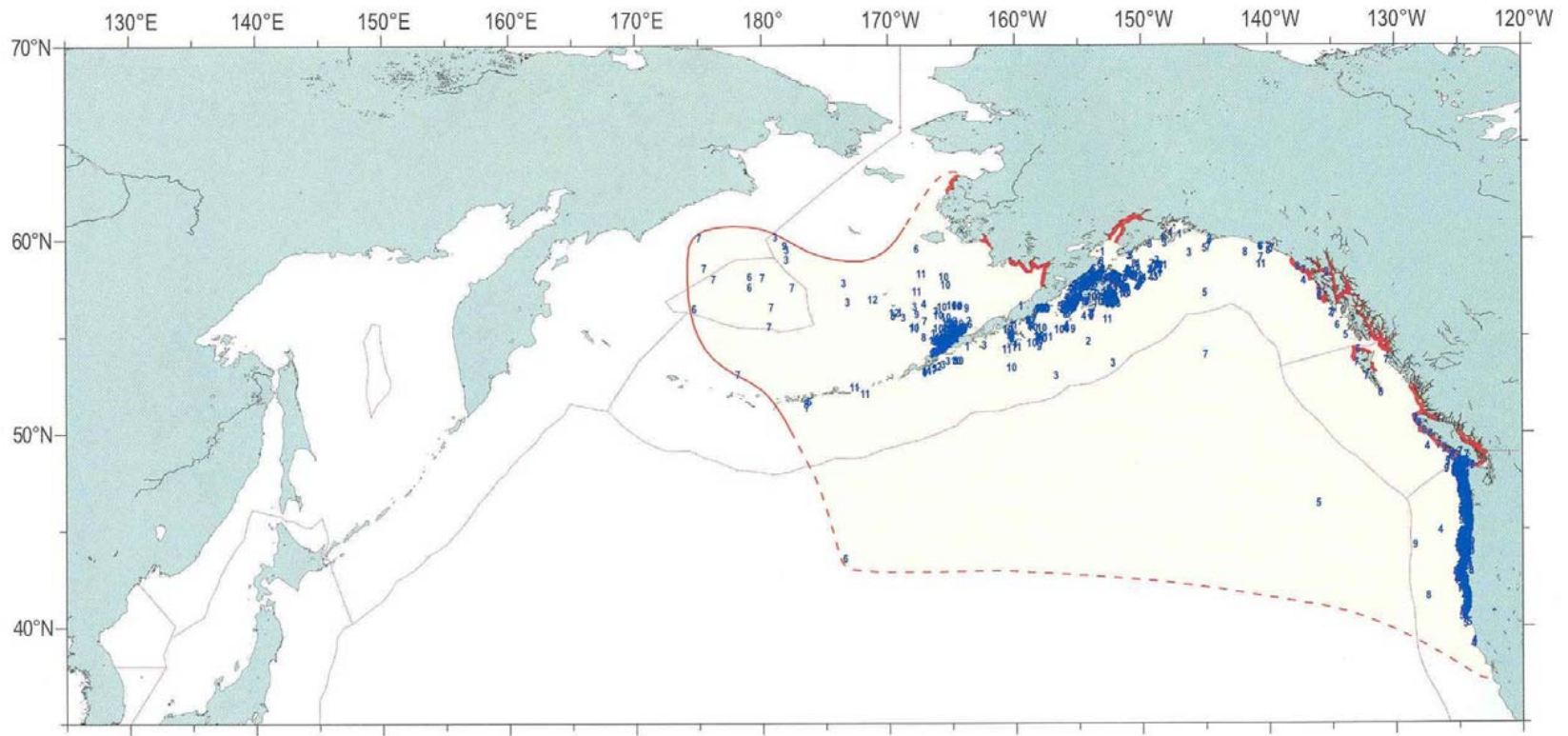
Coho Salmon

North American coast

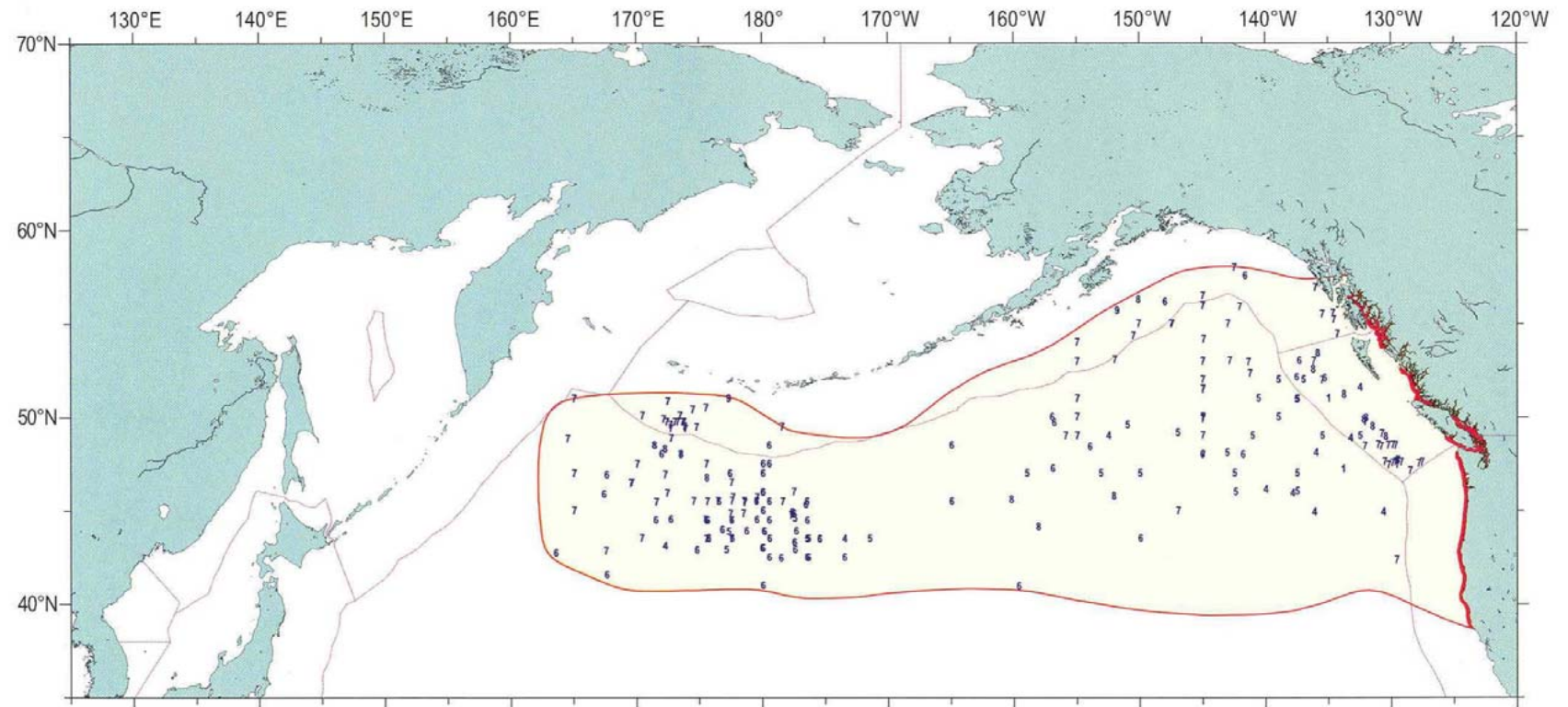


Chinook Salmon

North America



Steelhead



Marine Derived Nutrients

"This nutrient deficit may be one indication of ecosystem failure that has contributed to the downward spiral of salmonid abundance in general and etc...."¹

1860's		
N	3.04% ² →	6,850,000 kg
P	0.36% →	810,000 kg

¹Gresh et al. 2000. An estimation of historic and current levels of salmon production in the northeast Pacific ecosystem. Fisheries 25:15-21.

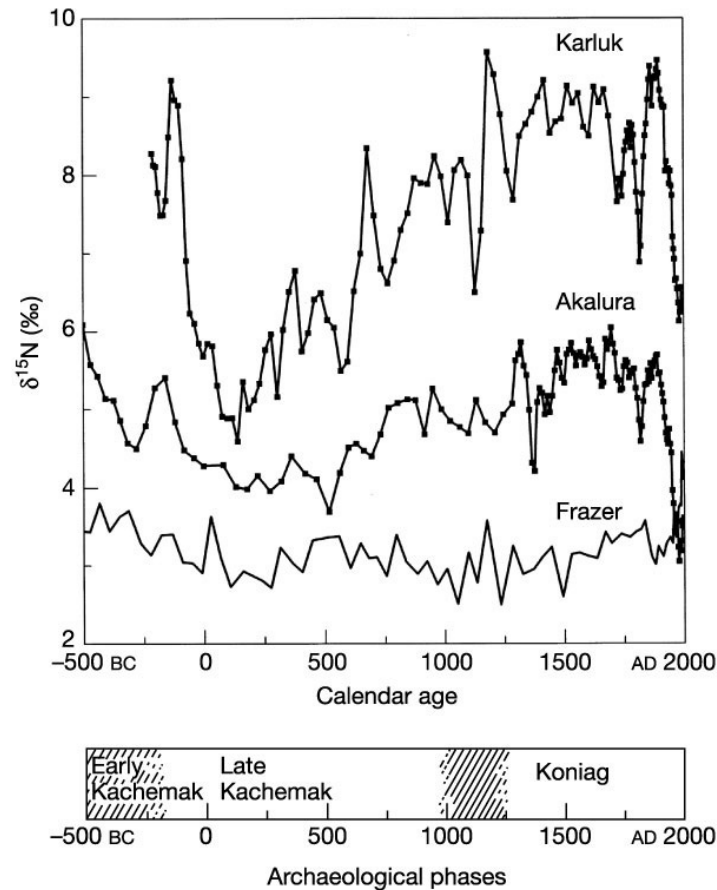
²Larking and Slaney. 1997. Implications of trends in marine-derived nutrient influx to south coastal British Columbia salmonid production. Fisheries 22:16-24.

What Does it Mean?

- It depends on the question, but if it is, “What does it mean for Pacific salmon production?” the answer may be that juvenile salmon grew to sizes that maximized their chances of survival in the ocean. However, if more survived in freshwater were they smaller or larger as juveniles?
 - Depends on the ecosystem
 - A) Lake Superior study
 - 8 to 80% in P and 3 to 12% increase in N over ambient concentration in two rivers depending on time and the river.
 - B) Lake enrichment
 - 100-150 tons inorganic fertilizer (P and N) added to outercoast lakes results in 2-3x increased production.
-

Historic Sockeye salmon abundance

Finney et al. 2002



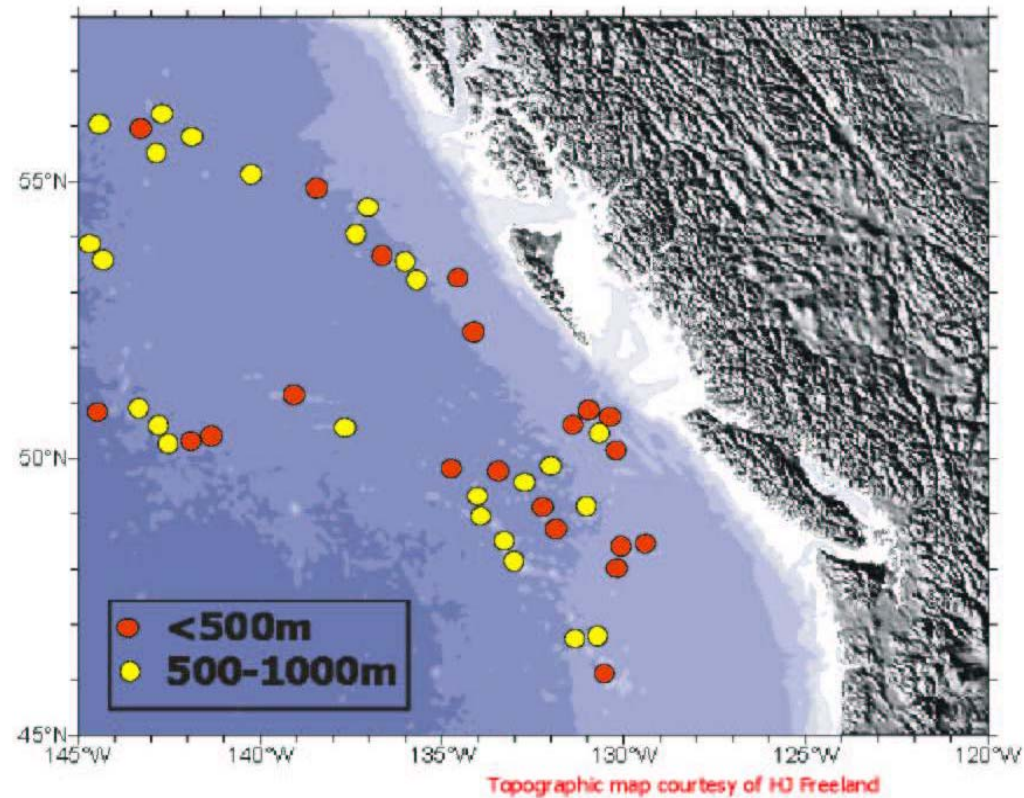
Delivery of pollutants by spawning salmon

Nature. 2003. Vol. 425: 255-256.

□ one million North American spawning



Seamounts



Species Observed at Bowie Seamount

□ Invertebrata

- **Porifera** (sponges) 1+
- **Cnidaria** (anemones, jellyfish, hydroids) 7+
- **Annelida** (polychaete worms) 2
- **Bryozoa** (moss animals) 1+
- **Mollusca** (snails, octopus, squid, chitons, bivalves) 6
- **Arthropoda** (barnacles, crabs, amphipods, copepods) 30
- **Echinodermata** (sea stars, brittle stars, sea cucumbers) 6

□ Urochordata

- **Larvacea and Thaliacea** (salps) 4

□ Vertebrata

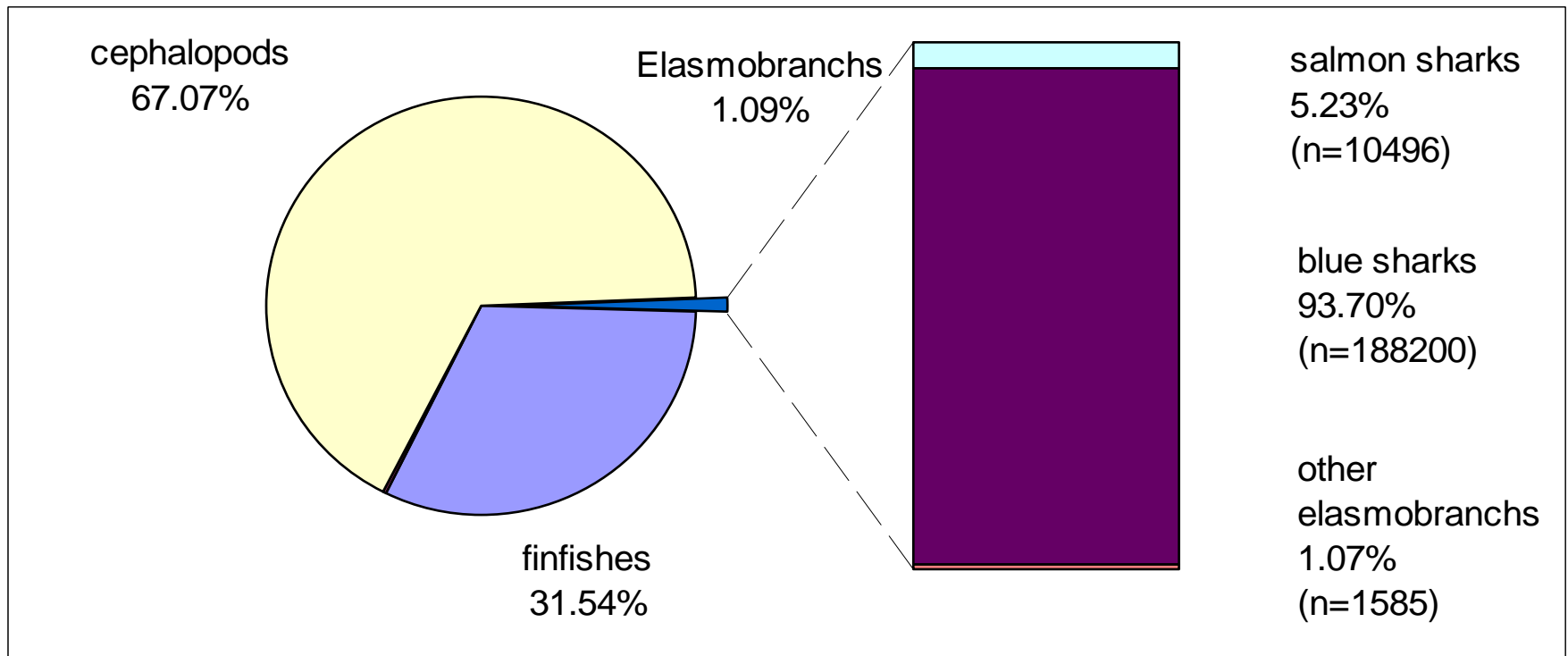
- **Chondrichthyes** (sharks, skates) 7
- **Osteichthyes** (flounders, soles, rockfish, sculpins) 53+
- **Aves** (albatrosses, auklets, puffins, petrels, shearwaters) 13+
- **Mammalia** (seals, sea lions, dolphins, whales) 8+

Species Observed at Bowie Seamount

<input type="checkbox"/> Sablefish	<input type="checkbox"/> Pacific ocean perch	<input type="checkbox"/> Brown cat shark
<input type="checkbox"/> Pacific halibut	<input type="checkbox"/> China rockfish	<input type="checkbox"/> Basking shark
<input type="checkbox"/> Rougheyeye rockfish	<input type="checkbox"/> Tiger rockfish	<input type="checkbox"/> Blue shark
<input type="checkbox"/> Yelloweye rockfish	<input type="checkbox"/> Bocaccio rockfish	<input type="checkbox"/> Pacific sleeper shark
<input type="checkbox"/> Pacific cod	<input type="checkbox"/> Canary rockfish	<input type="checkbox"/> Spiny dogfish
<input type="checkbox"/> Aurora rockfish	<input type="checkbox"/> Redstripe rockfish	<input type="checkbox"/> Skates
<input type="checkbox"/> Redbanded rockfish	<input type="checkbox"/> Yellowmouth rockfish	<input type="checkbox"/> Wolf eel
<input type="checkbox"/> Shortraker rockfish	<input type="checkbox"/> Harlequin rockfish	<input type="checkbox"/> Pacific flatnose
<input type="checkbox"/> Silvergray rockfish	<input type="checkbox"/> Shortspine thornyhead	<input type="checkbox"/> Turbot
<input type="checkbox"/> Darkblotched rockfish	<input type="checkbox"/> Longspine thornyhead	<input type="checkbox"/> Arrowtooth flounder
<input type="checkbox"/> Splitnose rockfish	<input type="checkbox"/> Longfin dragonfish	<input type="checkbox"/> Snipe eel
<input type="checkbox"/> Greenstriped rockfish	<input type="checkbox"/> Petrale sole	<input type="checkbox"/> Highfin dragonfish
<input type="checkbox"/> Widow rockfish	<input type="checkbox"/> Red Irish lord	<input type="checkbox"/> Twoline eelpout
<input type="checkbox"/> Yellowtail rockfish	<input type="checkbox"/> Ragfish	<input type="checkbox"/> Pomfrets
<input type="checkbox"/> Rosethorn rockfish	<input type="checkbox"/> Broadfin lampfish	<input type="checkbox"/> Blacktail snailfish
<input type="checkbox"/> Quillback rockfish	<input type="checkbox"/> Rock sole	<input type="checkbox"/> Pacific viperfish
<input type="checkbox"/> Vermillion rockfish	<input type="checkbox"/> Dover sole	<input type="checkbox"/> Rattail
<input type="checkbox"/> Pollock	<input type="checkbox"/> Scorpionfish	<input type="checkbox"/> Sculpins
<input type="checkbox"/> Prowfish	<input type="checkbox"/> Deepsea sole	

Japanese Squid Driftnet Fisheries: 1990-91

McKinnell and Seki 1998. Fish. Res. 39: 127-138.



Abundant Open Ocean Sharks

Blue shark (*Prionace glauca*)



- Evidence of north-south migration and some east-west (Seki et al. 2001)

Salmon Shark (*Lamna ditropis*)

- Recent evidence (Alaska Shark Assessment Program) indicates open ocean – coastal migrations



These sharks inhabit both coastal and open ocean systems

Blue Shark Diet



Squid

Small sharks

Mammals

Offshore

Salmon

Pomfret

Tuna

Saury

Coastal

Herring

Sardines

Mackerel

Hake

Pollock

Salmon Shark Diet



Squid

Small sharks (Spiny dogfish)

Small mammals

Offshore

Salmon (mainly sockeye, chum, pink)

Daggertooth

Saury

Pomfret

Lanternfishes

Coastal

Salmon (occasionally coho, chum)

Lancetfish

Mackerel

Sculpin

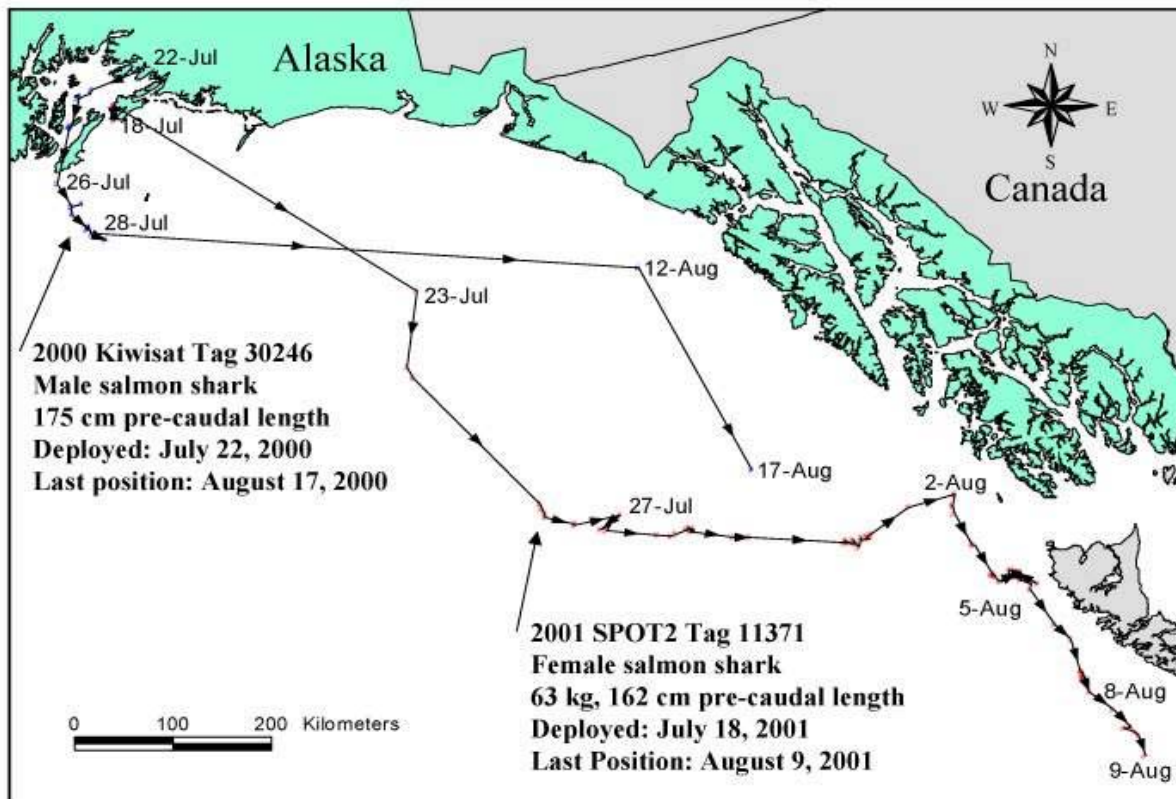
Pollock

Herring

Capelin

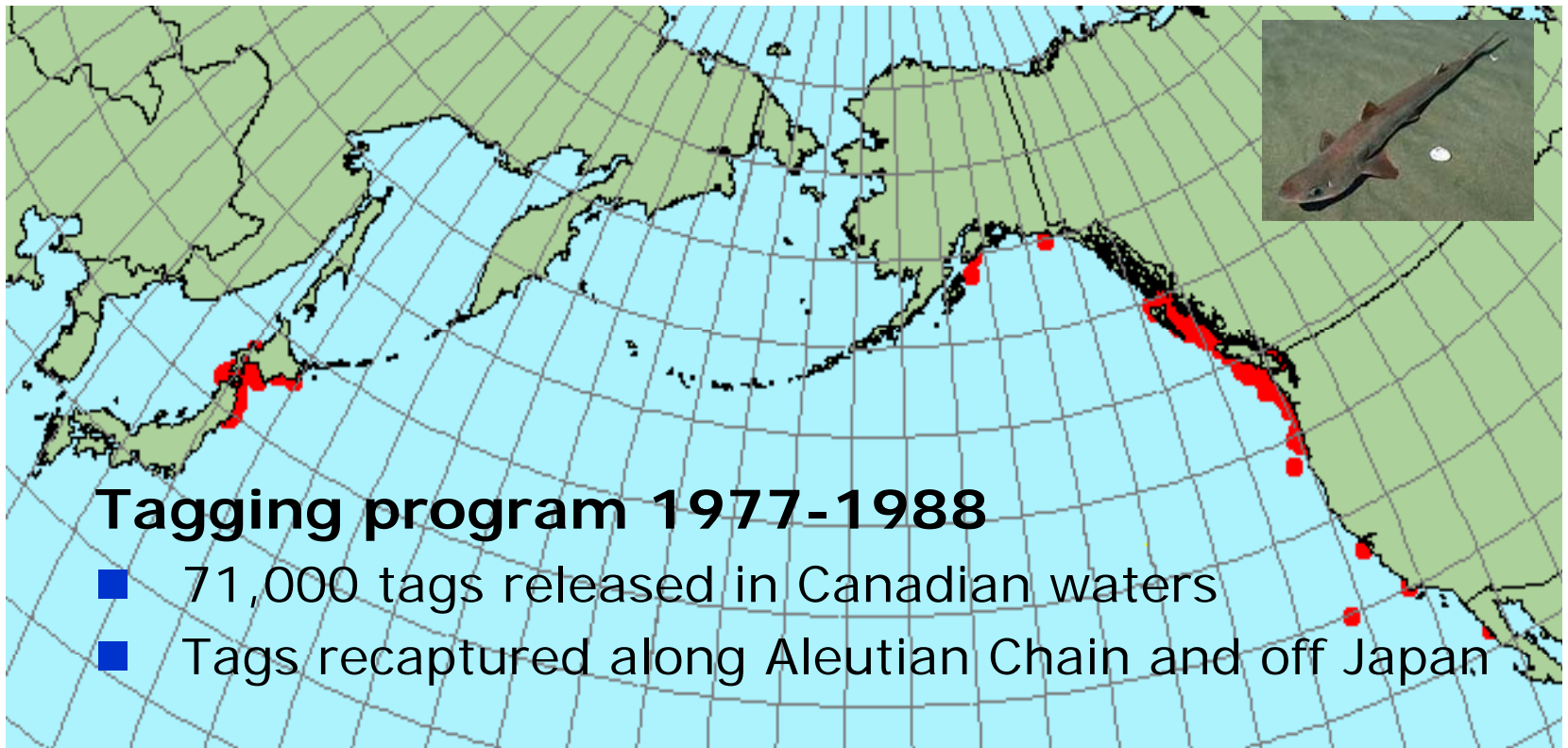
Sardine

Salmon Shark Movement



Extensive Shark Migration

Spiny Dogfish (*Squalus acanthias*)

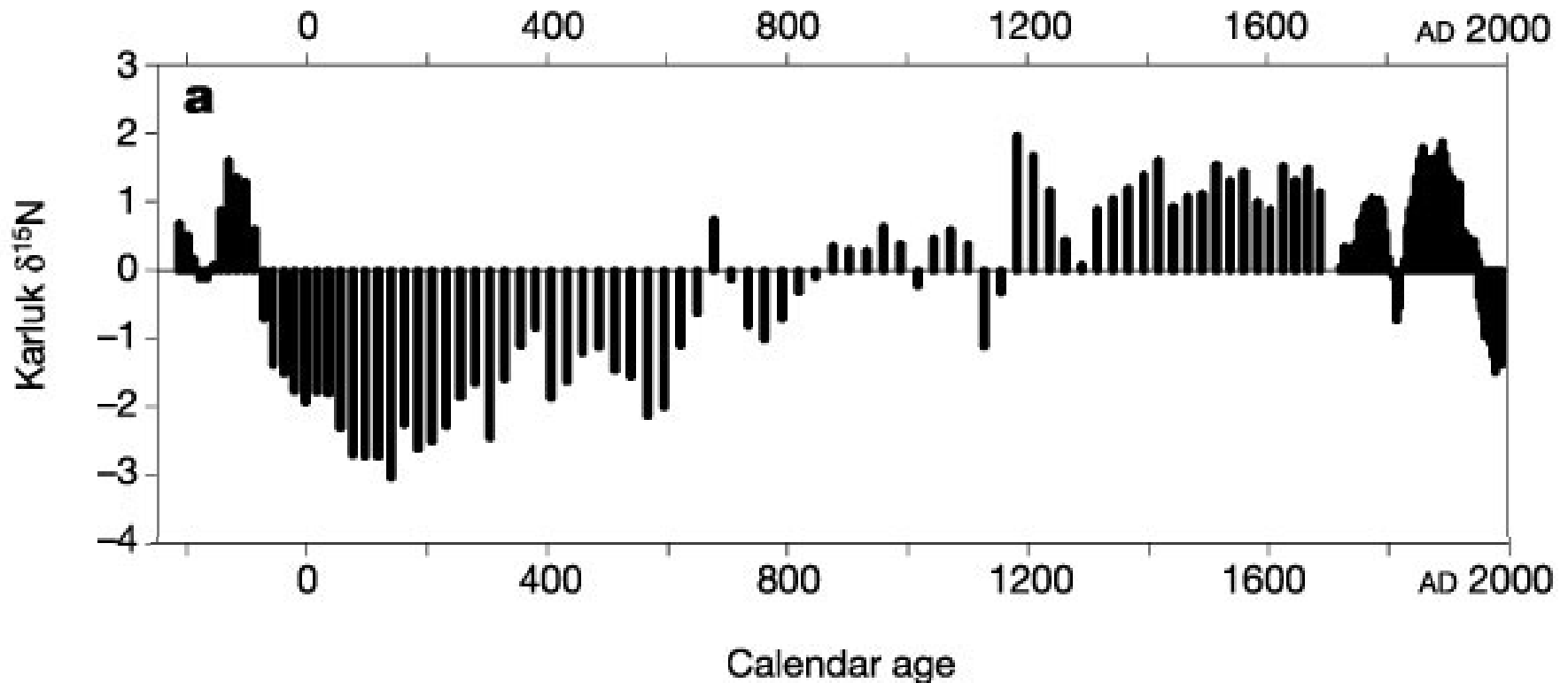


Conclusions

- ❑ Fisheries off the west coast of North America are virtually all coastal.
 - ❑ Most fish stocks are coastal.
 - ❑ Exceptions occur for some species, with Pacific salmon being the major group of species moving between the coast and the high seas.
 - ❑ The advantage for Pacific salmon is that they can achieve large sizes and large abundances.
 - ❑ The major impact on production of this behaviour is the transport of nutrients back to freshwater when the salmon die and decompose.
-



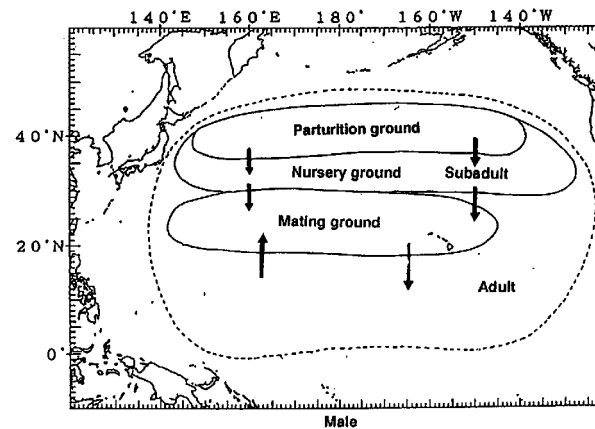
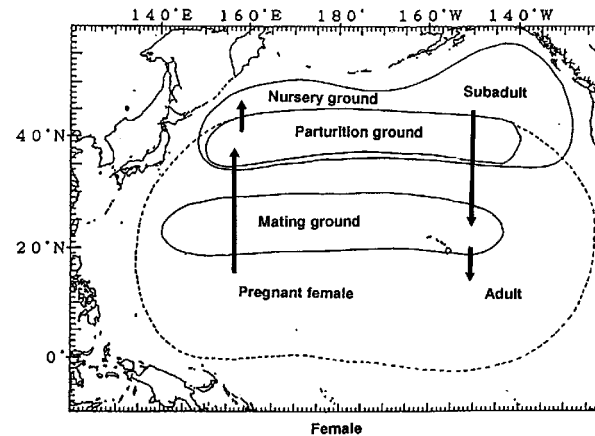
Reconstructed Sockeye salmon abundance in Alaska



Finney *et al.* 2002. Nature.

Blue Shark Migration

- Schematic blue shark migration model by sex proposed by Nakano (1994)



Pacific Sardine

