Contaminants in Stellers sea lions

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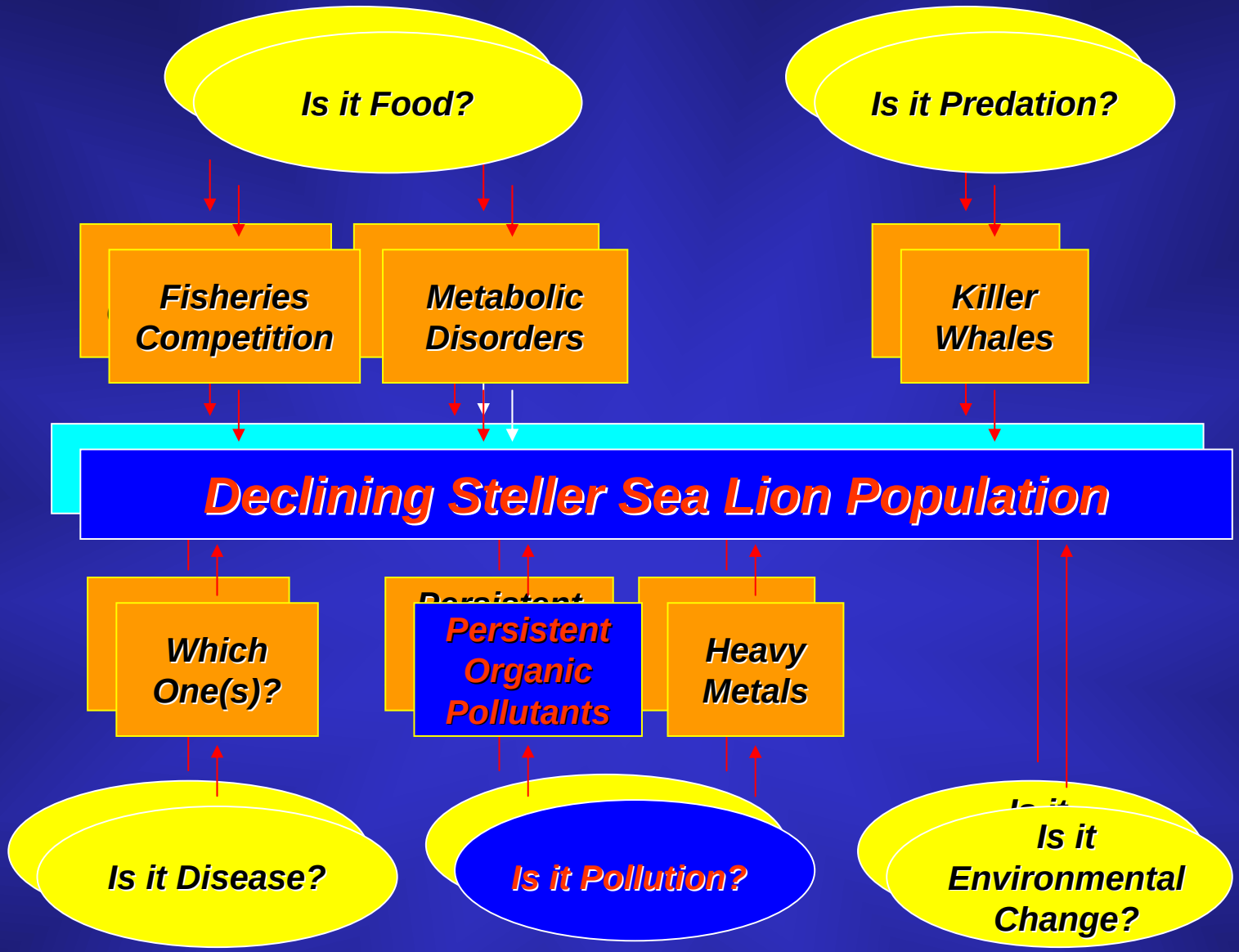
Outline

- Decline concept
- Background
- Contaminants
- Summary

The SSL decline concept



PCBs

- polychlorinated biphenyl, any one of a group of poisonous chemicals used in industry as electrical insulators and in plastics manufacture

DDT

Muller, Paul Hermann (1899-1965), a Swiss chemist, won the 1948 Nobel Prize for physiology or medicine for discovering the insect-killing properties of DDT (dichloro-diphenyl-trichloroethane)

DDT first was produced in Austria in 1873, but Muller discovered DDT's value as an insect killer in 1939. DDT was used during World War II (1939-1945) to kill body lice that carried typhus

Rachel Carson, a marine biologist, wrote about the destructive effects of DDT and other pesticides in her book Silent Spring (1962). She pointed out that pesticides poison the food supply of wild animals and could also contaminate the food supply of human beings. Beginning in 1972, DDT has been gradually phased out.

DDT ban was disservice to Third World

PAULA EASLEY
COMMENT

With deadly disease outbreaks and threats of bioterrorism a reality, Congress should revisit DDT's suitability for public safety uses.

"J. Gordon Edwards, prominent California biologist and entomologist, swallowed a tablespoon of DDT while speaking to a medical symposium, whereupon he retched, writhed, and died a horrible death."

Most would expect such an outcome but the truth is, 32 years and many tablespoons later, Dr. Edwards is still teaching, writing, and running up and down mountains in remarkably good health. His goal: to prove DDT, contrary to Rachel Carson's "Silent Spring" accusations, is a safe insecticide.

Many Americans took Carson's word as gospel: DDT was a carcinogen, sabotaged ecological systems, caused eggshell thinning in birds, and dissipated slowly in humans.

In 1972, EPA administrator William Ruckelshaus, banned DDT production nationally. This, despite a Nobel Prize in Medicine given its discoverer, the EPA science advisors' conclusions, and a 1970 National Academy of Sciences report declaring: "To only a few chemicals does man owe as great a debt as to DDT. ... In a little more than two decades, DDT has prevented 500 million deaths due to malaria that otherwise would have been inevitable."

Ruckelshaus, in a subsequent fund-raising letter for the Environmental Defense Fund , credited it with "blowing the whistle on DDT." (the defense fund also orchestrated the Alar debacle.) The entire DDT saga, which I've monitored for years, demonstrates how easily a government agency can disregard scientific evidence for political purposes. It also demonstrates the difficulty of rescinding a misguided federal action or correcting its global consequences: annual malarial infections of 300 to 500 million people and more than 2.5 million deaths a year (World Health Organization).

Once banned in the U.S., other countries were pressured to follow suit. Dr. Roger Bate ("When Politics Kills: Malaria and the DDT Story") finds such pressure immoral.

"For rich countries to tell poor nations ... to ban chemicals that help control disease-carrying insects — and then claim to be responsible, humanitarian and compassionate — is to engage in hypocrisy of the most lethal kind," writes Ron Bailey ("Greens vs. the World's Poor").

Steven Milloy ("Junk Science Judo") notes that since agricultural spraying was discontinued, "residue of its byproducts may still be found in our bodies and the environment. So what? No harm, no foul. There's never been any credible evidence that the low levels of DDT residue in our bodies and the environment have caused any harm. ... DDT will, however, kill mosquitoes, which is better than mosquitoes killing us."

Malaria and other mosquito, lice and flea-borne diseases such as typhus, yellow fever, encephalitis and bubonic plague are making a comeback — yet the safest, most cost-effective treatment, DDT, is less available. Greenpeace, Environmental Defense Fund, the World Wildlife Fund and Sierra Club are seeking a worldwide ban. But as a population control method?

"People are the cause of all the problems. We have too many of them. We need to get rid of some of them and this is as good a way as any," said the Environmental Defense Fund's Scientific Advisory Council chairman Dr. Charles Wurster, a key promoter of banning DDT. Michael McCloskey explains: "Sierra Club wants a ban on pesticides, even in countries where DDT has kept malaria under control ... (because by) using DDT, we reduce mortality rates in underdeveloped countries without the consideration of how to support the increase in population." (I did not make this up.)

With deadly disease outbreaks and threats of bioterrorism a reality, Congress should revisit DDT's suitability for public safety uses. There is now a huge body of research to aid such action.

We now have West Nile Virus in America. As of Sept. 15, Colorado's cases lead the nation for 2003: 1,214 cases and 19 deaths (CDC). I shudder to think of the health consequences to Alaskans of a mosquito-borne virus epidemic, especially considering our endless wetland breeding grounds and the annual migration of potentially infected birds.

Such an epidemic could easily wreak havoc on the state's visitor industry. Not to worry. The CDC says just stay inside whenever mosquitoes are present, eliminate standing water sources, and apply a heavy dose of DEET to reduce chances of becoming infected. Oh, great. That should assure some fine, stress-free Alaska summers.

■ Paula Easley is a public policy consultant and former executive director of the Resource Development Council for Alaska.

Anchorage Daily News, Sept. 21, 2001

California sea lions

- DeLong et al. (1973) concentrations of DDTs in cows that experienced premature births was 8 times higher than animals that had full term births

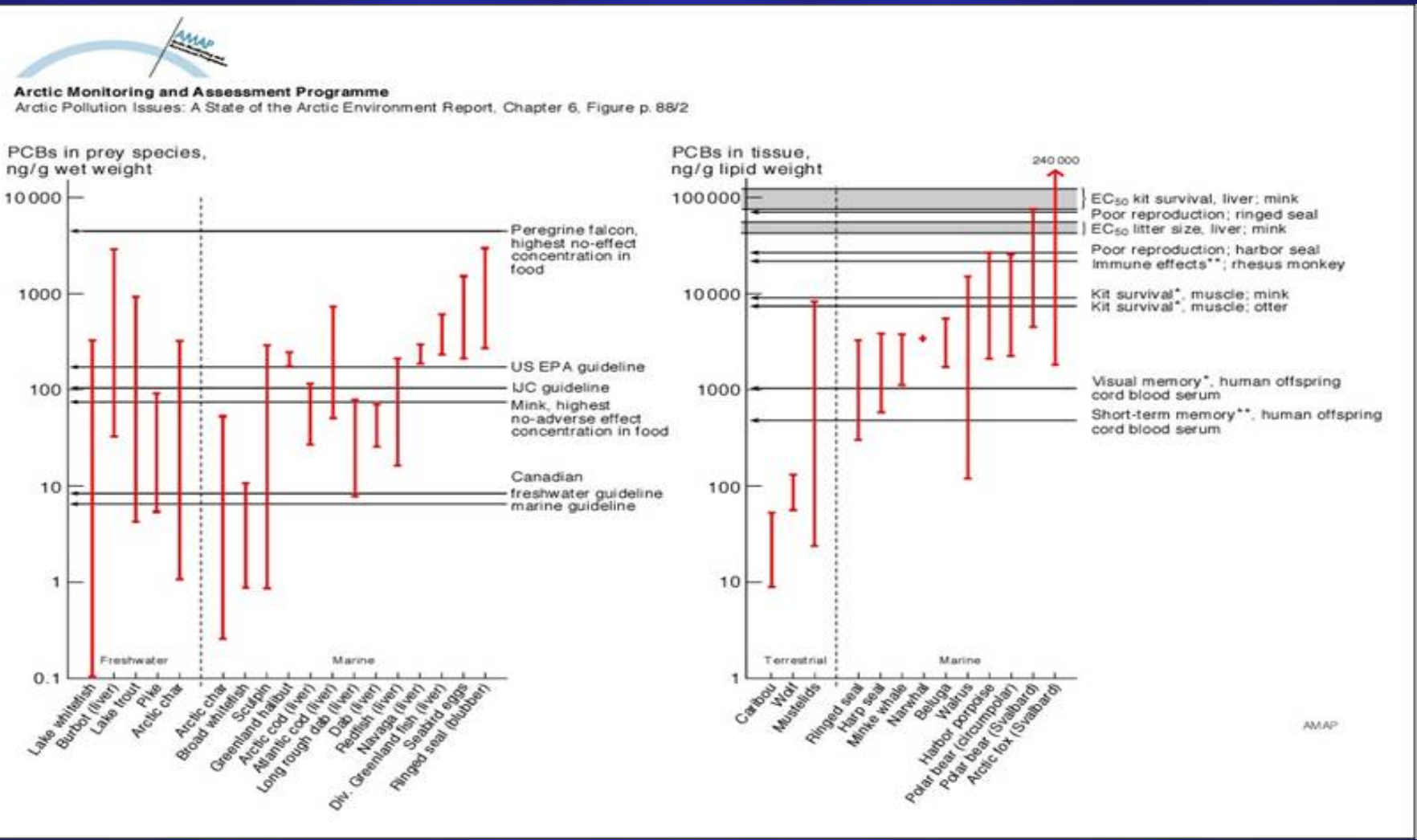
- Ylitalo et al. (2005) animals that died of carcinoma had 85% more PCBs and 30% more DDTs than other animals

Steller sea lions

- Baker et al. (2005) separate genetic stock in Russian Far East

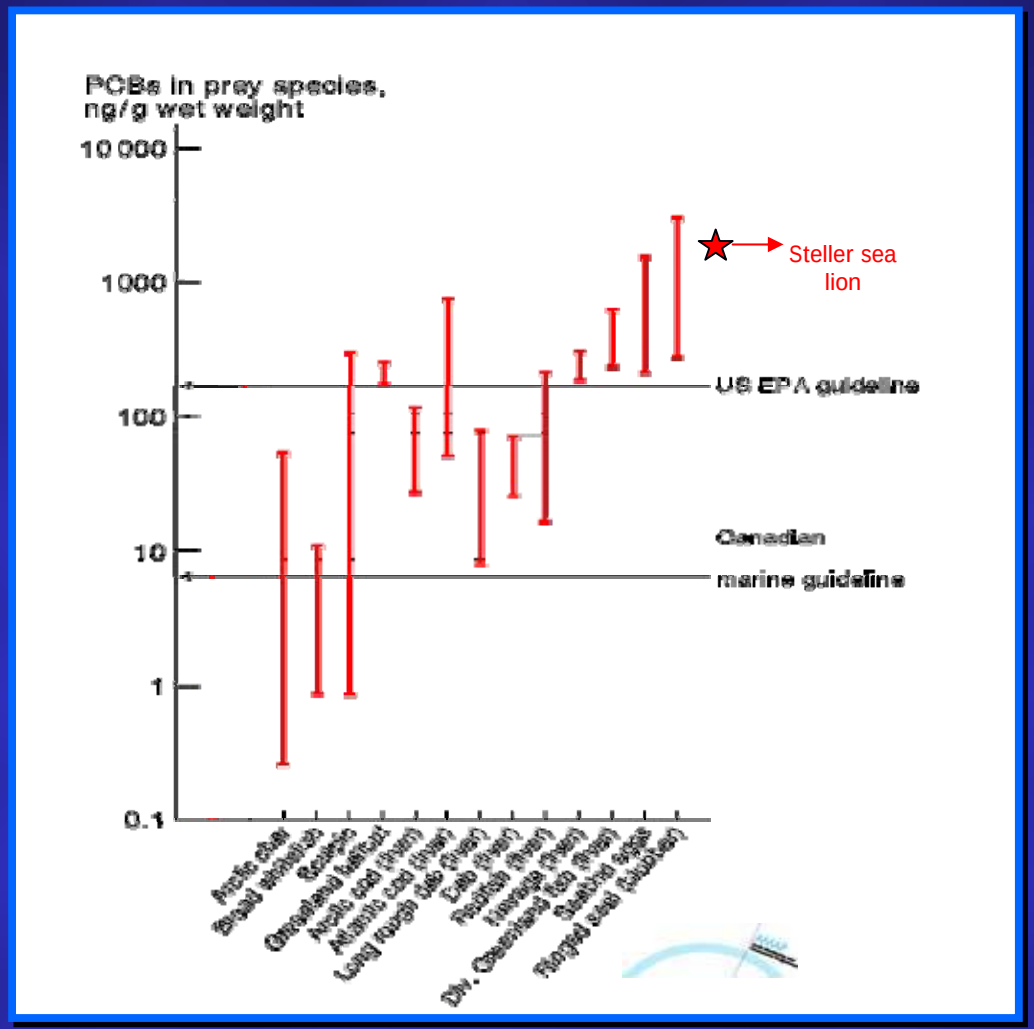
- Holmes and York (2003) fecundity the problem in the 90's

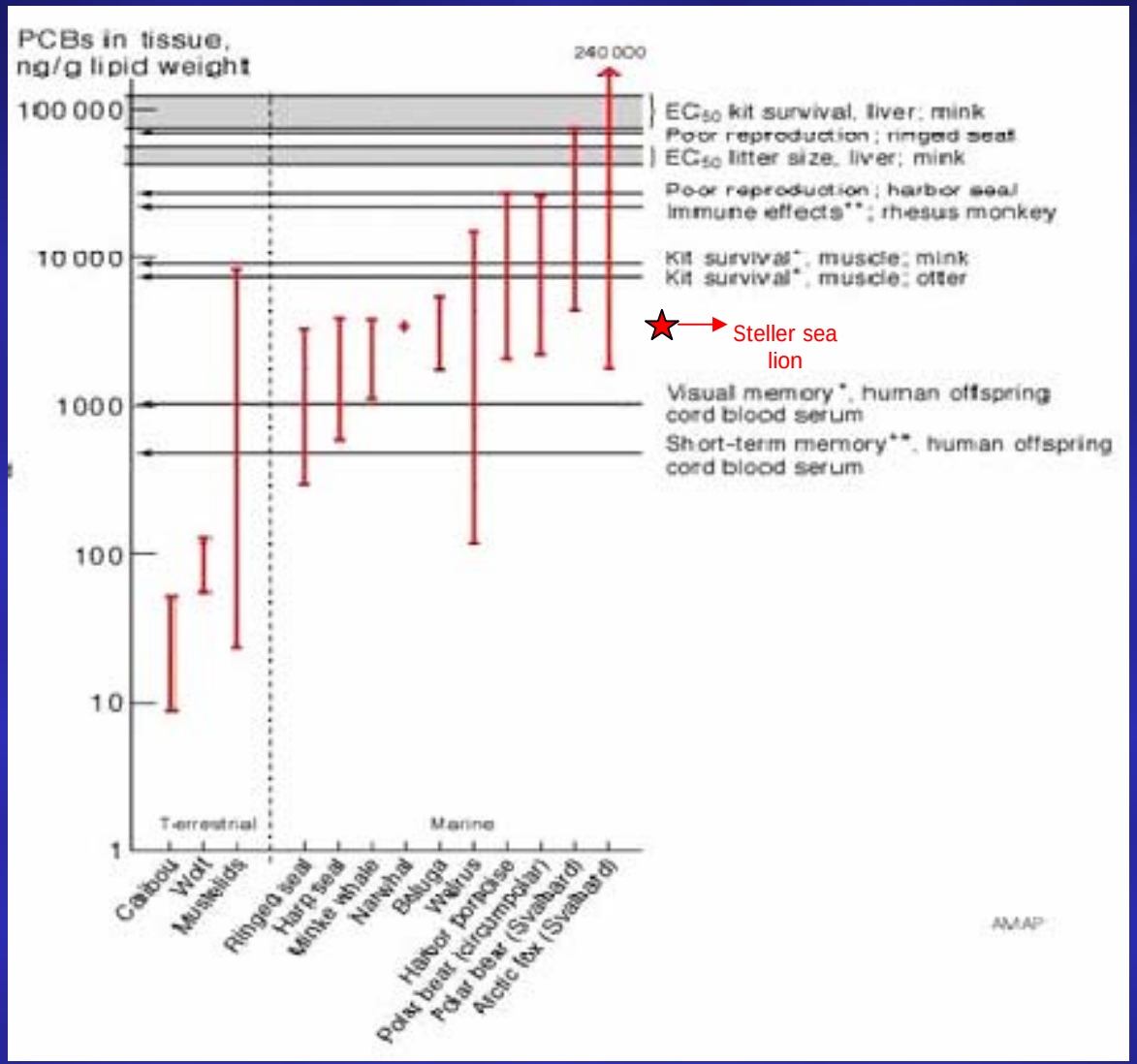
US EPA Guidelines



Steller sea lions from the Bering Sea

Field No.	∑PCBs	∑PCB TEQs	∑DDTs	∑PCB (lw)	∑PCB TEQs (lw)	∑DDTs (lw)
SSL-2	990.00	10.54	819.00	2675.68	28.49	2213.51
SNPSLS9808	2600.00	32.73	2002.00	5652.17	71.16	4352.17
SNPSLS0004	1000.00	12.02	1326.00	3225.81	38.76	4277.42
SNPSLS9901	3000.00	38.42	3831.00	5454.55	69.85	6965.45
SSL9802SNP	5700.00	69.47	4000.00	13255.81	161.56	9302.33
SSL-3	4000.00	49.01	4075.00	9523.81	116.69	9702.38
SSL-4	2300.00	28.46	1854.00	4423.08	54.72	3565.38
JB01FWS02	1000.00	2.26	587.00	1851.85	4.19	1087.04
SP0100EJ	1100.00	12.90	912.00	2115.38	24.81	1753.85
mean	**2410.00**	**28.42**	**2156.22**	**5353.13**	**63.36**	**4802.17**
se	**545.91**	**7.21**	**478.56**	**1265.17**	**16.45**	**1059.00**


PCBs in prey species,
ng/g wet weight
10 000
1000
100
10
1
0.1
Steller sea lion
US EPA guideline
Canadian
marine guideline


PCBs in tissue, ng/g lipid weight
240 000
100 000
10 000
1000
100
10
1
EC50 kit survival, liver; mink
Poor reproduction; ringed seal
EC50 litter size, liver; mink
Poor reproduction; harbor seal
Immune effects**; rhesus monkey
Kit survival*, muscle; mink
Kit survival*, muscle; otter
Steller sea lion
Visual memory*, human offspring cord blood serum
Short-term memory**, human offspring cord blood serum
Terrestrial
Marine
Caribou
Wolf
Mustelids
Ringed seal
Harp seal
Minke whale
Narwhal
Beluga
Walrus
Harbor porpoise
Polar bear (circumpolar)
Polar bear (Svalbard)
Arctic fox (Svalbard)
AMAP

OC Samples

- 212 separate blood samples were analyzed for contaminants from free ranging pups
- For Russia n=136 and for southwest Alaska n=76

Samples were collected in collaboration with Wildlife Consultants Inc., the National Marine Fisheries Service (NMFS) and the Alaska SeaLife Center (ASLC) during the field season of 2002

There is a sample bias but in this case it helps control for season and age.

Methods

- Organochlorines were measured in blood samples. All samples were analyzed for PCBs and congeners, plus DDT, DDE and DDD
- All samples were analyzed at the NMFS Northwest Fisheries Science Center in Seattle, Washington
- The procedure is a HPLC/PDA (high-performance liquid chromatography with photodiode array detection) method that was developed to rapidly screen for toxic “dioxin-like” CBs and congeners

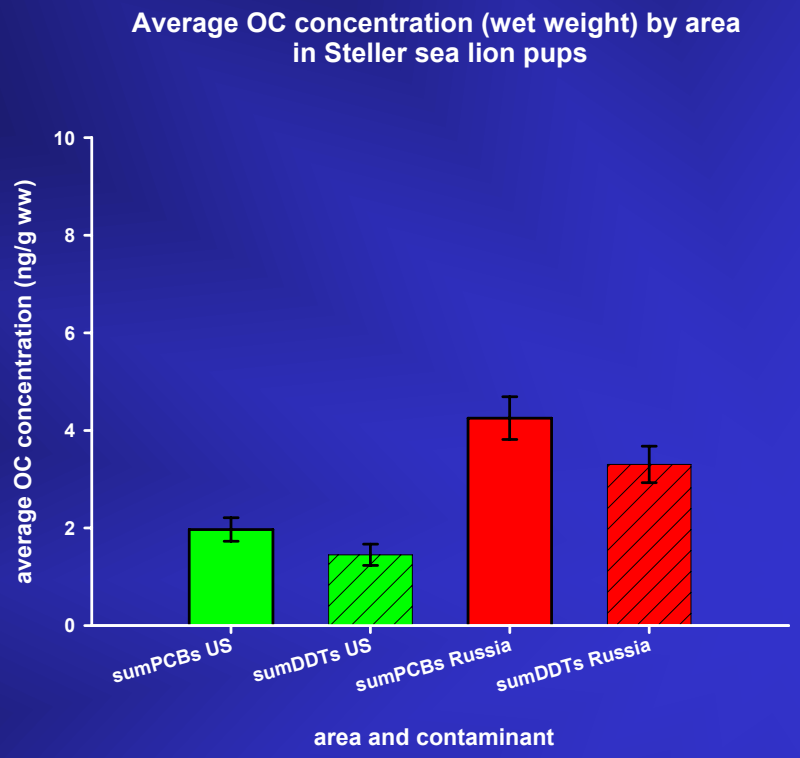
Limitations to this type of study

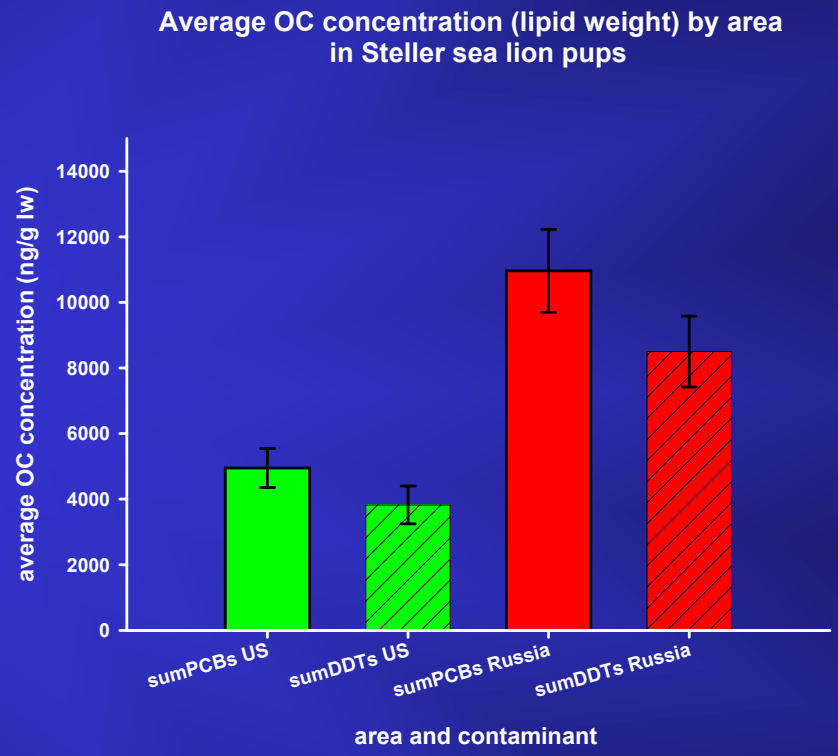
- Can’t determine causality
- Only statistical association between biomarkers and contaminants
- Other contaminants may induce synergistic, additive or antagonistic effect
- Cofounders include biological variables (age, sex, body condition, disease or other stressors)

Lipid adjusted values

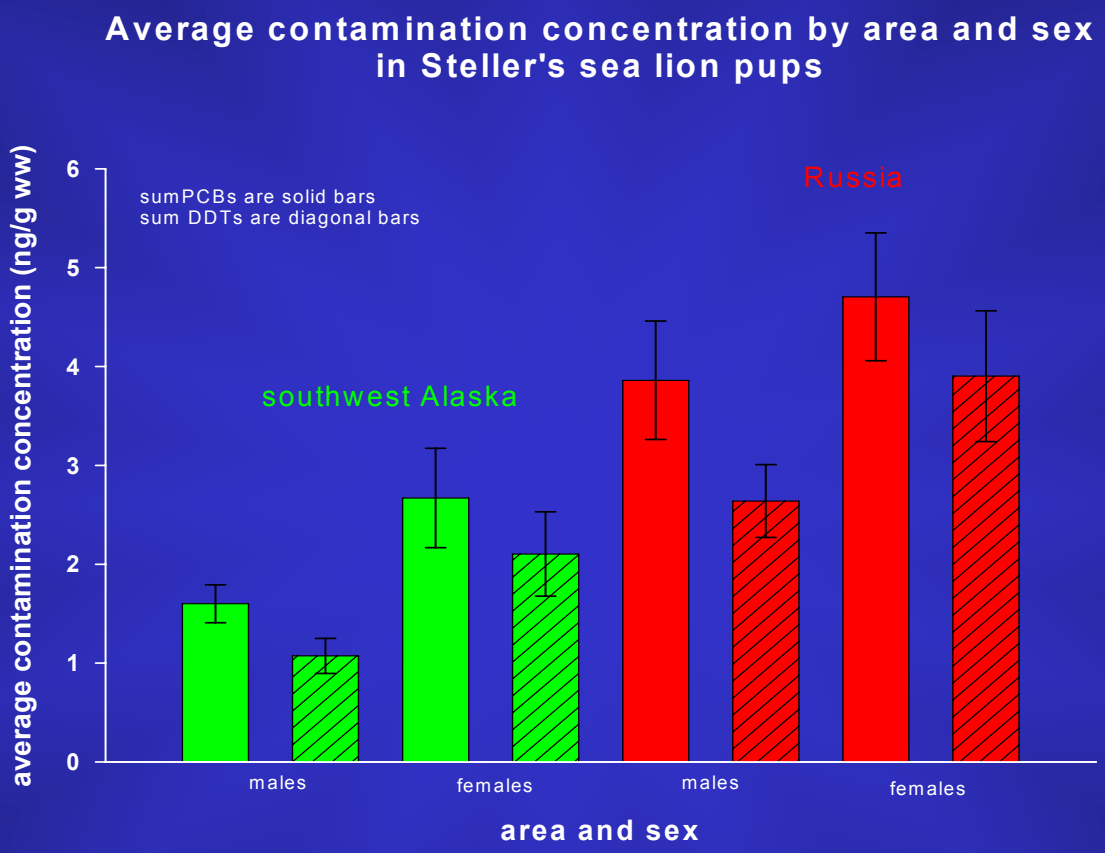
- Assumes that OCs are evenly distributed in the lipid stores of all organs within the organism
- Lipids determined in blood at the lower end of detection range by Iatroscan instruments
- As lipids near lower limits of detection, the values are less accurate
- If there are nutritional problems and lipid stores in blubber are metabolized, OC concentrations could increase

OCs by area


Average OC concentration (wet weight) by area in Steller sea lion pups
average OC concentration (ng/g ww)
0
2
4
6
8
10
sumPCBs US
sumDDTs US
sumPCBs Russia
sumDDTs Russia
area and contaminant

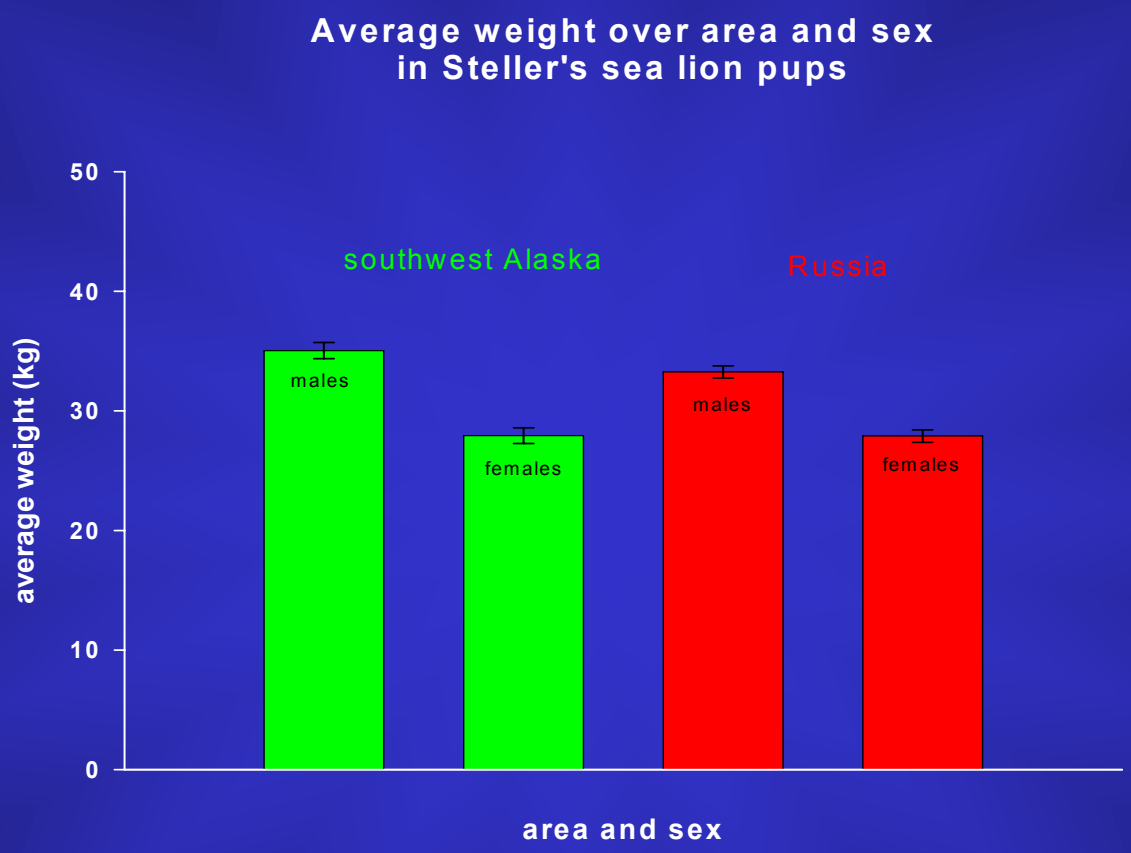

Average OC concentration (lipid weight) by area in Steller sea lion pups
average OC concentration (ng/g lw)
0
2000
4000
6000
8000
10000
12000
14000
sumPCBs US
sumDDTs US
sumPCBs Russia
sumDDTs Russia
area and contaminant

OCs by area and sex



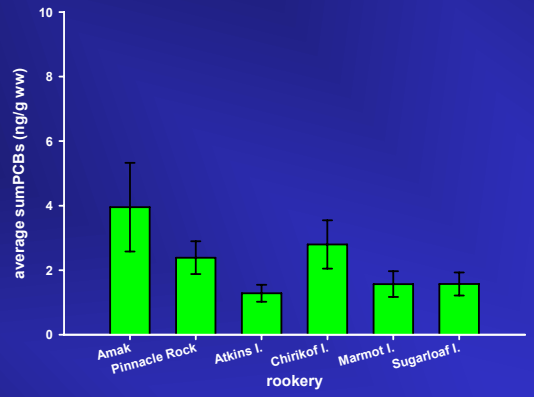
(for PCBs p = 0.009 for females and p = <0.001 for males; for DDTs p = 0.026 for females and p = < 0.001 for males)

Size and sex

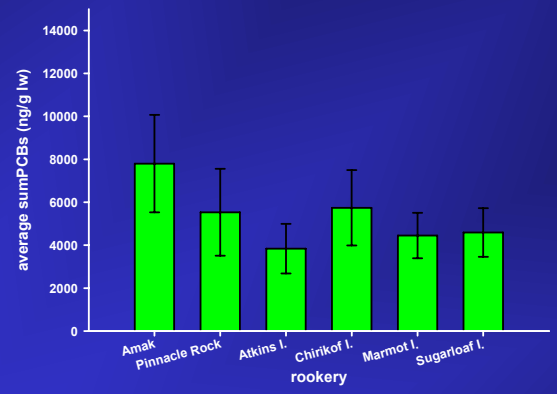

Average weight over area and sex
in Steller's sea lion pups
50
40
30
20
10
0
average weight (kg)
southwest Alaska
Russia
males
females
males
females
area and sex

Western Alaska

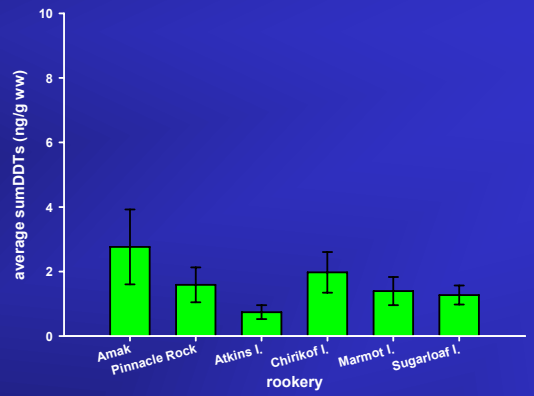
Average sumPCB concentration (wet weight) by rookery in western Alaska Steller sea lion pups



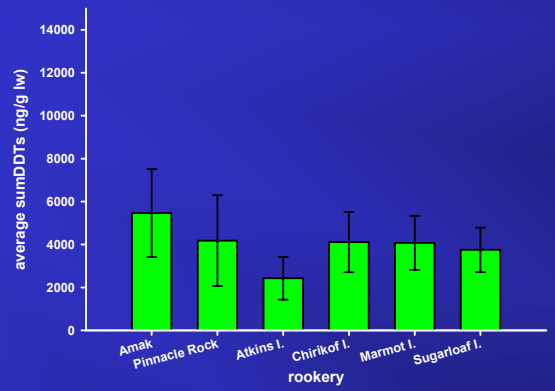
Average sumPCB concentration (lipid weight) by rookery in western Alaska Steller sea lion pups



Average sumDDT concentration (wet weight) by rookery in western Alaska Steller sea lion pups

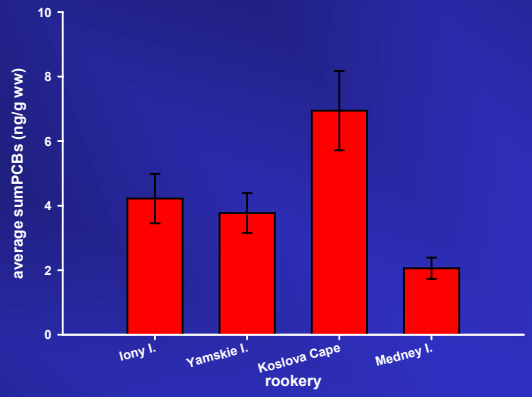


Average sumDDT concentration (lipid weight) by rookery in western Alaska Steller sea lion pups

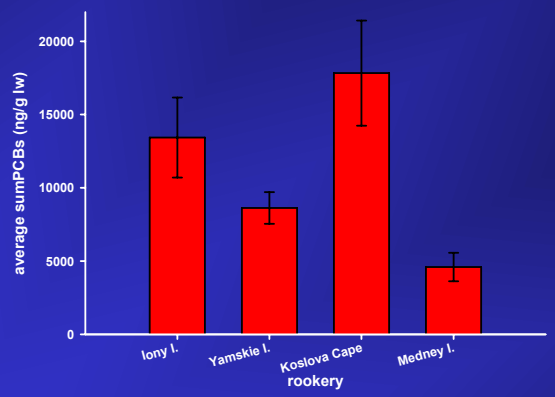


The Russian Far East

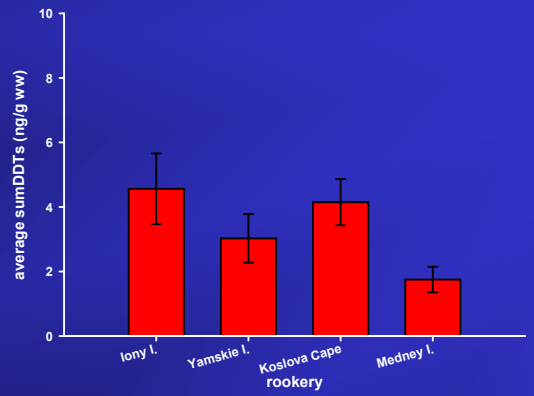
Average sumPCB concentration (wet weight) by rookery
in Russian Far East Steller sea lion pups



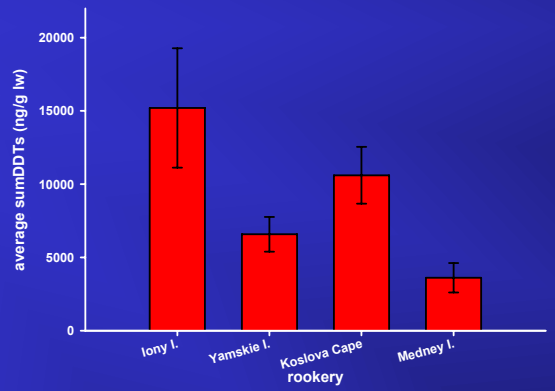
Average sumPCB concentration (lipid weight) by rookery
in Russian Far East Steller sea lion pups

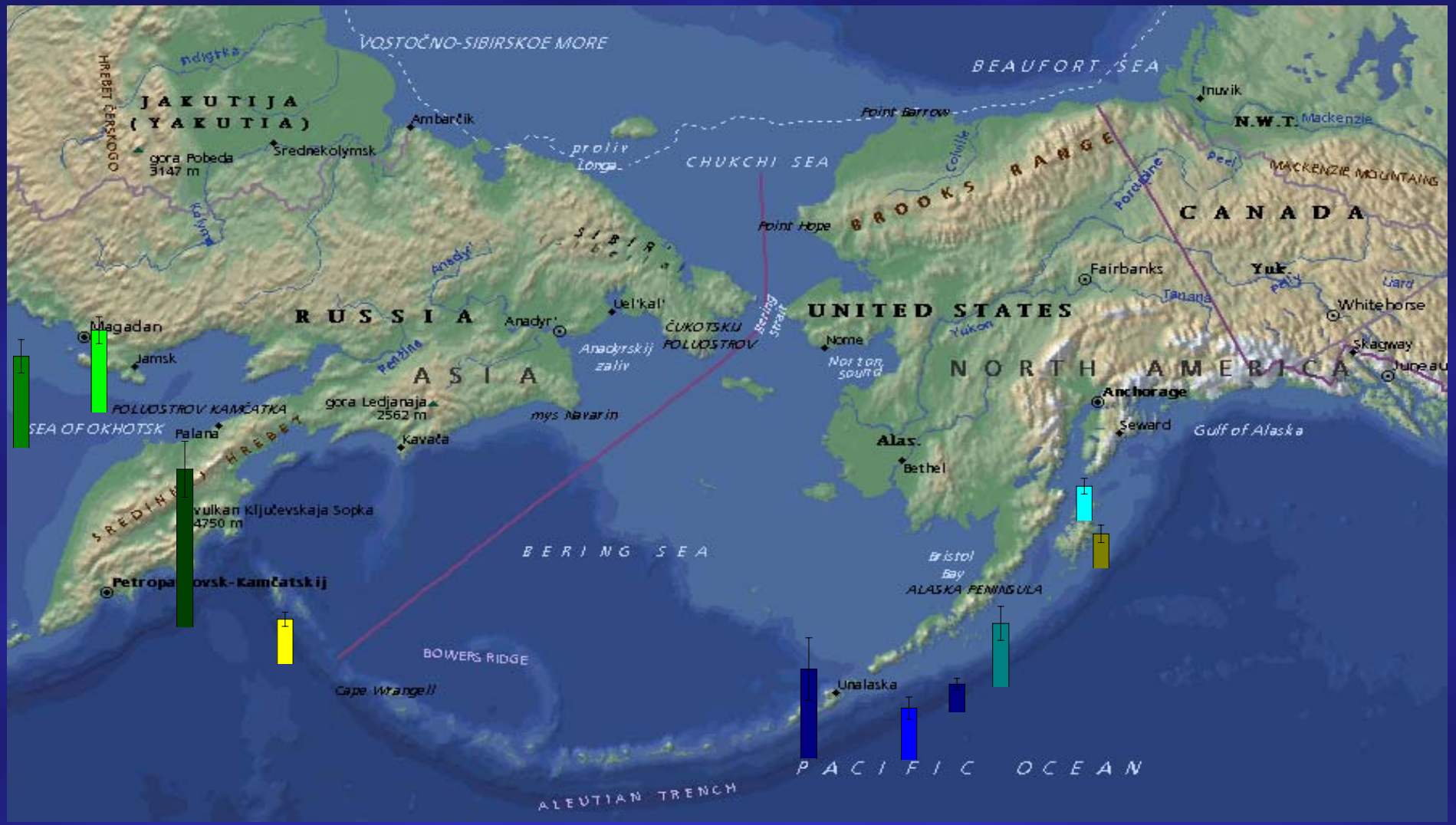


Average sumDDT concentration (wet weight) by rookery
in Russian Far East Steller sea lion pups



Average sumDDT concentration (lipid weight) by rooker
in Russian Far East Steller sea lion pups





According to AMAP, Gulf of Alaska concentrations are 631 ng/g ww in blubber and PWS was 467 ng/g ww

OC concentrations compared to levels associated with biological and physiological effects

- Kannan et al. (2000) recommended a PCB threshold concentration of 11,000 ng/g lipid weight for marine mammal blood

- TEQs measured in the blood of immune-compromised harbor seals (DeSwart et al., 1994, 1996; Ross et al., 1995) was 72 pg/g lipid weight

∑PCBs

- western Alaskan pups mean ∑PCBs was 5155 ng/g lipid weight (below threshold levels)
- 9 out of 76 pups (or 12%) exceeded the threshold concentration
- Russian pups mean ∑PCBs of 10960 ng/g lipid weight (at threshold levels)
- 39 of the 136 pups sampled (or 29%) exceeded the threshold concentration

∑PCB TEQs

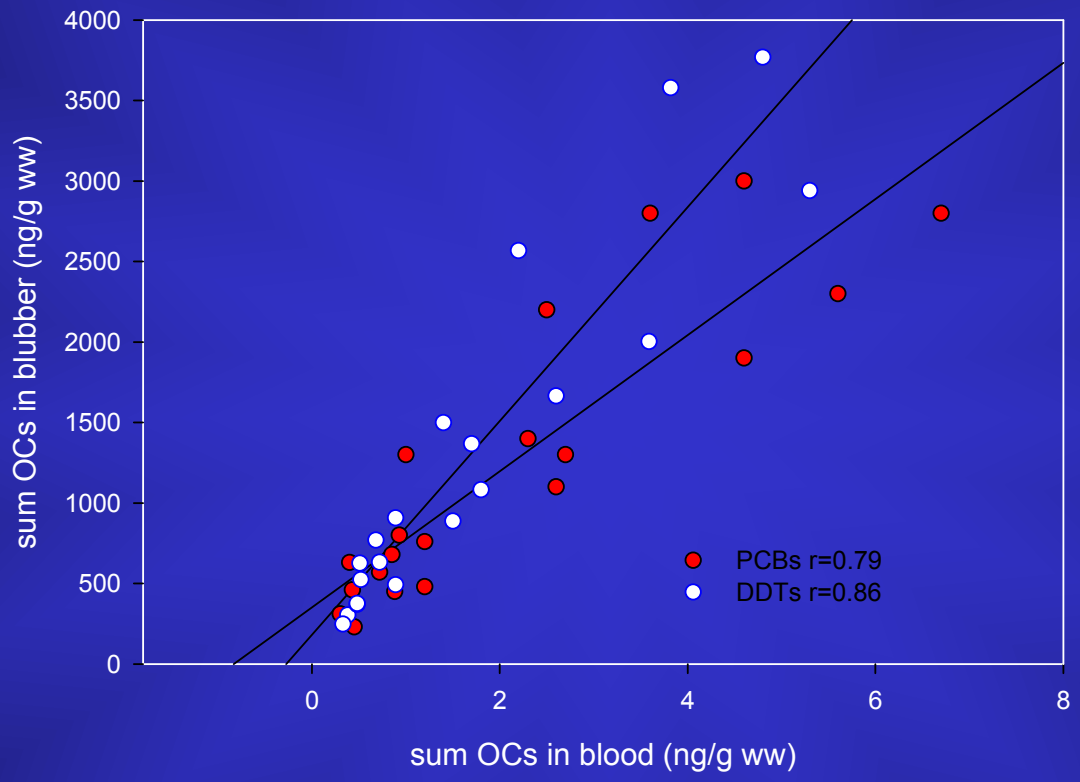
- western Alaskan pups TEQ averaged 71 pg/g lipid weight which is near the threshold
- 30 of the 76 pups (or 40%) exceeded threshold.
- For Russian pups the TEQ average was 206 pg/g lipid weight or almost three times the threshold value
- 87 of the 136 Russian pups (or 64%) of the animals exceeded the threshold

Koslova Cape ∑PCBs

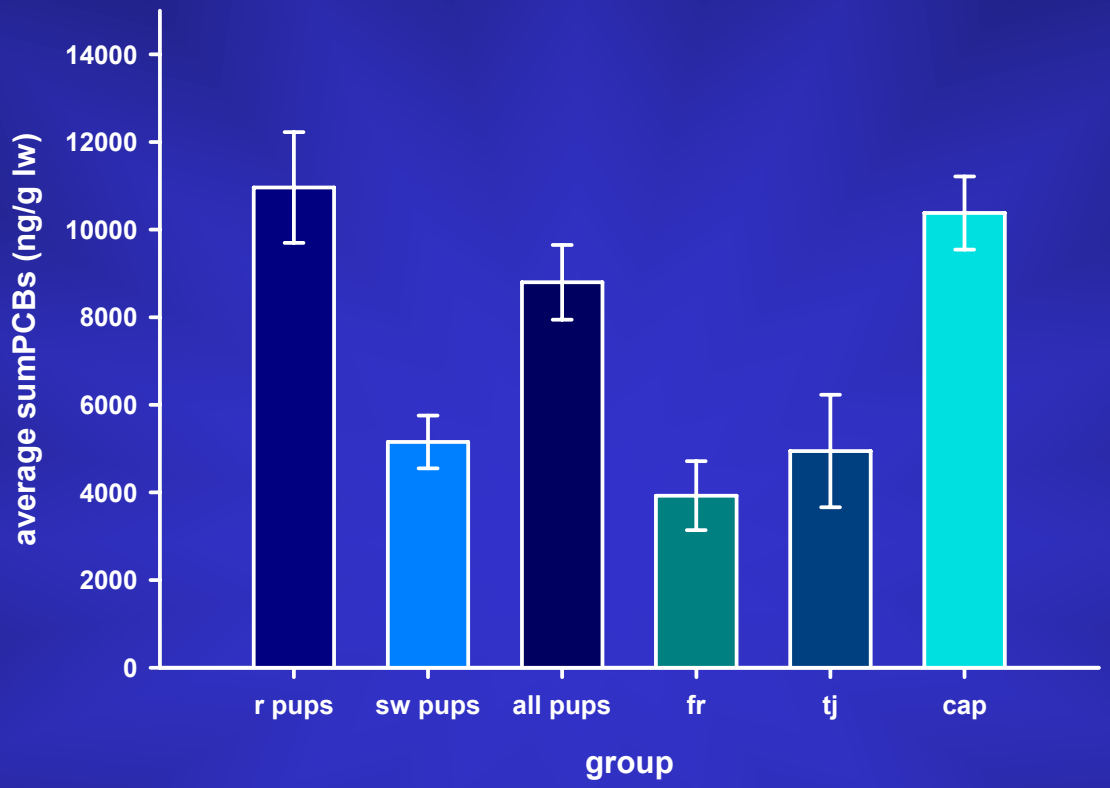
- Koslova Cape mean ∑PCBs were 6.94 ng/g wet weight and 17831 ng/g lipid weight
- The average ∑PCBs lipid adjusted at Koslova Cape are more than 1½ times that of the 11,000 ng/g lipid weight recommended by Kannan et al. (2000)
- 16 of 38 or 42% of the Koslova Cape animals exceeded this threshold
- one individual had ∑PCB concentration of 120000 ng/g lipid weight

Blood vs Blubber

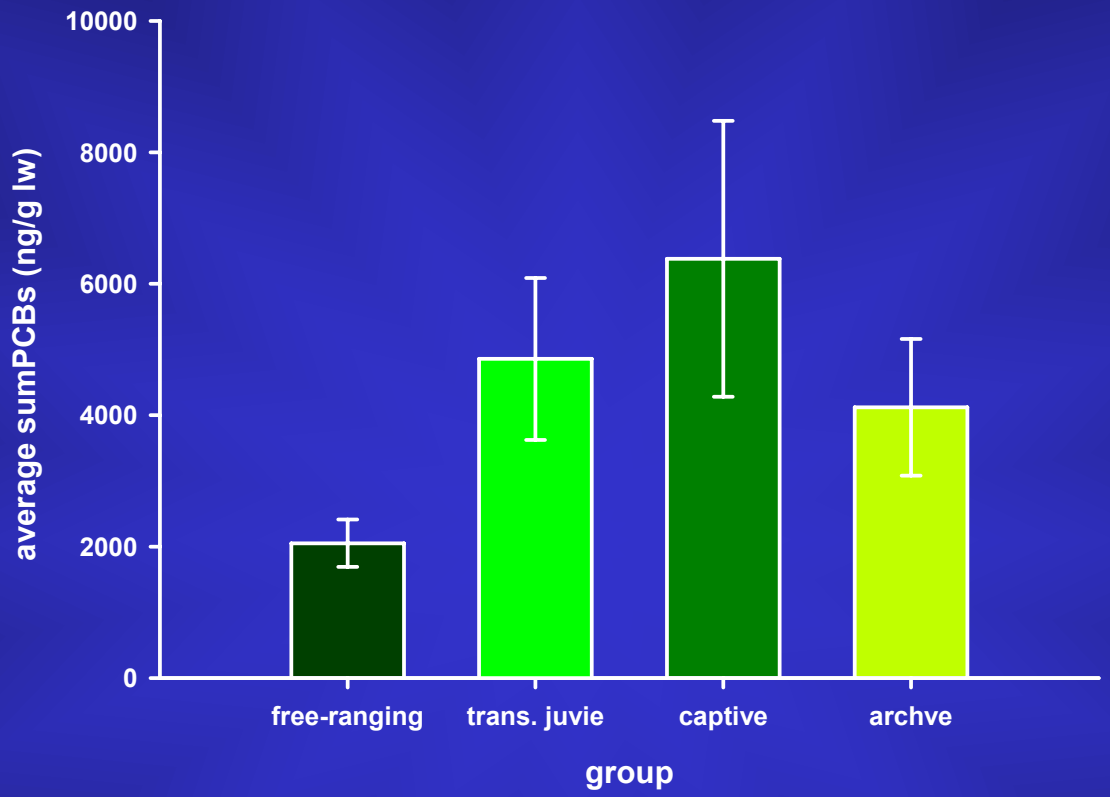
blood vs blubber for sum PCBs and sumDDTs (wet weight)
in free-ranging juvenile Stellers sea lions



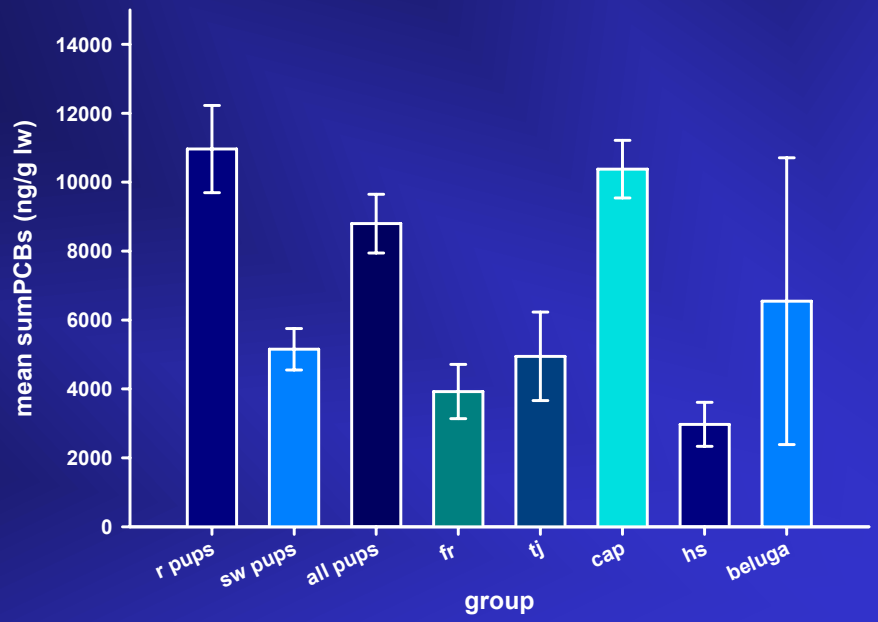
Average sumPCBs in blood (lw) in groups of Steller sea lions



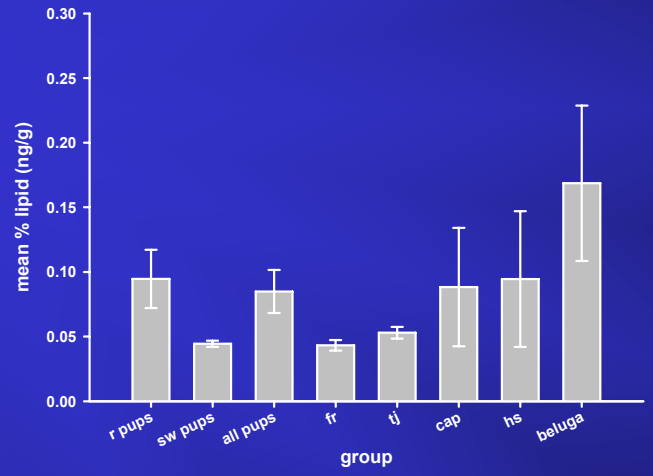
Average sumPCBs (lw) in blubber in groups of Steller sea lions



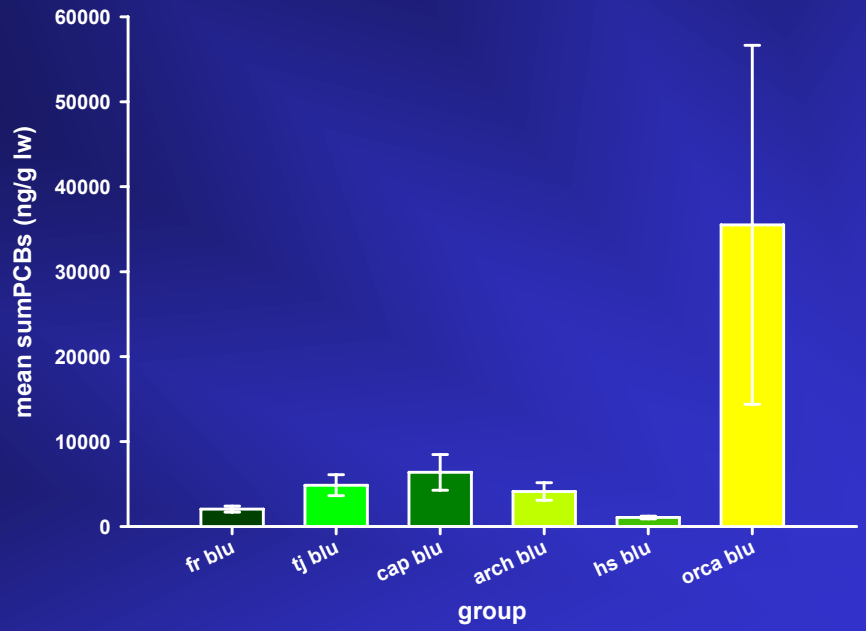
mean sumPCBs (lw) in Steller sea lion and other marine mammal blood



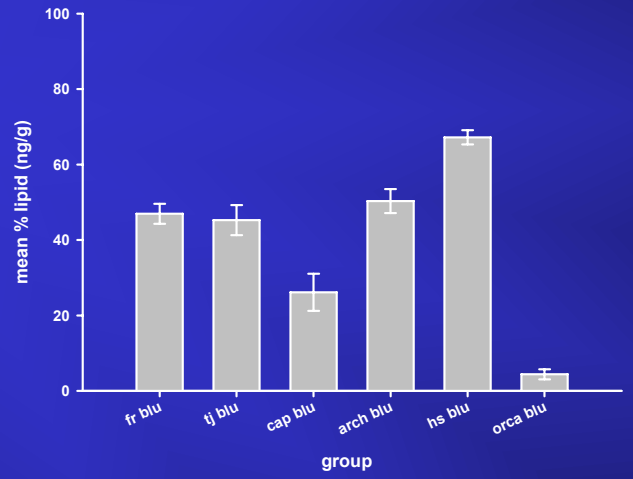
mean lipid % in Steller sea lion and other marine mammal samples



mean sumPCBs (lw) in Steller sea lion and other marine mammal blubber



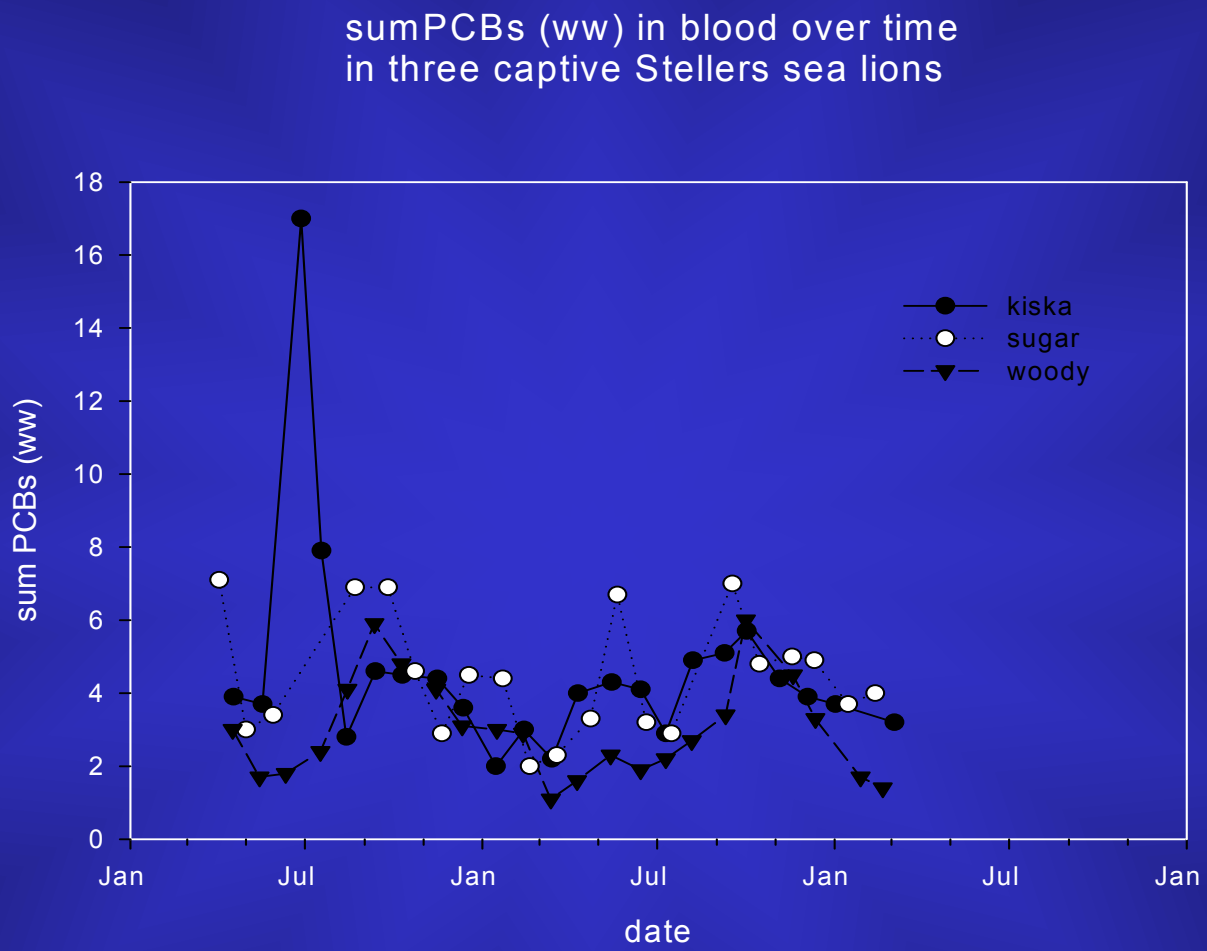
mean % lipid in Steller sea lion and other marine mammal blubber samples



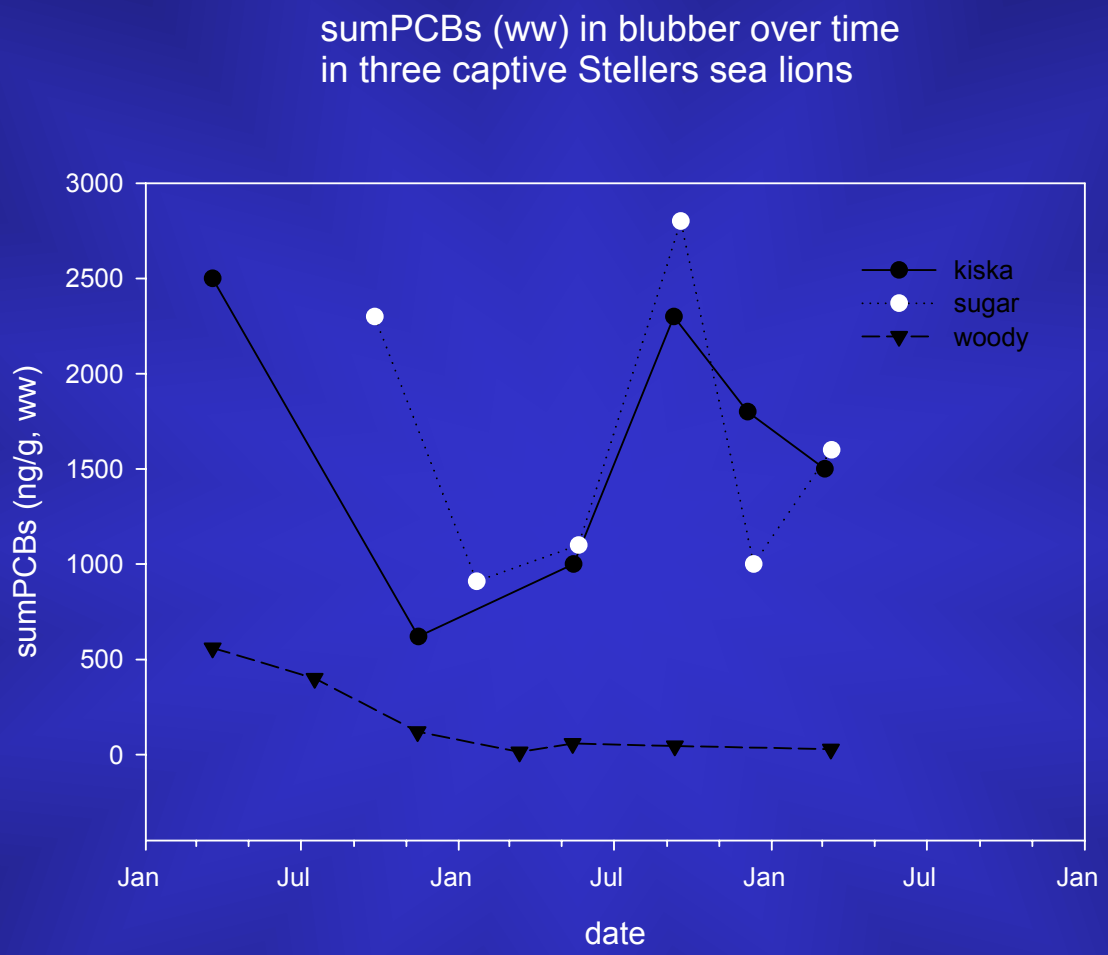
Future work

- Contaminants over time in captives
- Biomarkers

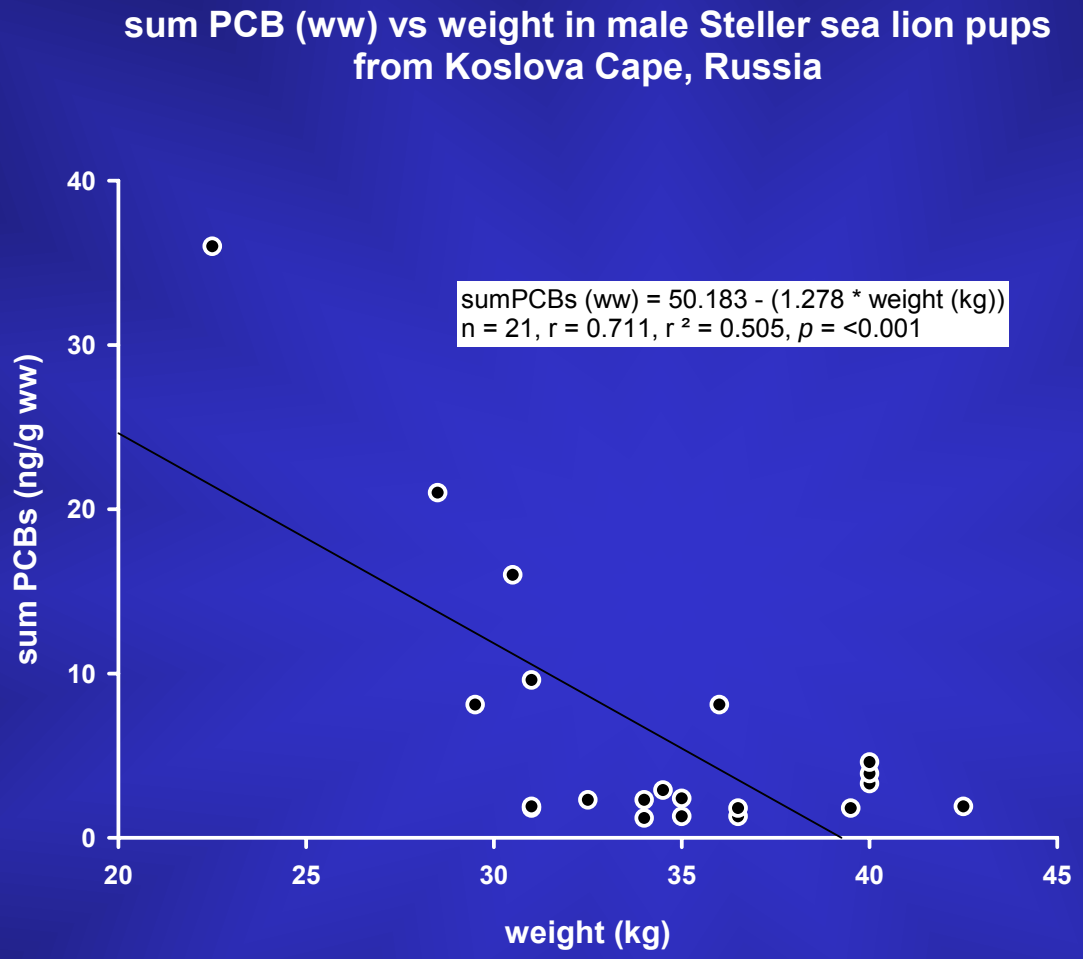
PCBs over time in captives (blood)



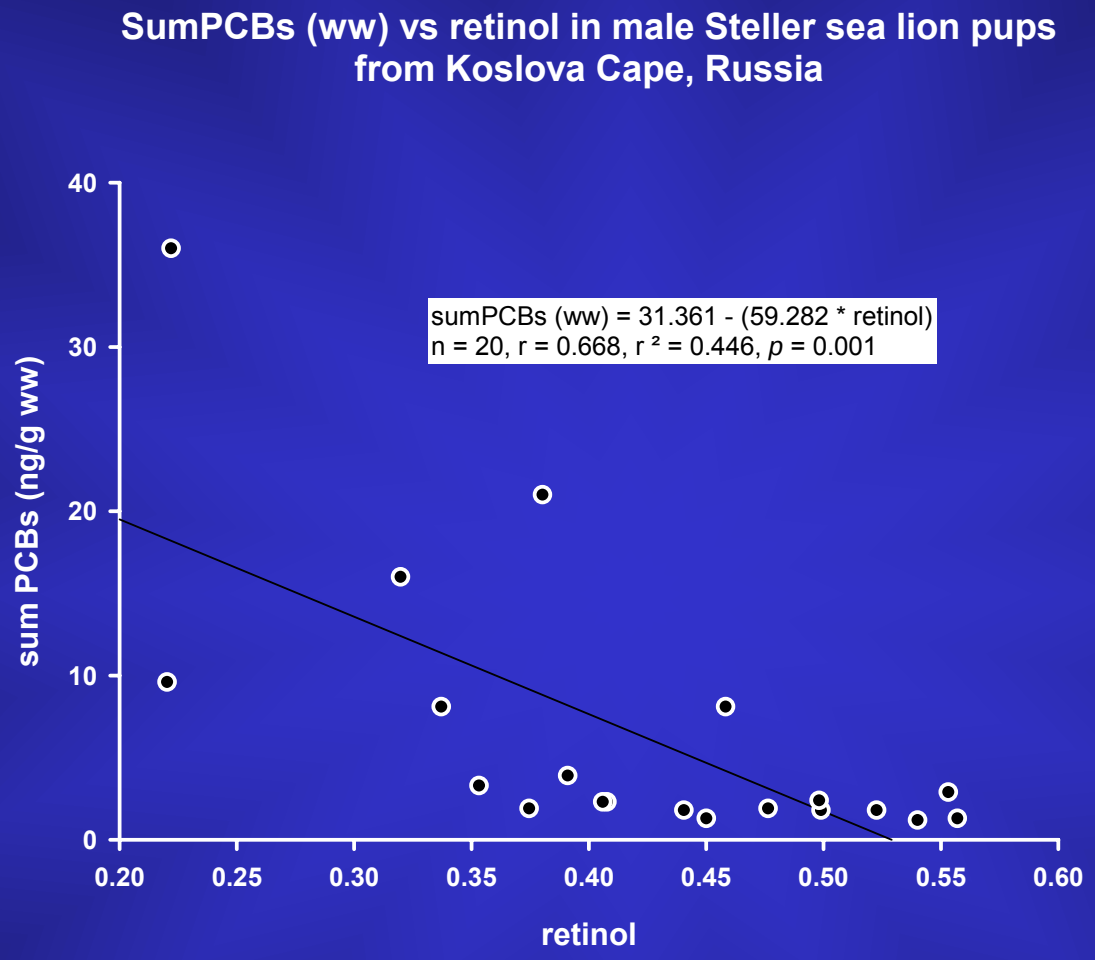
PCBs over time in captives (blubber)



∑PCBs (blood) and weight



∑PCBs (blood) and retinol



Summary OCs

- Stellers sea lion pups from Russia had higher loads of both sumPCBs and sumDDTs
- Concentrations of OCs in some animals are comparable to levels that cause physiological problems in other studies and could effect SSL population structure
- SumPCBs change over time in captive animals and show a seasonal cycle
- SumPCBs are correlated to both weight and retinol

Acknowledgements

- Dr. Peggy Krahn, Gina Ylitalo and staff at the NMFS Northwest Fisheries Science Center
- ASLC staff
- Dr. Tom Loughlin and NMFS

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Questions?