

Contaminants in harbor seals from San Francisco Bay and associations with health, growth and survival

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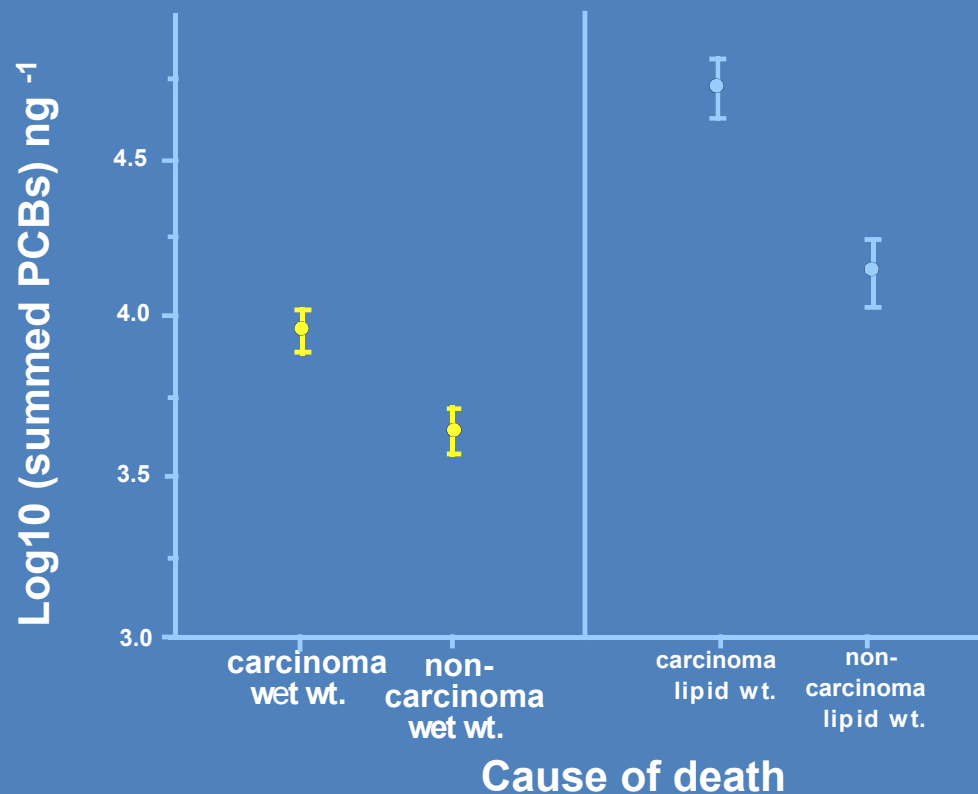
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Contaminants and Disease

- Legacy contaminants (PCBs and DDTs) have been detected in marine mammal tissues for decades
- Contaminants have been associated with cancer in belugas the Gulf of St Lawrence (Martineau *et al* 2002 Environ Health Perspect 110:285-92) and in California sea lions along our coast (Ylitalo *et al* 2005 Marine Pollution Bulletin 50:30-9)



Contaminants and Disease

1988/89 phocine distemper outbreak

victims had greater contaminant levels than survivors (Hall *et al* 1992 *Science of the Total Environment* 115:145-162)

Harbor seals fed contaminated herring from the Baltic Sea

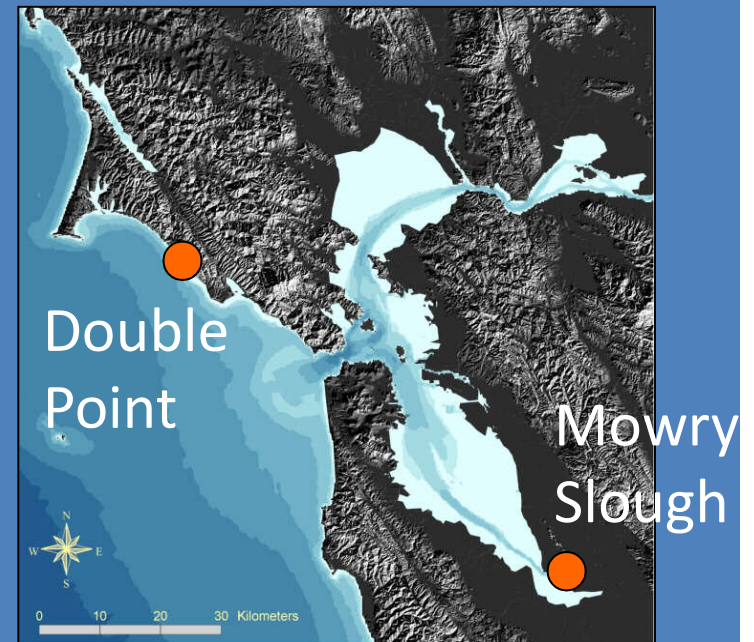
- ↓ vitamin A and thyroid hormone (Brouwer *et al* 1989 *Aquatic Toxicol* 15:99-105)
- ↓ natural killer cell and T cell responses (DeSwart *et al* 1996 *Environ Health Perspect* 104(Suppl):823-28, Ross *et al* 1996 *Aquatic Toxicol* 34:71-84)
- ↓ reproductive success (Reijnders 1986 *Nature* 324:456-57)

SF Bay – PCBs and reproductive failure

1989-98: levels higher than contaminated Baltic seals
(She *et al* 2000 Organohalogen Compounds 49:422-425)

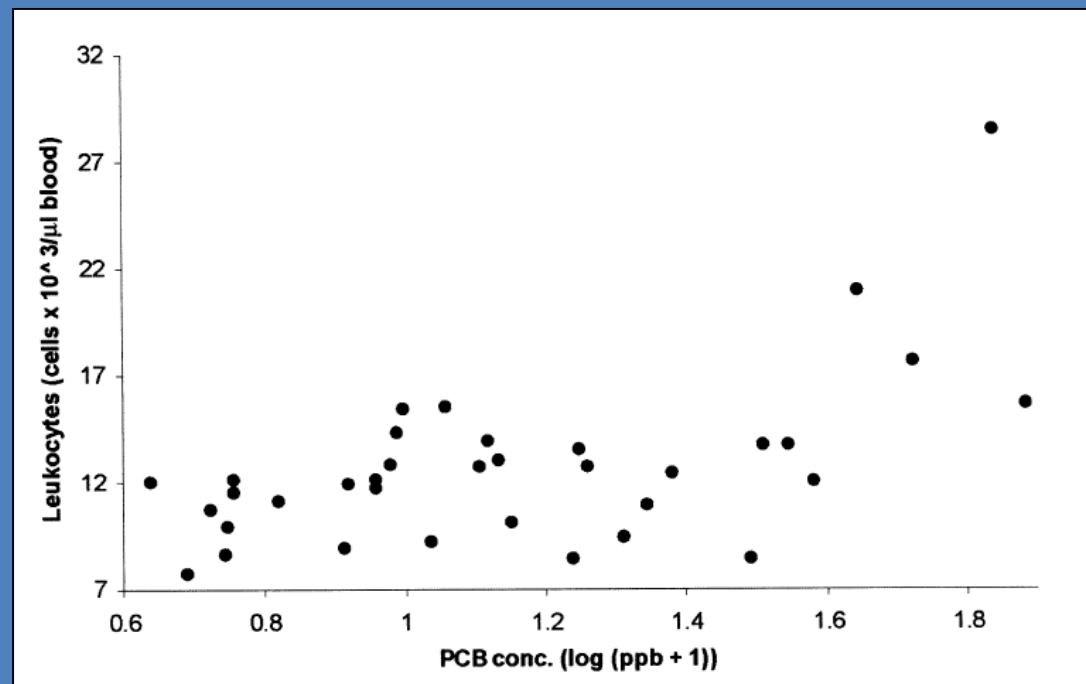
1976: high numbers of premature seals births noted
with blubber PCBs 16-120 ppm lipid (n=4 pups)
(Riseborough *et al* 1980 Report No. MMC 76/19)

Because high numbers of premature births were noted outside of the bay, the authors concluded that contaminants not likely to have played a role



SF Bay – Contaminants and Disease

High white cell counts in SF harbor seals were correlated with increased blood contaminant levels (Neale *et al* 2005 J of Toxicol and Environ Health, Part A 68:617-633)



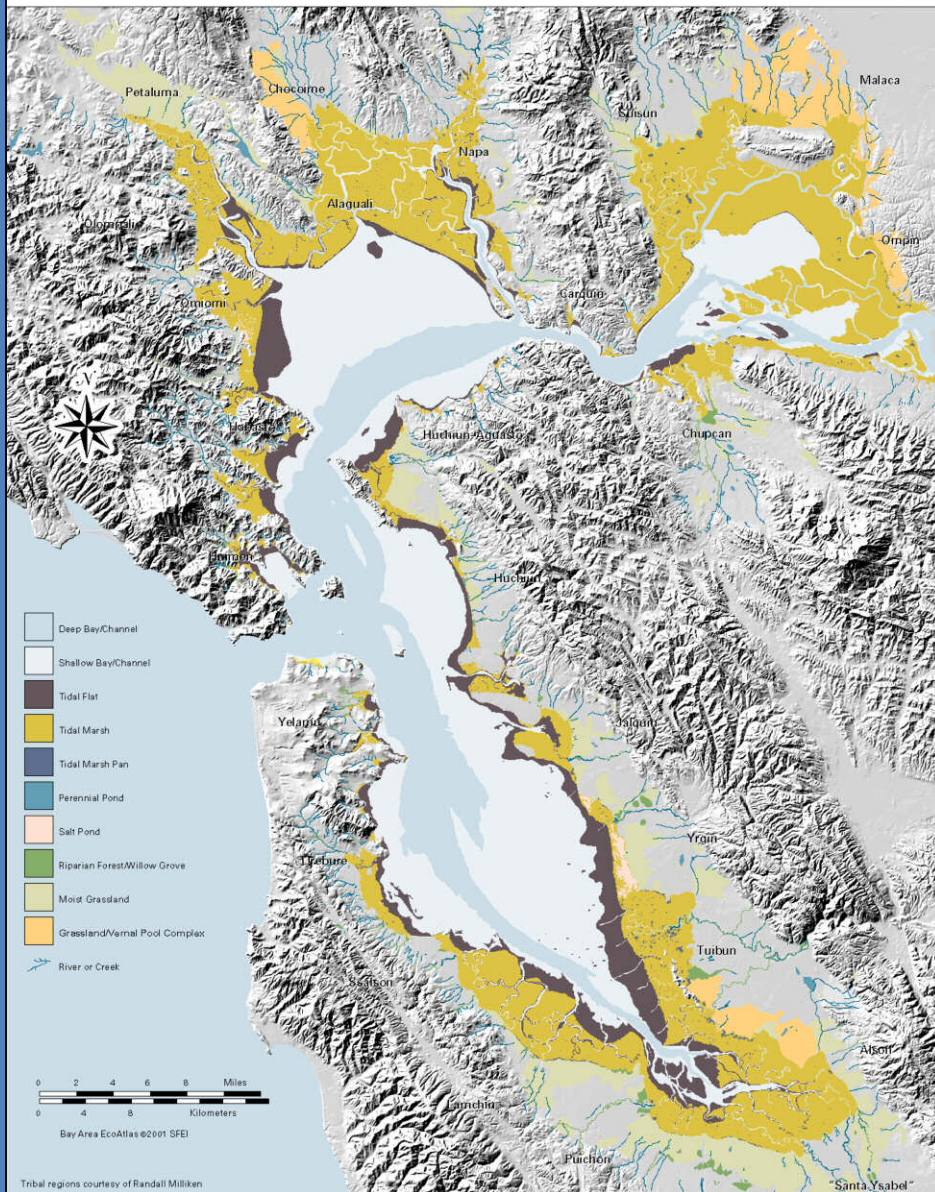
- Difficult to establish associations between tissue levels and health parameters when using a natural wildlife model (as opposed to a controlled lab experiment).



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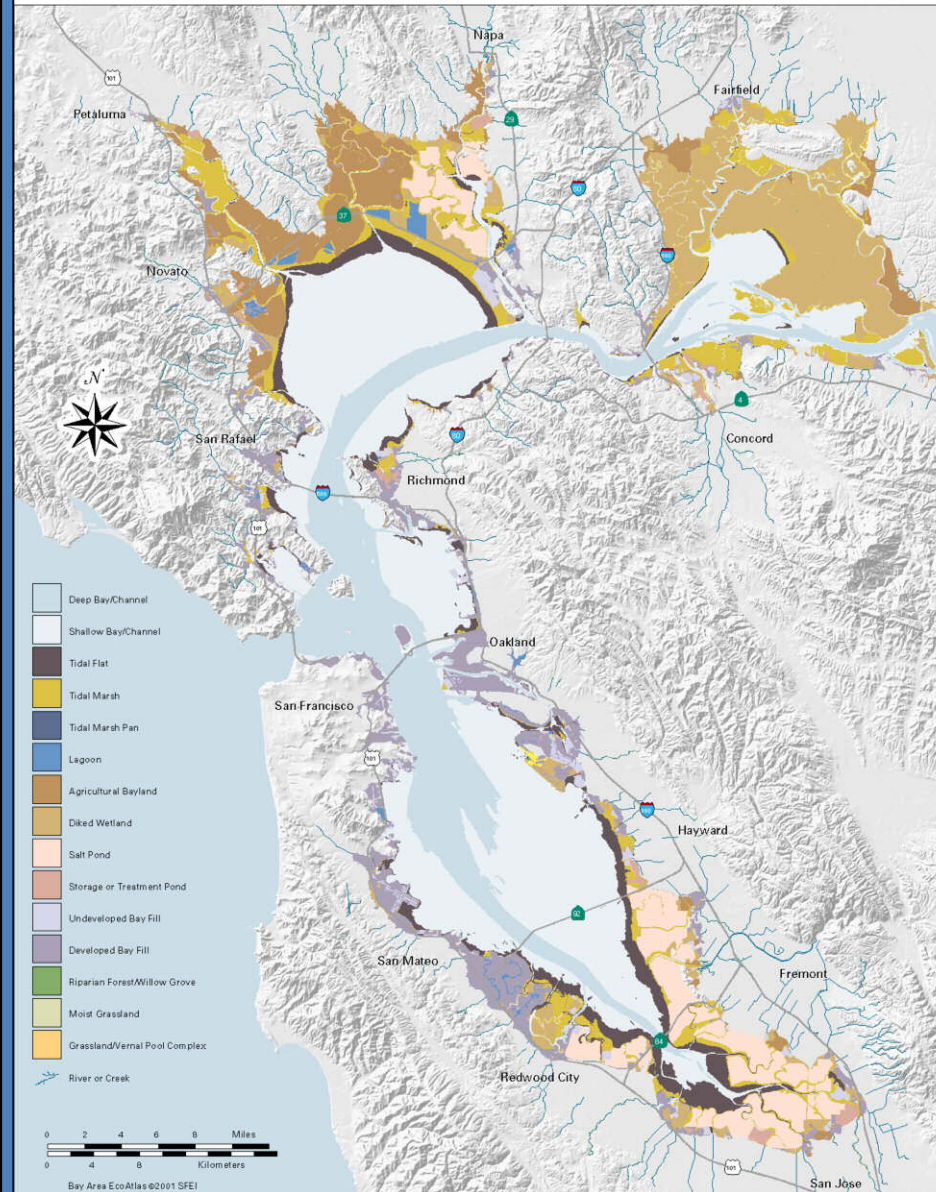
Historical Baylands



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Modern Baylands



<http://www.sfei.org/ec atlas/Habitat/index.html>

Study objectives

1. To document contaminant concentrations in developing harbor seals
2. To use an epidemiological framework to determine whether blubber contaminant concentrations were likely to effect first year survival of harbor seals in SF Bay.

Objective 1 – contaminants in developing harbor seals

- Live and dead harbor seal pups were sampled
 - At TMMC (n=142)
 - At necropsy (n=86)
 - At release (n=56)
 - In the wild (n=35)



Chemical Analyses

Blubber samples were analyzed at the Northwest Fisheries Science Center in Seattle, WA

- PCBs – electrical transformers, capacitors, hydraulic fluids, lubricating oils, plastics, paints, inks, adhesives, and sealants
- DDTs – pesticide (still used in the tropics for malarial control)
Suckled died
- PBDEs – flame retardants used in plastic, upholstery, fabrics, carpets and electronic devices
- CHLDs – pesticides
- HCHs – pesticides (Lindane still used for treatment of scabies and lice)

Data Analyses

- Because exposure route varies with age (gestation, nursing, fasting, fish diet), pups were divided into 7 categories depending on age and degree of suckling
 - For example, pups that stranded as newborns did not nurse so we wanted to separate them from those that did for comparison

Categories

- Neonate carcass
- Neonate died
- Neonate released

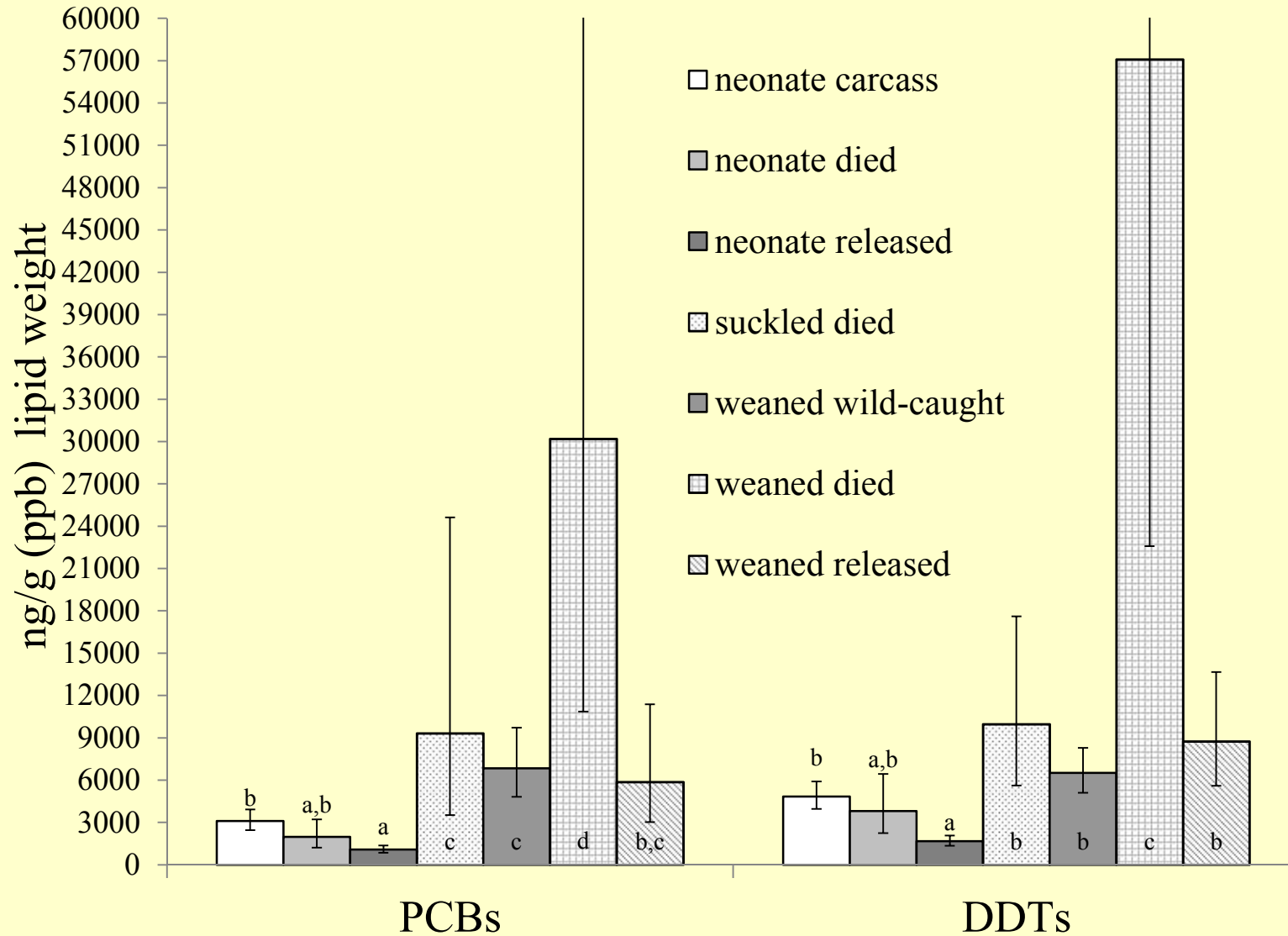
No contaminants from milk, variable effects from rehabilitation

-
- Suckled died

-
- Weaned wild-caught
 - Weaned died
 - Weaned released

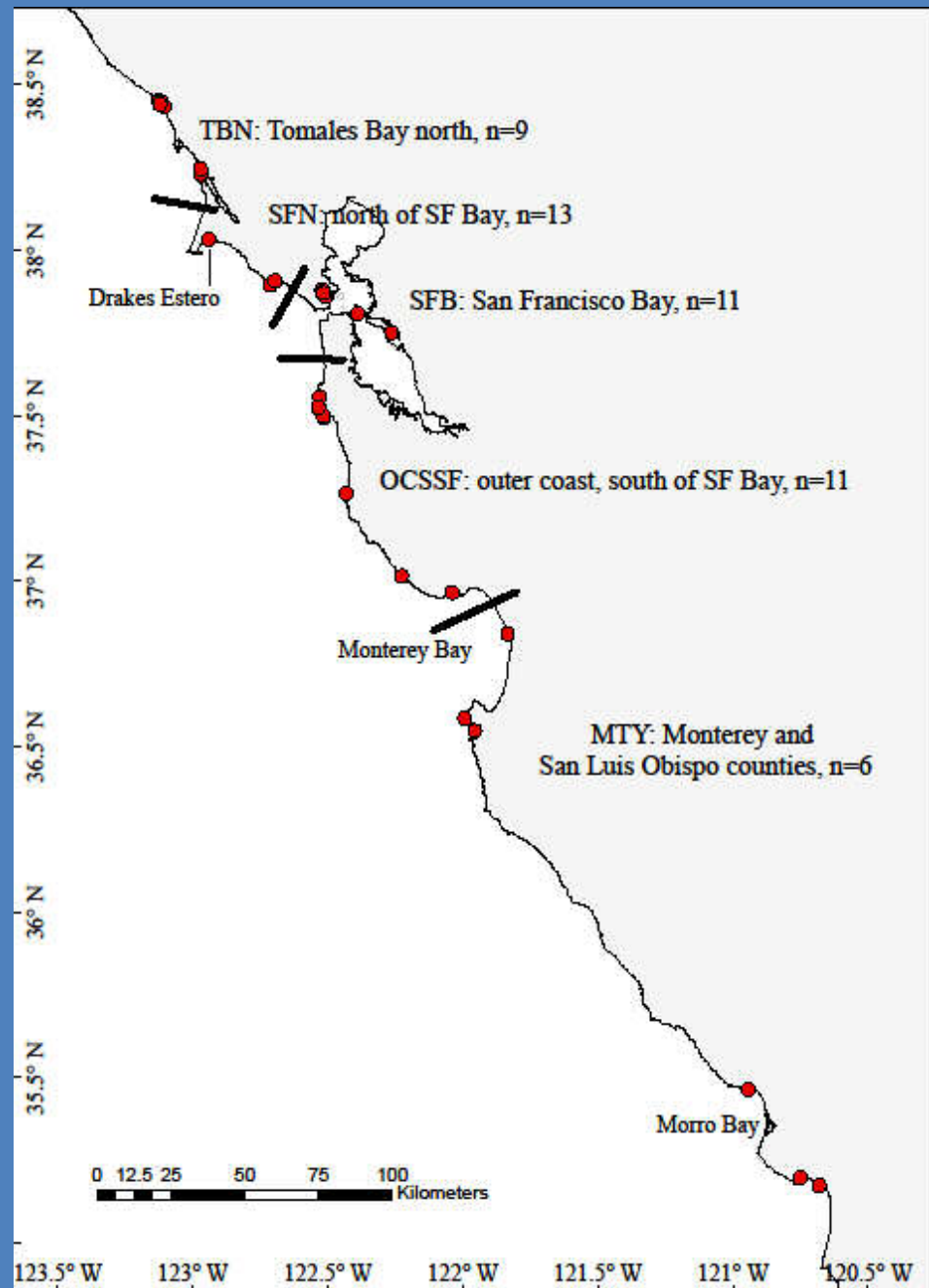
Full set of contaminants from milk, variable effects from rehabilitation

Results

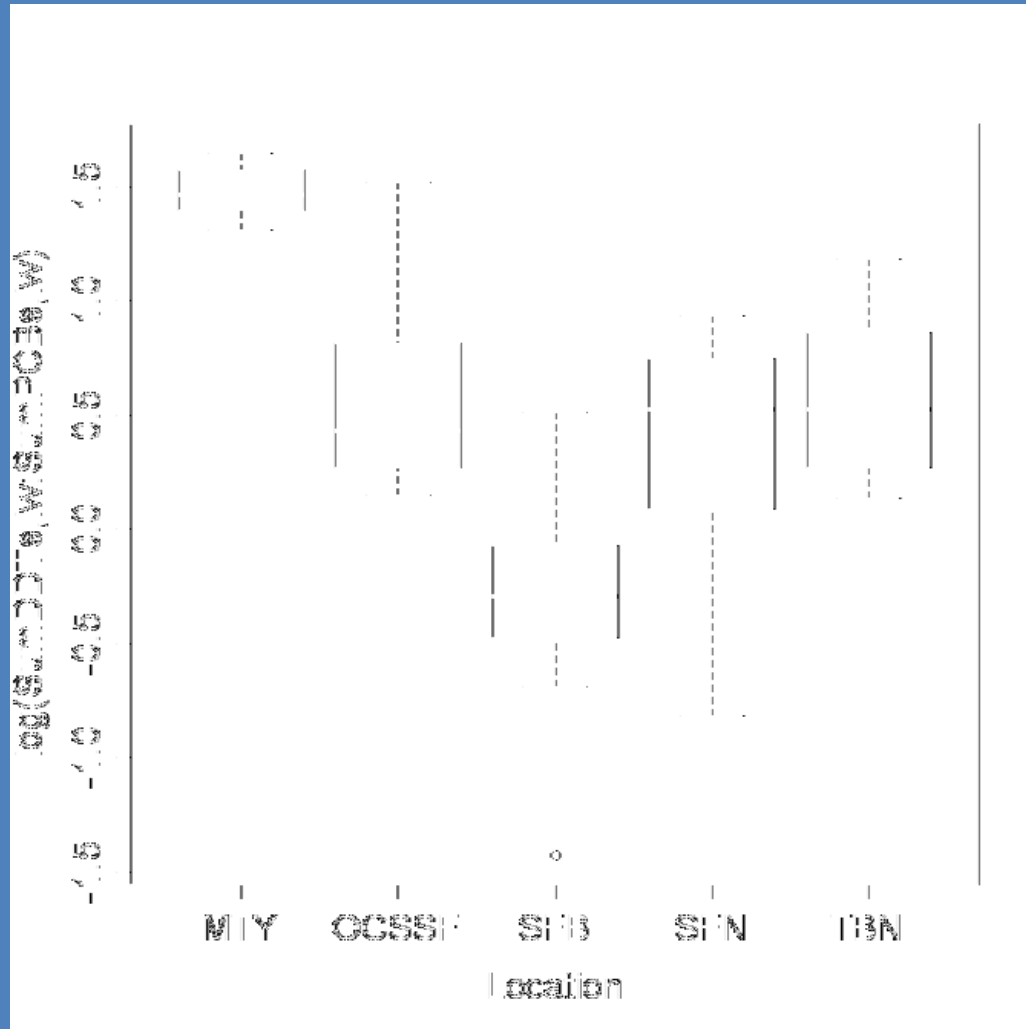


Spatial Analyses

- Newborn pups (n=50) that stranded dead or died soon after stranding were used to look at the spatial distribution of contaminants.
 - Assumptions
 - 1) these pups reflect maternal contaminant concentrations,
 - 2) pregnant adult females are fairly residential
 - 3) the pups stranded near their birth location



Spatial distribution of PCBs and DDTs

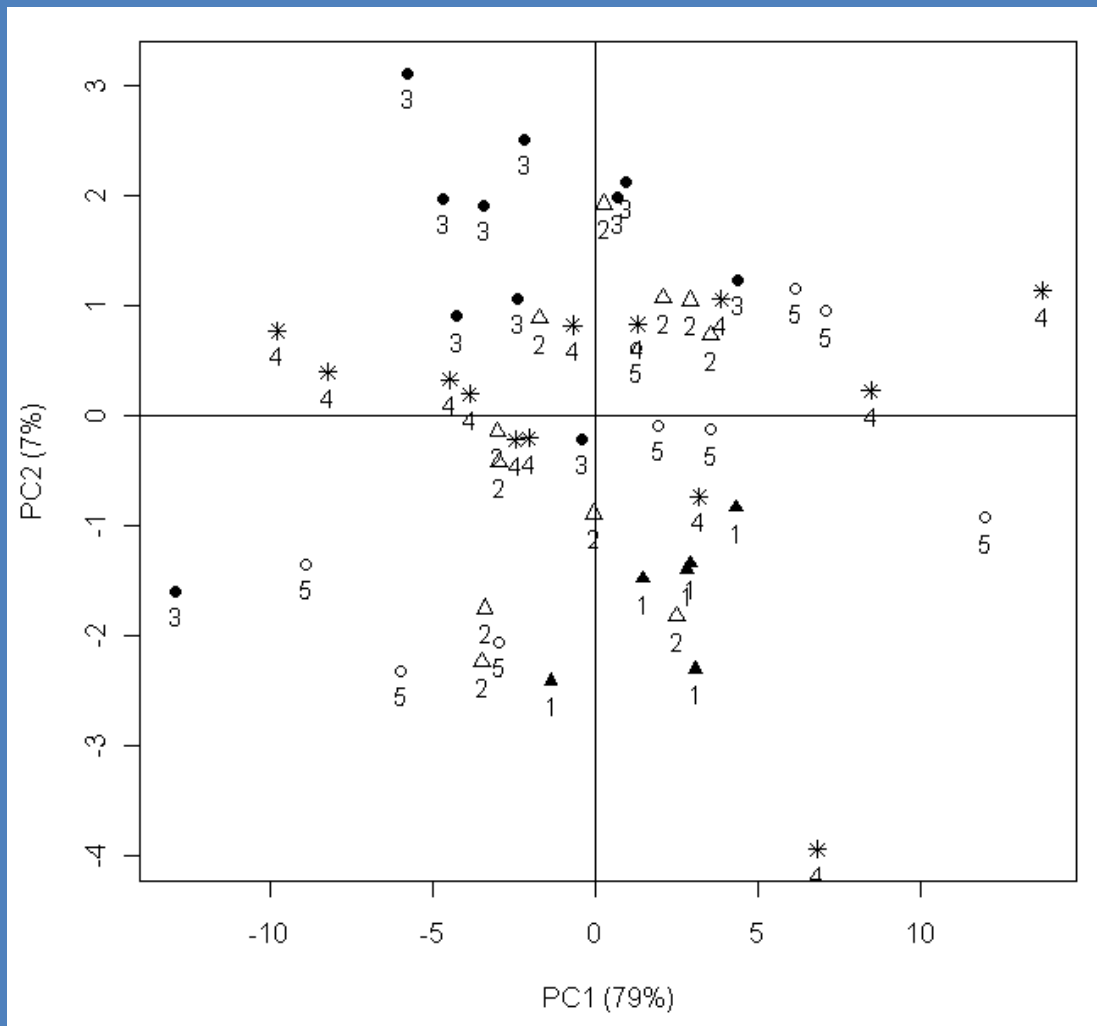


Monterey south -
highest ratio of DDTs to
PCBs.

SF Bay - dominated by
the PCBs

Area between SF Bay
and Tomales Bays
(primarily Drakes
Estero) is highly variable
and probably reflects
adult females from SF
Bay and other locations
giving birth there.

Spatial distribution of PCBs and DDTs



There were differences in the profiles of individual PCB, PBDE, and pesticide compounds by location

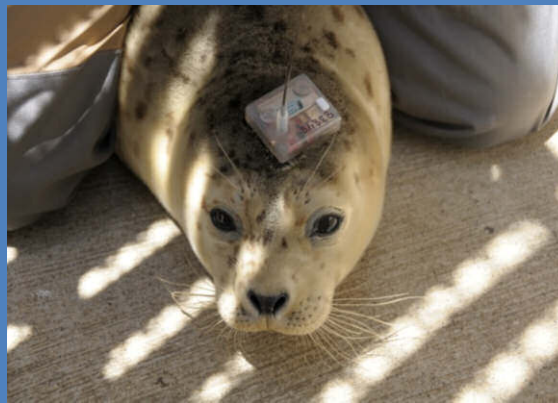
PC1 (PCB compounds)
PC2 (BDE 99, 100 and DDTs)

▲ Monterey south

● San Francisco Bay

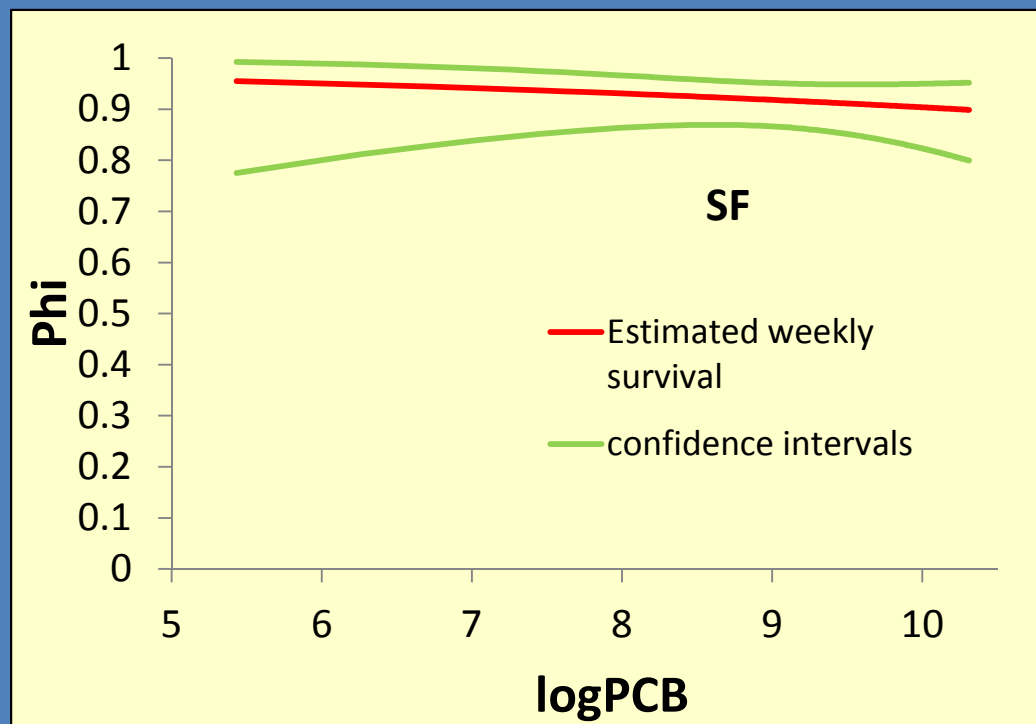
Objective 2 – do contaminants affect survival?

- Wild caught recently weaned pups from San Francisco Bay (n=19) and Tomales Bay (n=7) and pups released from rehabilitation (n=21) were tracked with satellite transmitters after their blubber sample.



Modeling the survival data

- The satellite tag mark-recapture data was modeled with contaminant concentrations and other health parameters as covariates.



In the final model using 24 weeks of satellite tag data, summed contaminant concentration, thyroid hormone levels, and dispersal speed were all associated with estimated survival probability.

Conclusions/future directions

- Measuring contaminant effects on wildlife in a natural setting is challenging – difficult to avoid confounding variables such as age, sex, season.
 - epidemiological studies are one way to examine the effects of contaminants as well as other factors
- Larger sample size for the survival portion of the study
 - difficult to reliably sample enough seals for a routine monitoring program every year, but might be worth a large effort every five years to examine time trends as well as health effects.
- Other contributing factors that were not examined in this study
 - Disturbance, boat strikes, fishing interactions, biotoxins, other contaminants (mercury, emerging contaminants)
- Other bay species (birds, fish, invertebrates, micro-organisms)
 - May be more useful for some RMP questions (like pathways to the bay and hotspots within the bay)



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