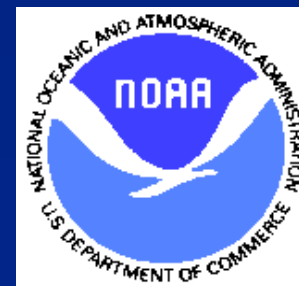


# Toxic contaminants, ESA listed salmon, and channel deepening in the Lower Columbia River

Sediment Quality Workshop  
June 7 and 8, 2001

Environmental Conservation Division  
Northwest Fisheries Science Center, Seattle, WA  
National Marine Fisheries Service, NOAA



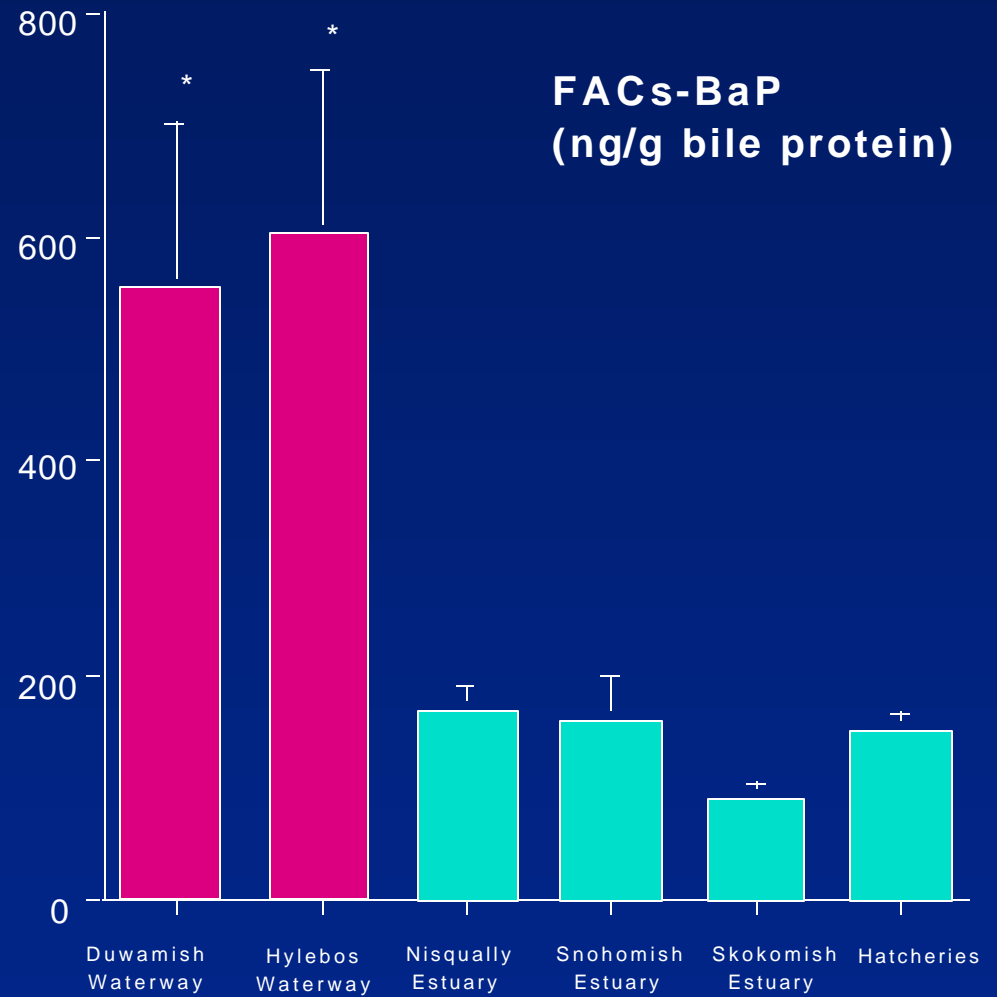
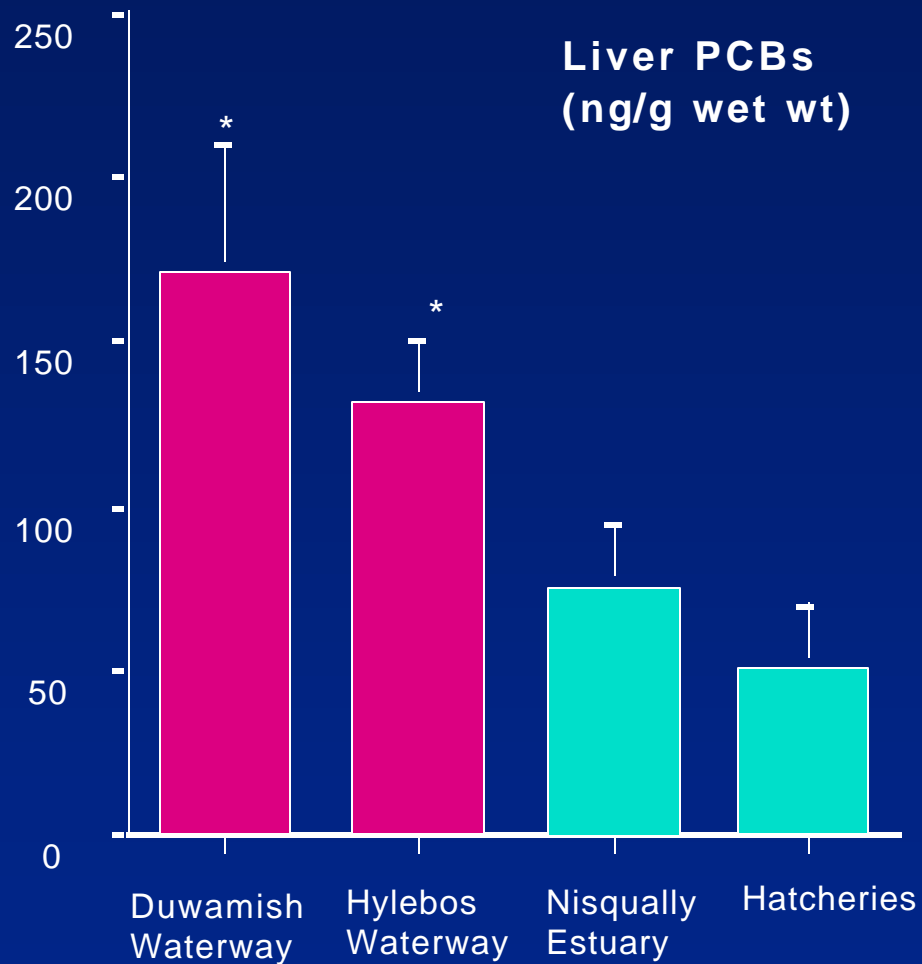
## **Overview of presentation**

- **What do we know about toxics and salmon?**
- **What are current levels of contaminant exposure in outmigrant juvenile salmon in the LCR?**
- **What are potential effects of the dredging project on contaminant exposure, and associated health risk in listed species?**
- **Summary and suggestions.**

# **Recent research on toxics and salmon health**

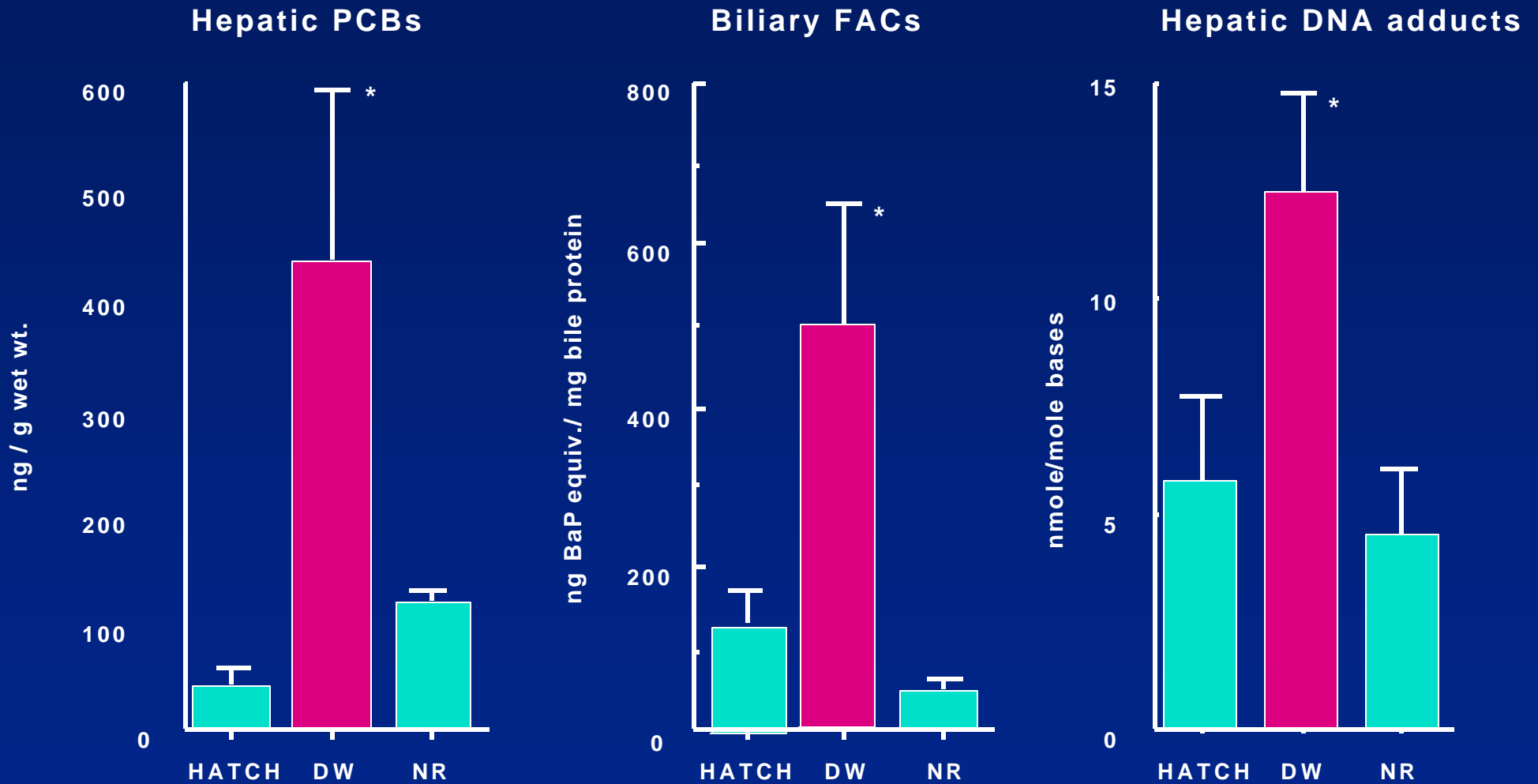
- **Juvenile outmigrant salmon can accumulate significant concentrations of toxicants during downstream migration and smolting.**
- **Adverse health effects have been demonstrated in field collected salmon exposed to PCBs and PAHs, as well as in laboratory studies.**
- **Impaired health is seen at relatively low contaminant concentrations**

# Contaminant exposure in juvenile chinook salmon



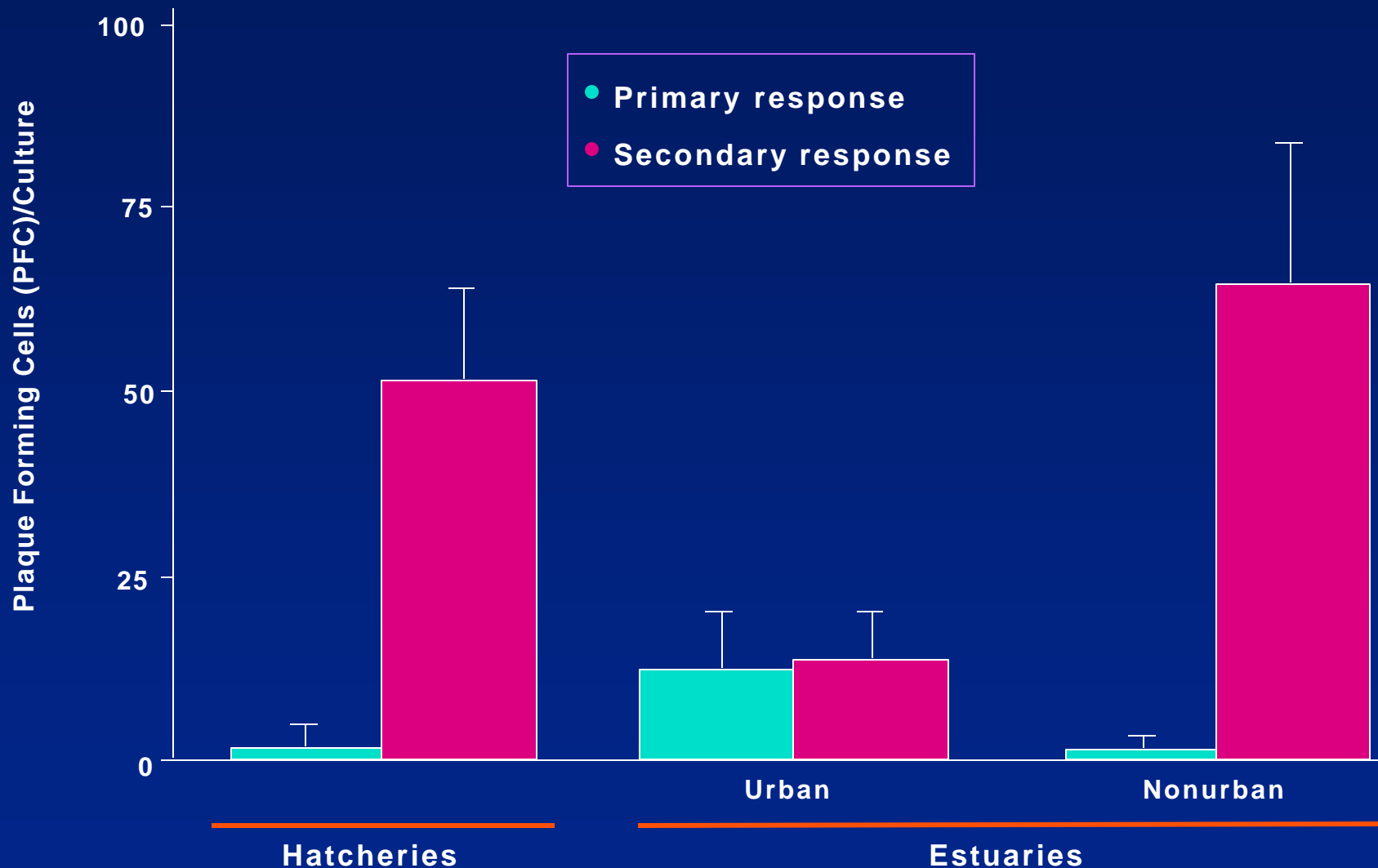
Stein et al. 1995

# Contaminant concentrations in juvenile Chinook salmon from urban and nonurban estuaries



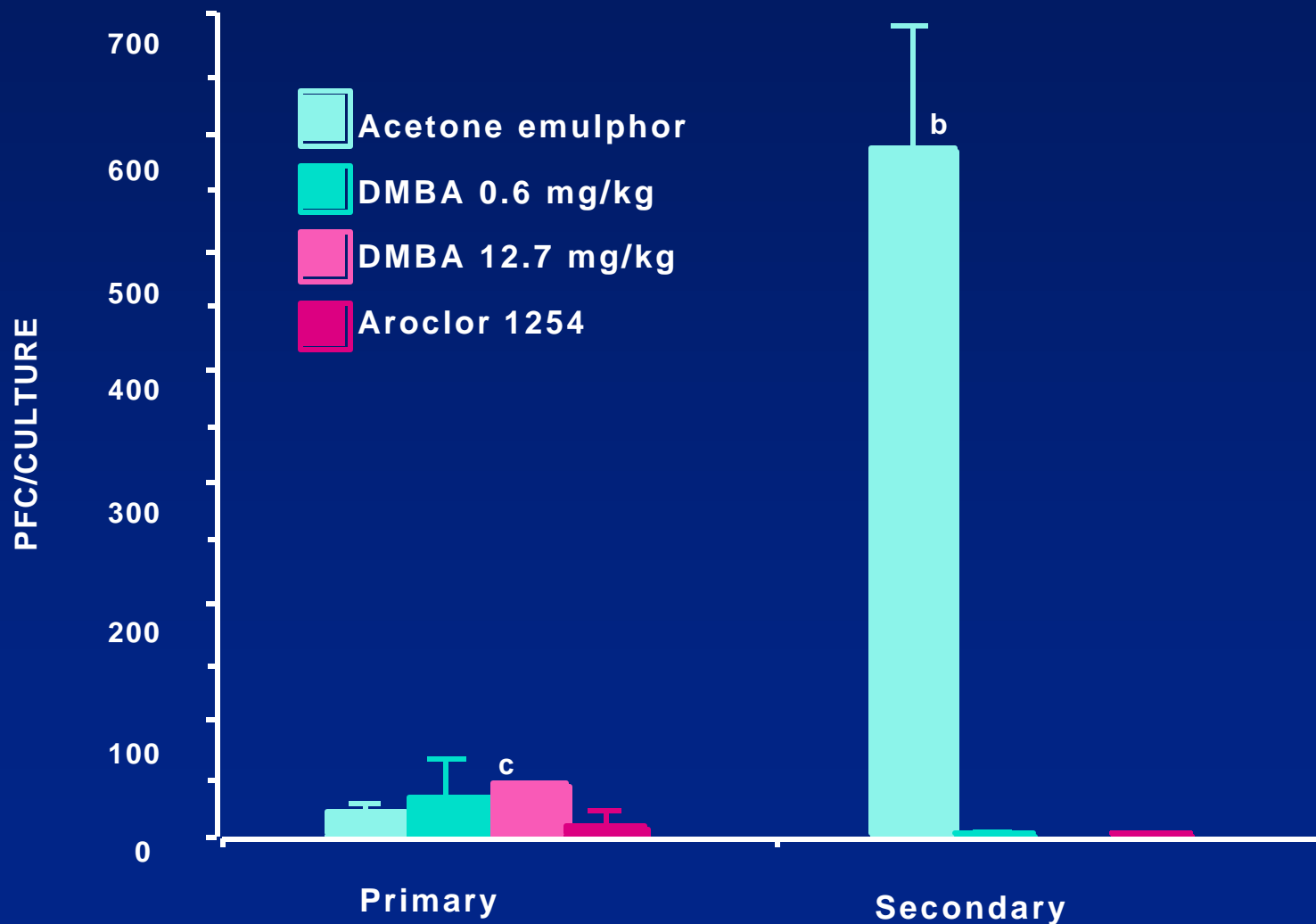
Stein et al. 1995

# Primary and secondary immune responses in juvenile Chinook salmon from urban and nonurban estuaries



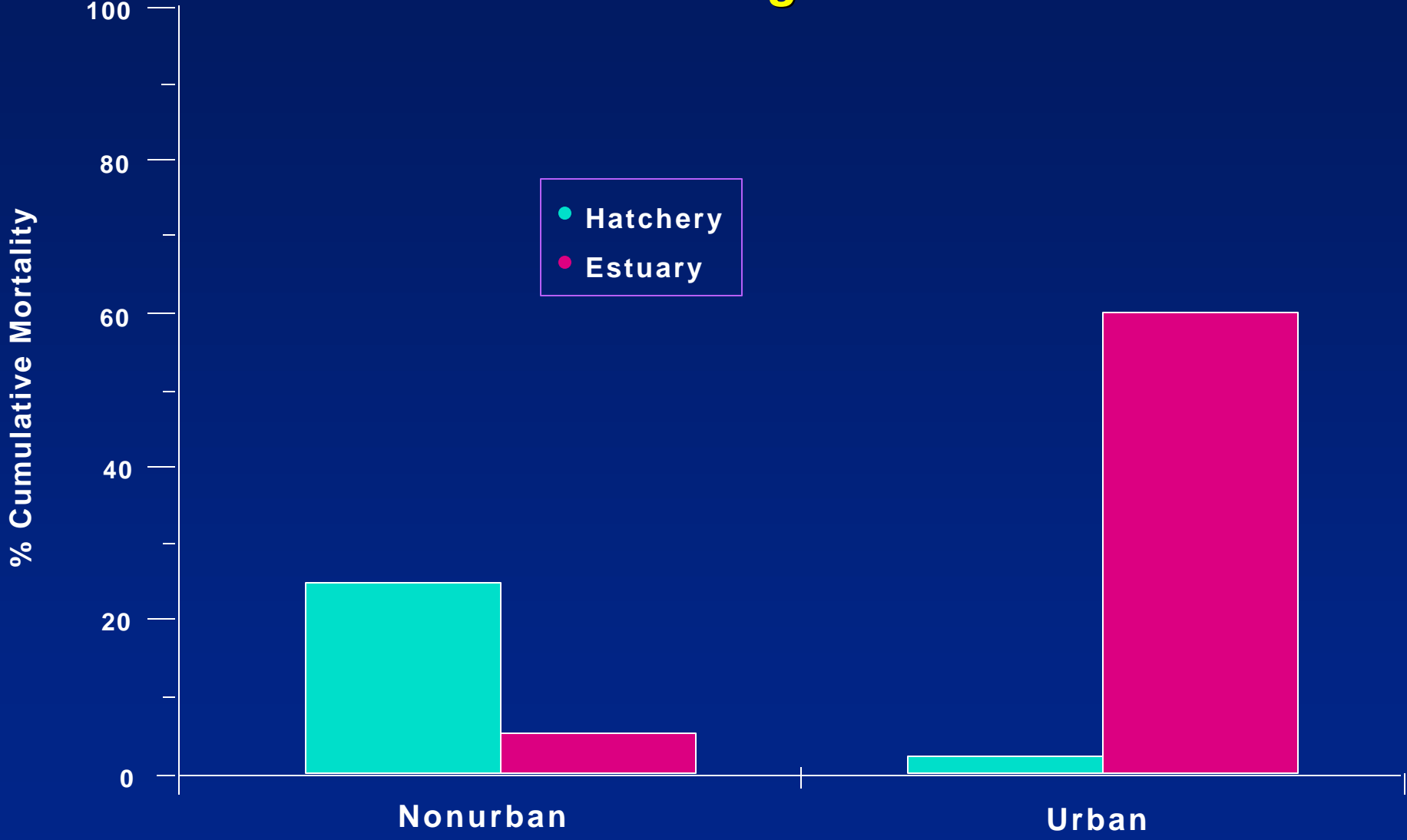
Arkoosh et al. 1991

# Primary and secondary immune responses in juvenile Chinook salmon exposed to model PAHs and PCBs



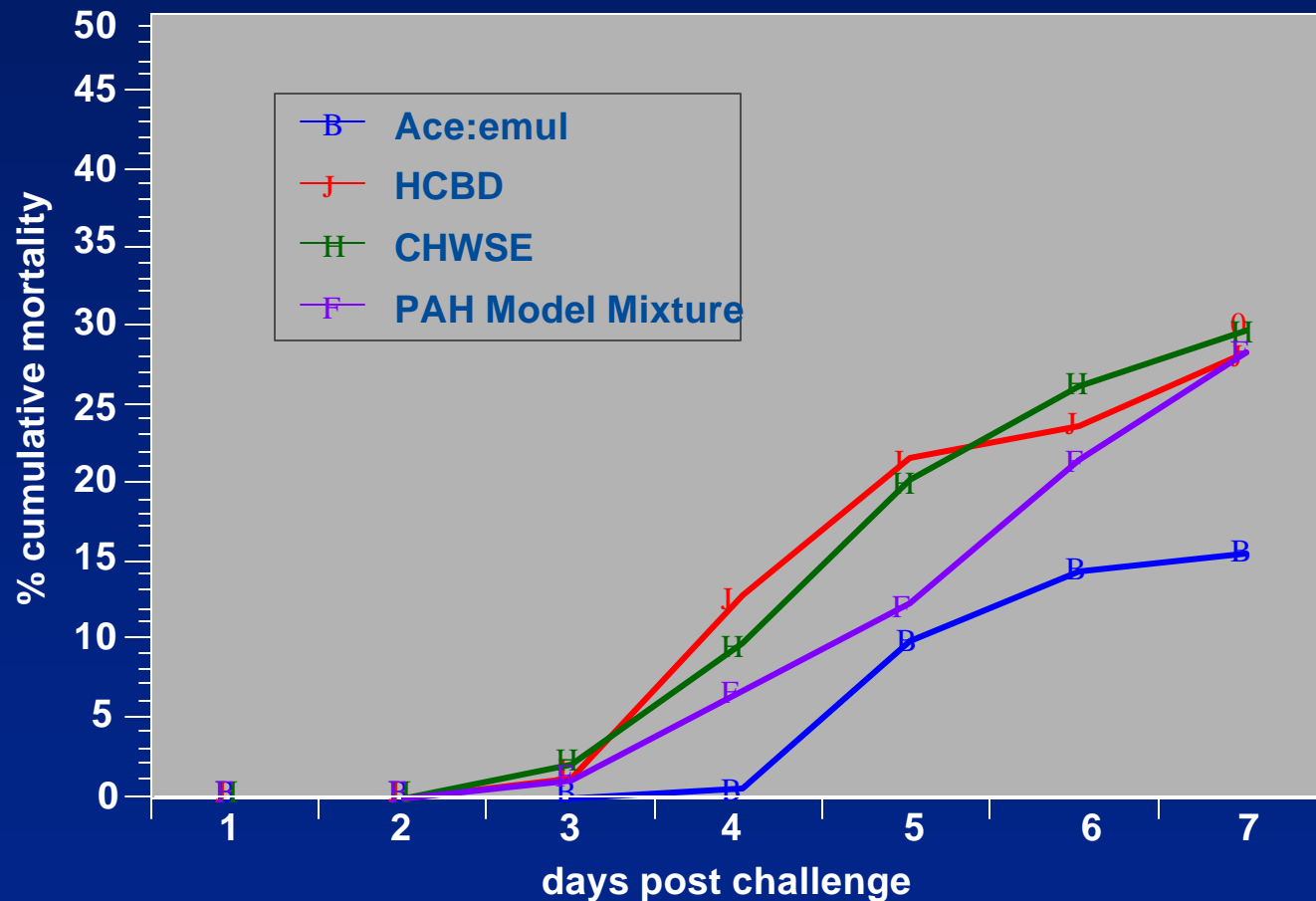
Arkoosh et al. 1994

# Cumulative mortality after exposure to *V. anguillarum*



Arkoosh et al. 1998

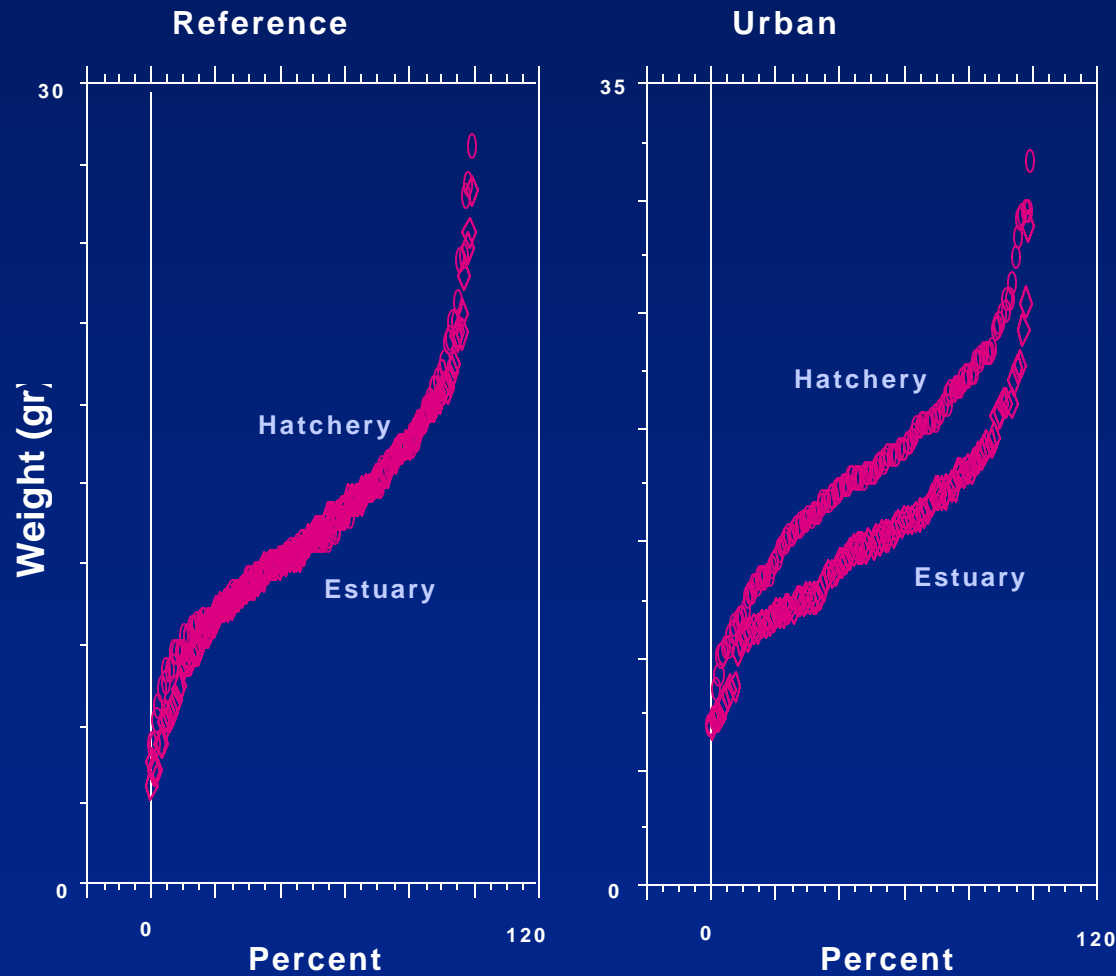
# Mortality of chinook salmon exposed to *Vibrio anguillarum* after treatment with hexachlorobutadiene, a PAH mixture, or an extract of contaminated sediment



Arkoosh et al. (2001) In press

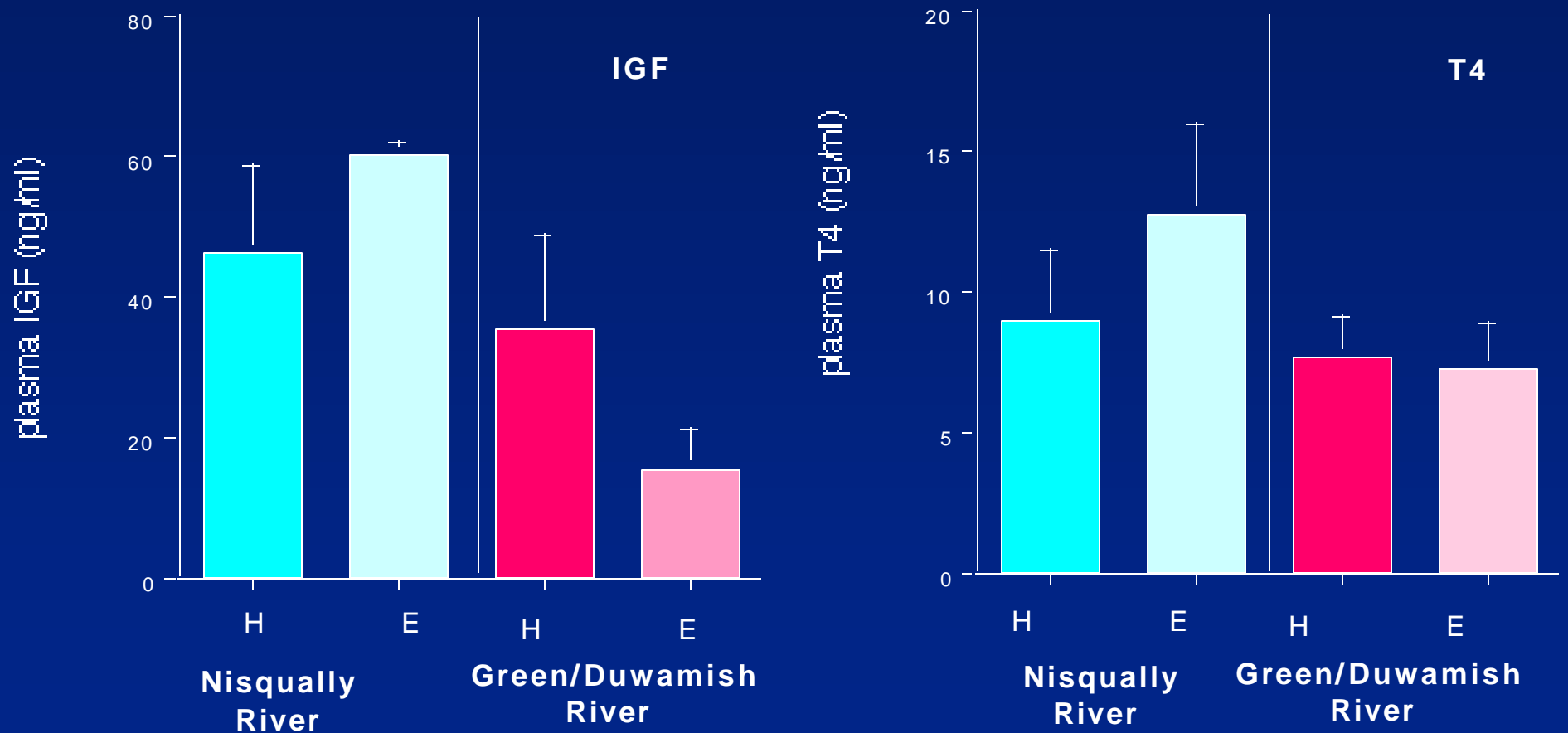
# Investigations of juvenile salmon from Puget Sound estuaries: Growth studies

Cumulative frequency distribution of growth



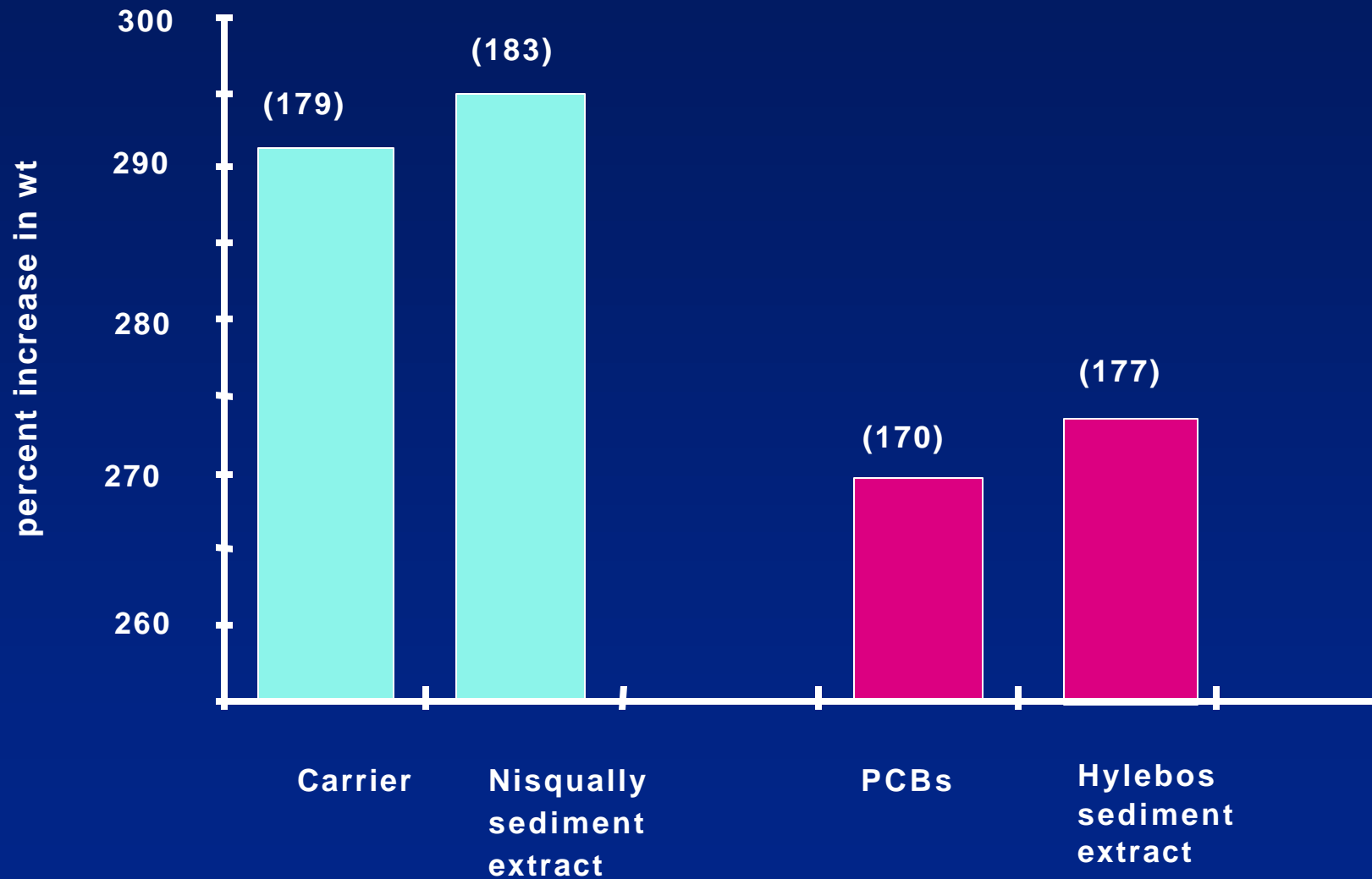
Casillas et al. 1995a,b; unpublished data

## Thyroid hormone and insulin-like growth factor in juvenile chinook salmon from urban and non-urban river systems



Casillas et al. 1995a,b; unpublished data

## Growth (%increase in weight) in juvenile chinook salmon exposed to PCBs or sediment extracts



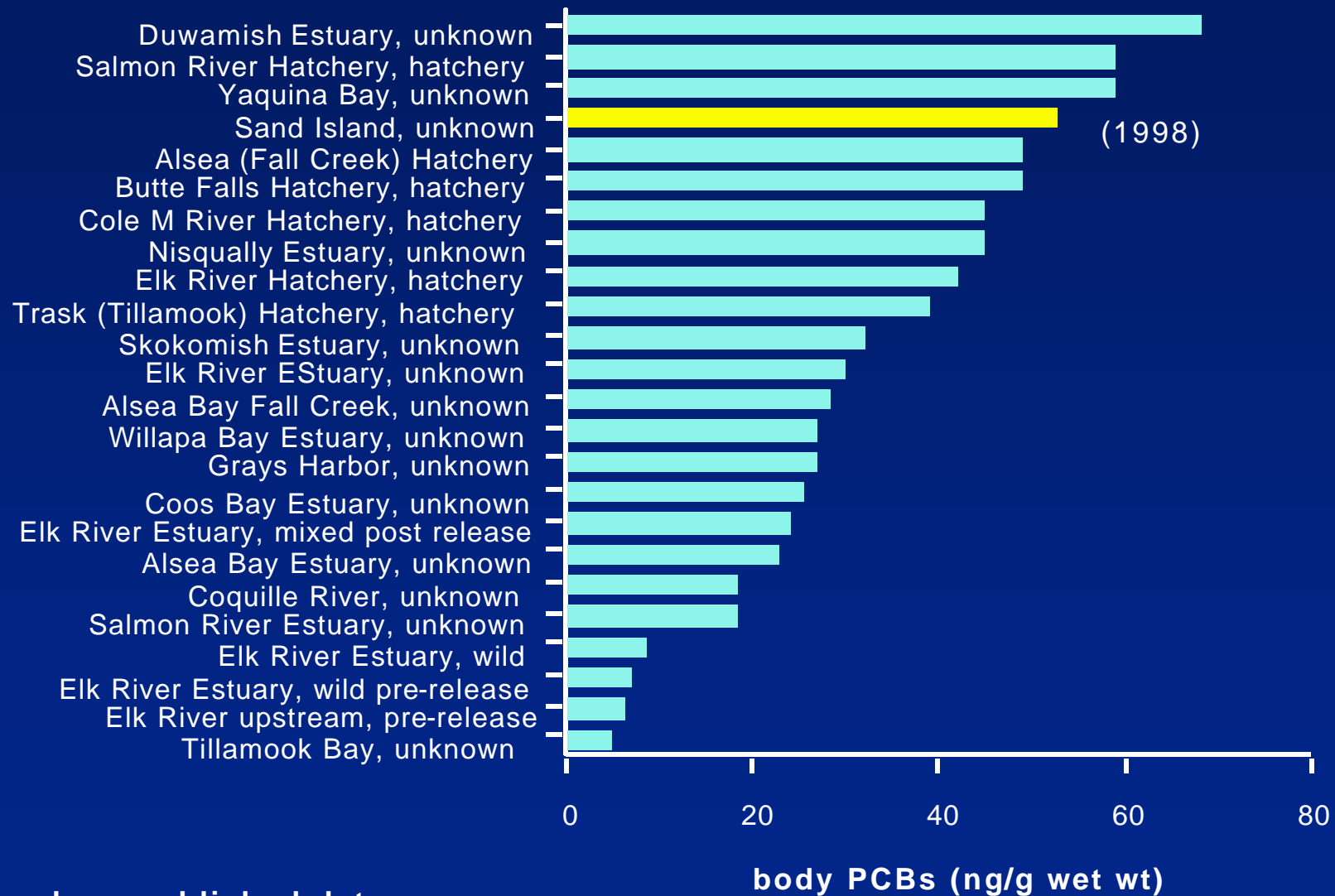
Adapted from Casillas et al. 1998

**What are current levels of contaminant exposure  
in outmigrant juvenile salmon in the LCR?**

## **What are current levels of contaminant exposure in outmigrant juvenile salmon in the LCR?**

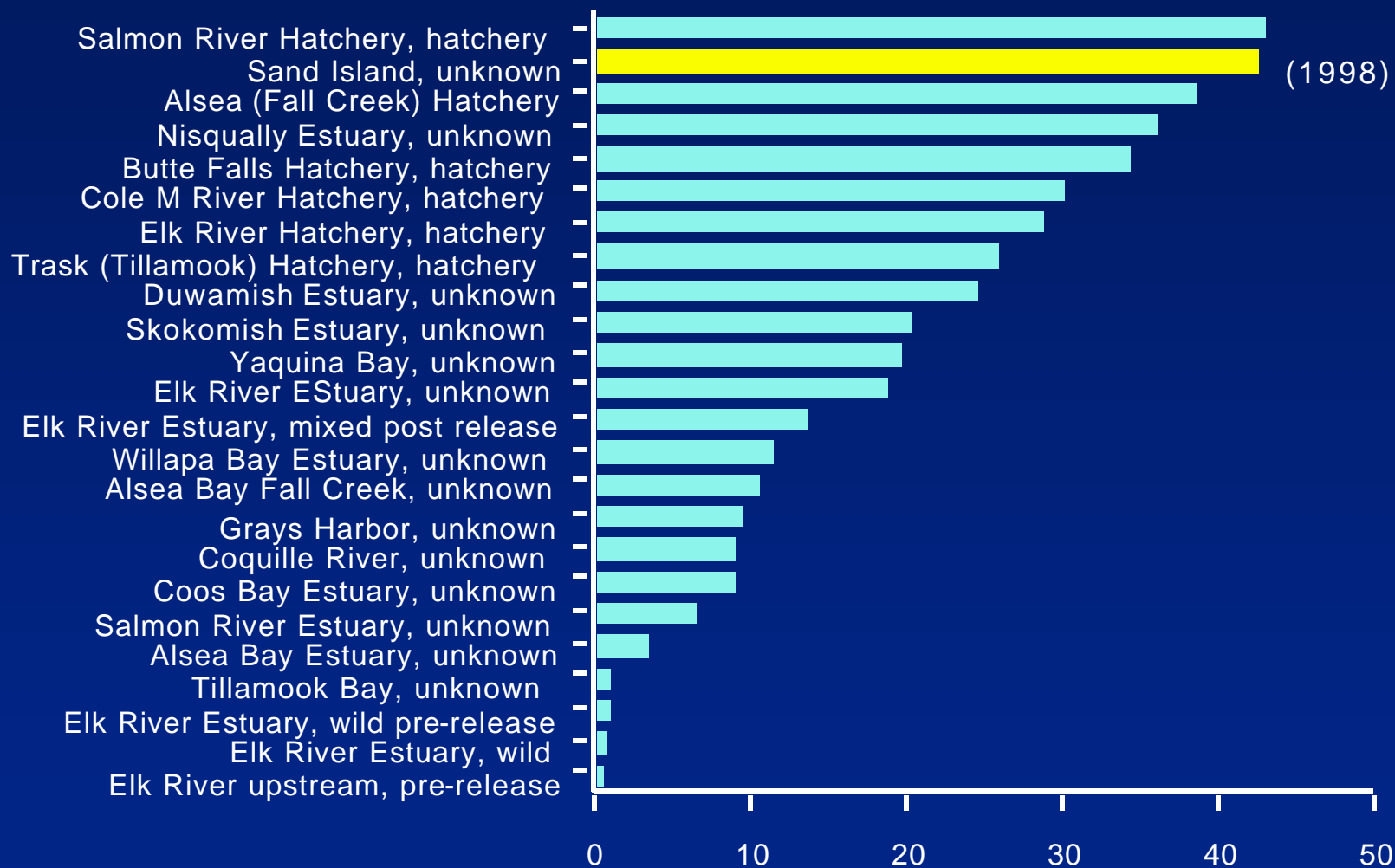
- **Fish tissues and stomach contents collected in 1998, 1999, 2000.**
- **Sediments collected in 2000.**
- **Prey base sampled in 2000.**
- **West Sand Island sampled in 1998-2000, Jones Beach in 2000.**
- **Analyses so far are focused on carcasses and stomach contents.**
- **Some fin clips in 1998 and 1999, none in 2000.**
- **Sampling imminent for 2001.**

# PCB concentrations in bodies of juvenile Chinook salmon from Washington and Oregon estuaries



Arkoosh, unpublished data

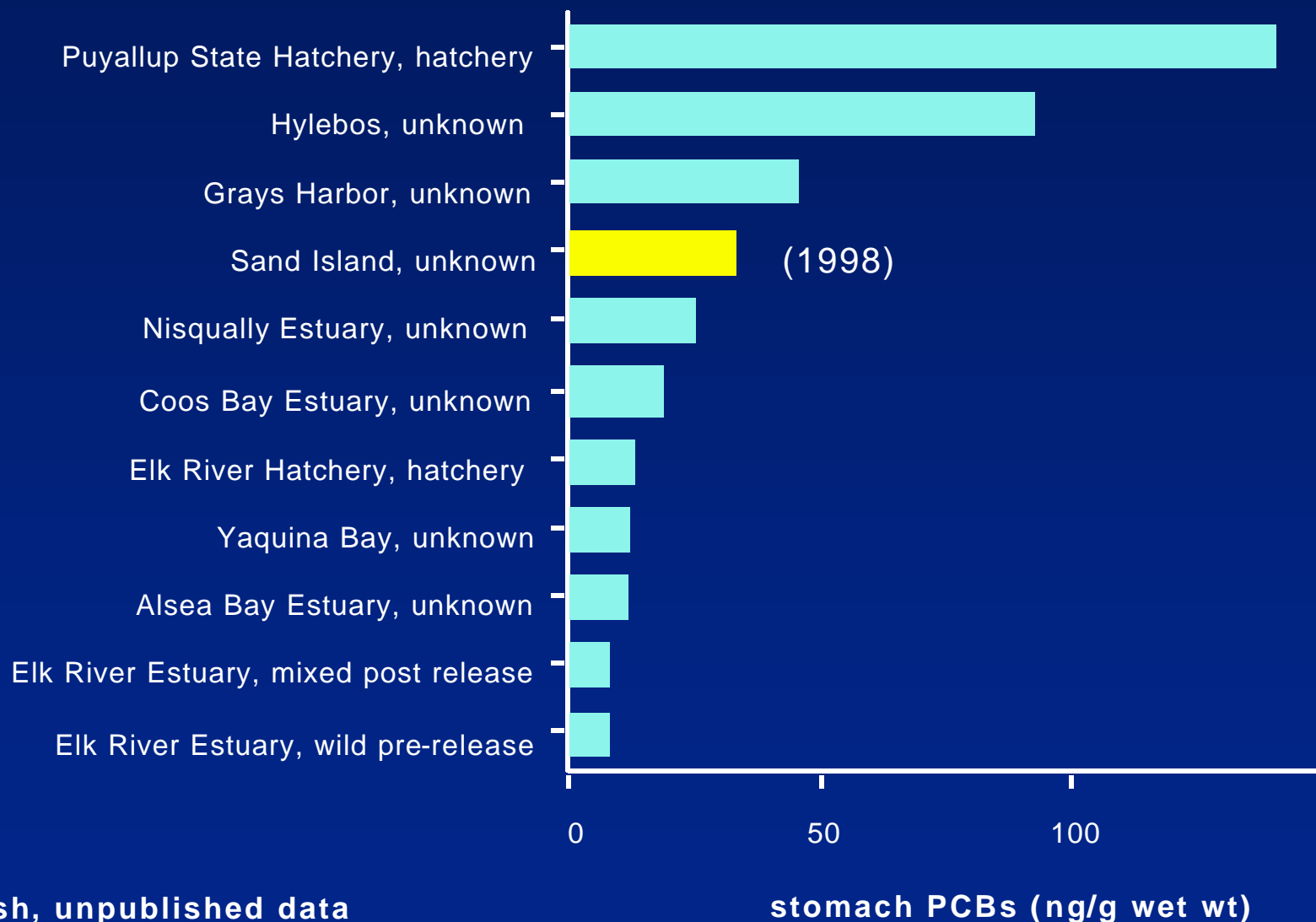
# DDT concentrations in bodies of juvenile Chinook salmon from Washington and Oregon estuaries



Arkoosh, unpublished data

body DDTs (ng/g wet wt)

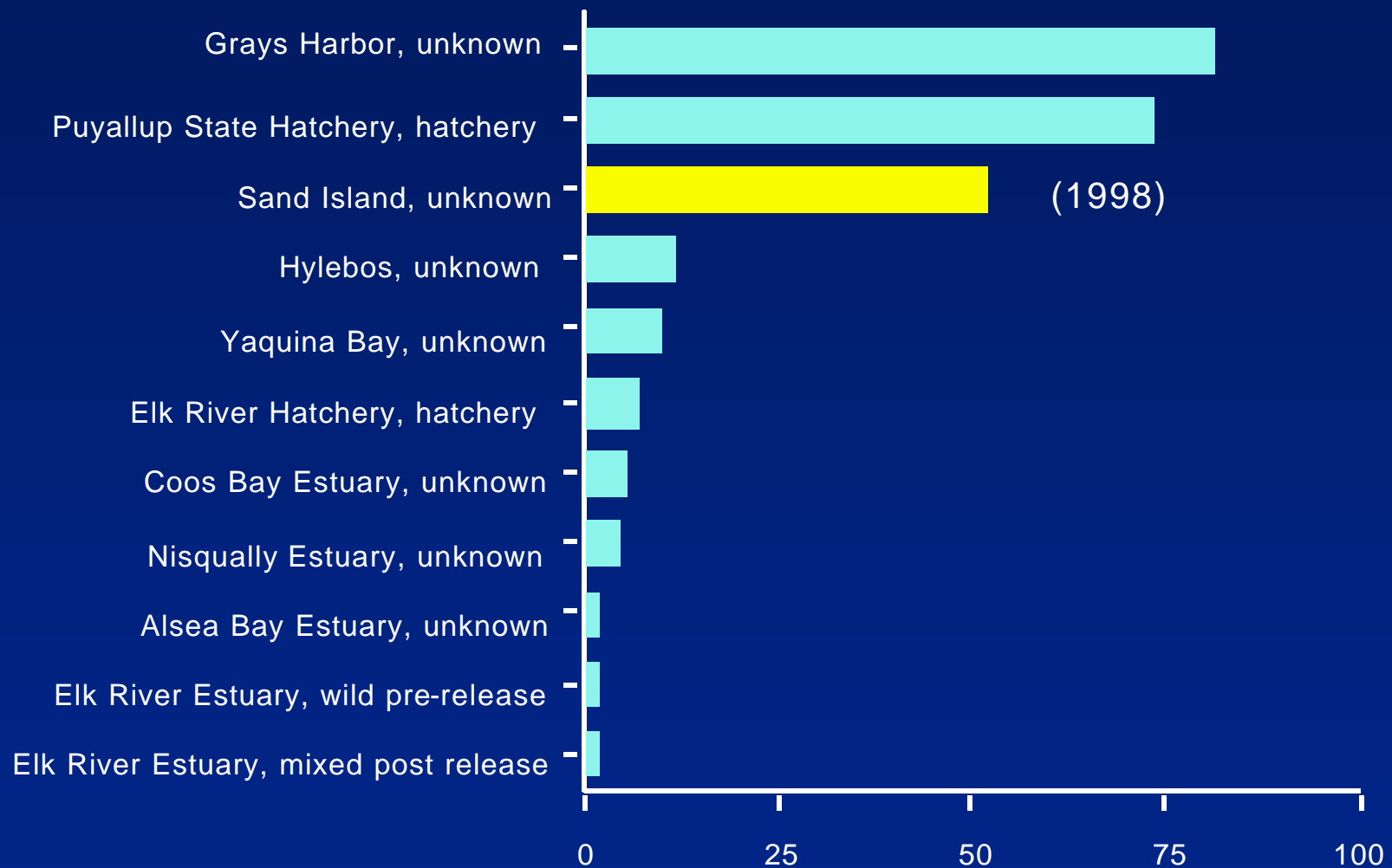
# PCB concentrations in stomach contents of juvenile Chinook salmon from Washington and Oregon estuaries



Arkoosh, unpublished data

stomach PCBs (ng/g wet wt)

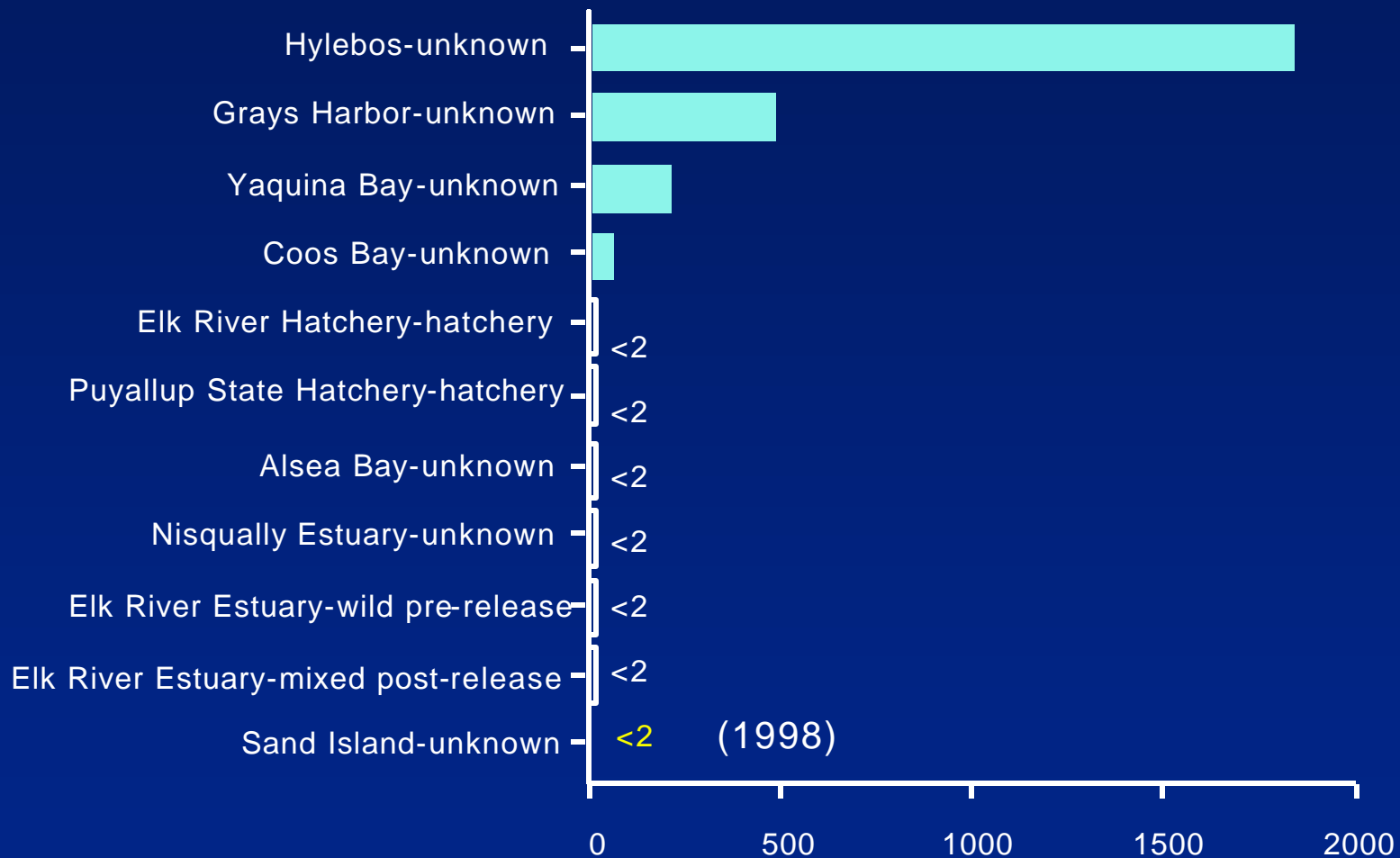
# DDT concentrations in stomach contents of juvenile Chinook salmon from Washington and Oregon estuaries



Arkoosh, unpublished data

Stomach DDTs (ng/g wet wt)

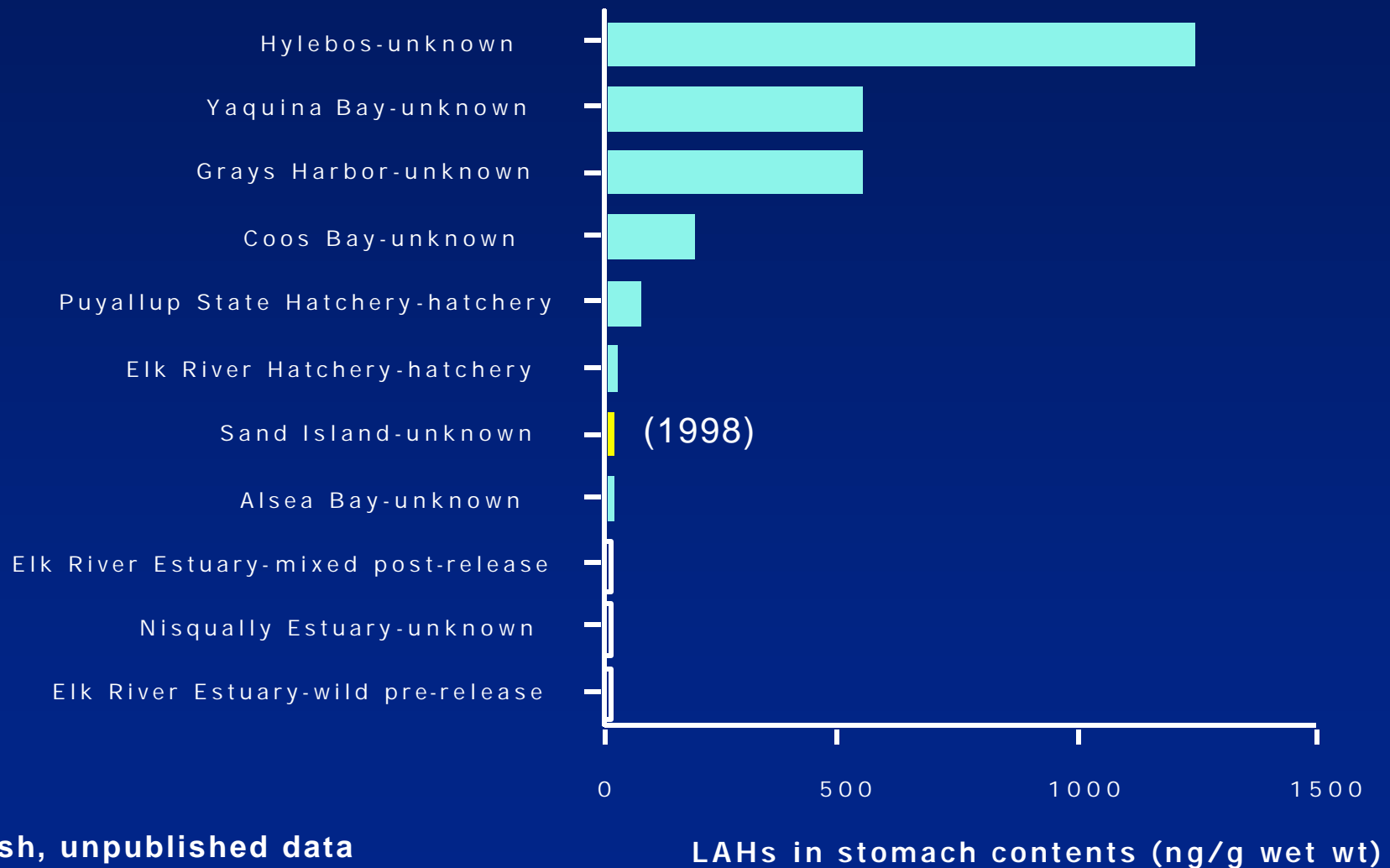
# HAH concentrations in stomach contents of juvenile Chinook salmon from Washington and Oregon estuaries



Arkoosh, unpublished data

HAHs in stomach contents (ng/g wet wt)

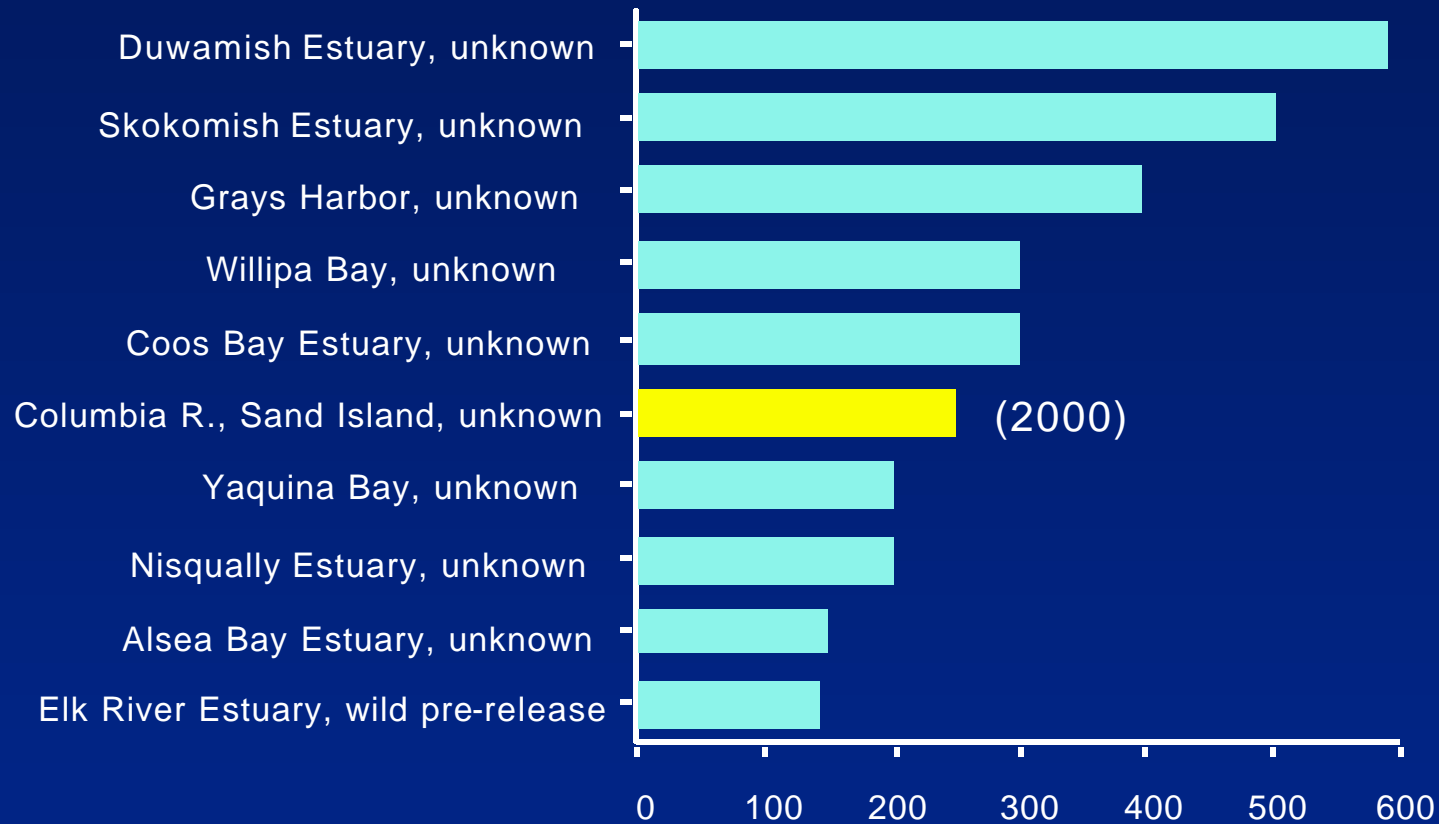
# LAH concentrations in stomach contents of juvenile Chinook salmon from Washington and Oregon estuaries



Arkoosh, unpublished data

LAHs in stomach contents (ng/g wet wt)

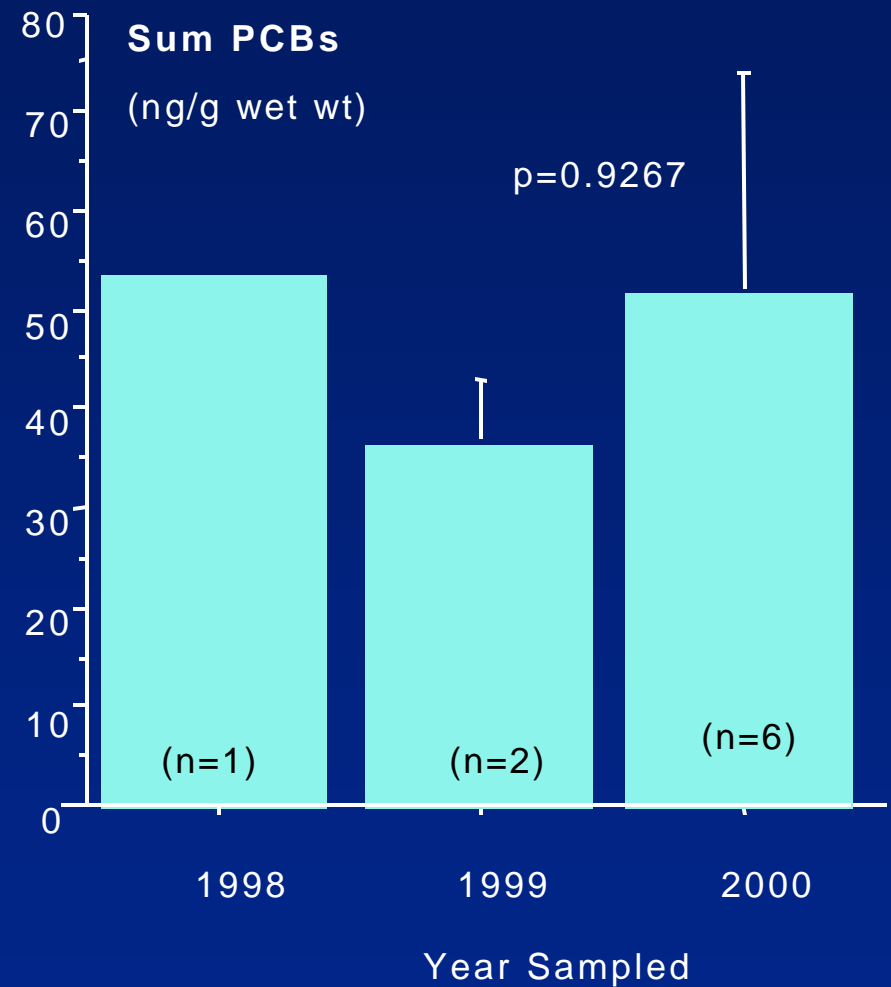
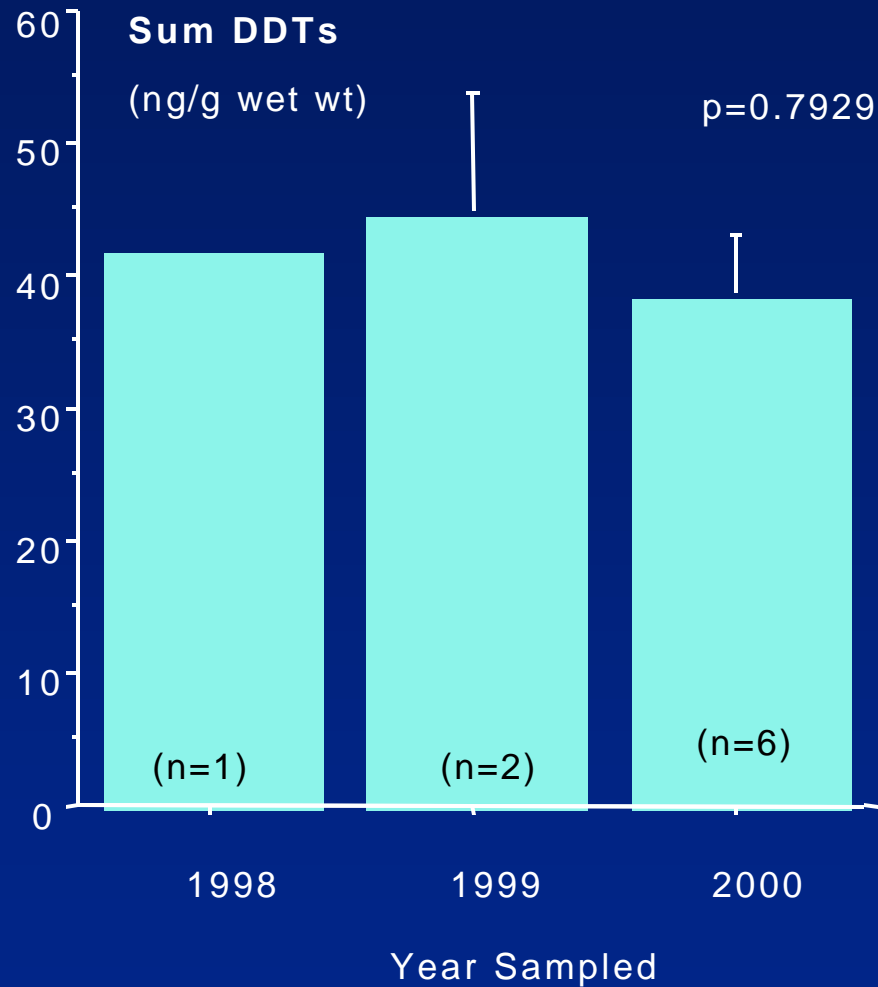
# PAH metabolite concentrations in bile of juvenile Chinook salmon from Washington and Oregon estuaries



Arkoosh, unpublished data

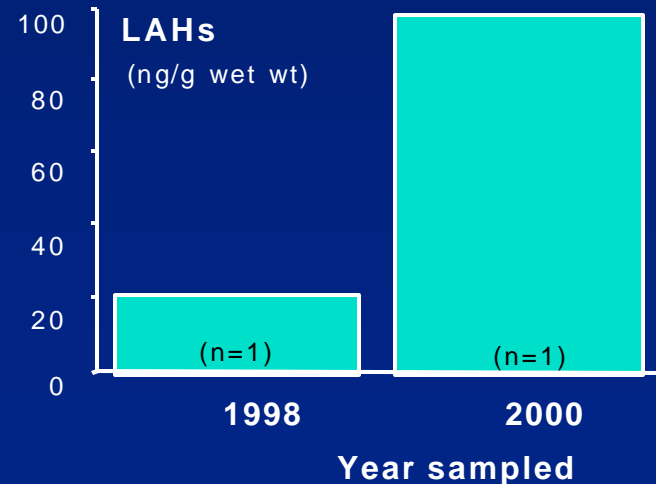
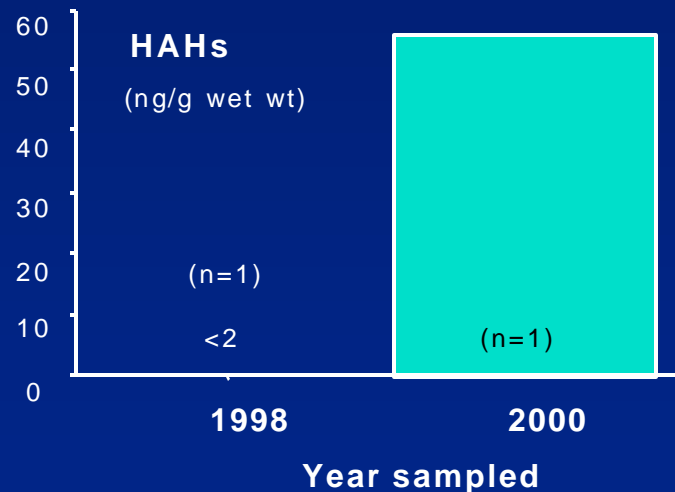
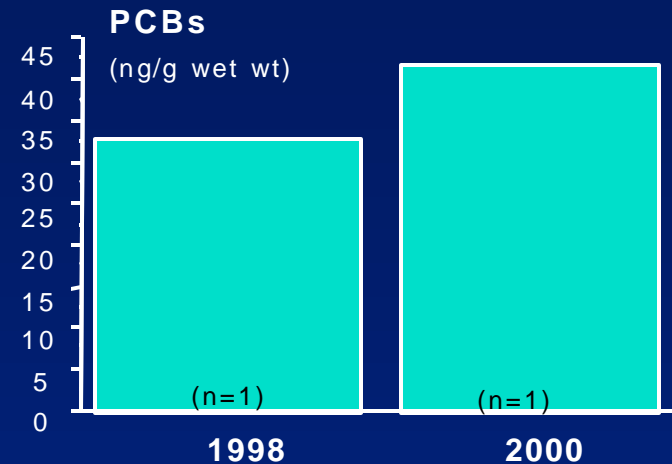
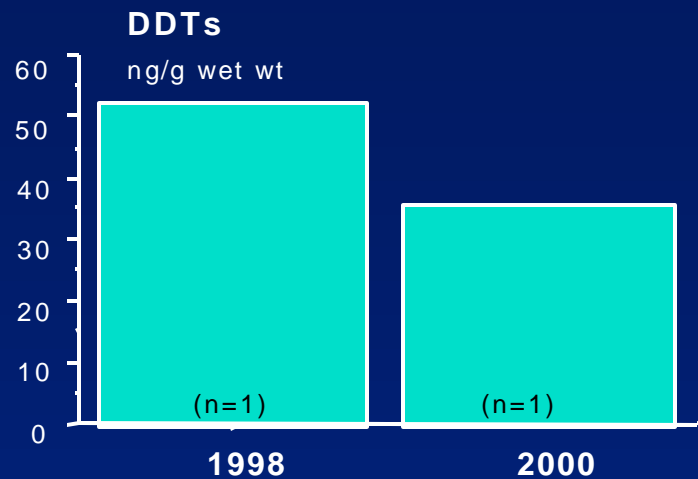
ng BaP equivalents/ml bile

# DDT and PCB concentrations in bodies of juvenile Chinook salmon from West Sand Island (1998-2000)



Arkoosh, unpublished data

# DDTs, PCBs, and PAHs in stomach contents of juvenile Chinook salmon from West Sand Island 1998-2000



Arkoosh, unpublished data

# **Is there potential for the project to alter contaminant exposure?**

- **Are there sufficient samples to characterize toxicant levels in the areas to be dredged?**
- **Are current sediment guidelines adequate to protect salmon health?**

## **Scope of sampling, as presented in the SEIS:**

**90 surface samples collected over 100 river miles**

**23 actual chemical analyses conducted**

**Core samples taken in 2 off channel areas**

**No core samples in main channel?**

**Question:** What is our level of certainty that there are no depositional (i.e. likely to be moderately contaminated) sediments anywhere in the channel deepening area?

# NMFS threshold data vs CoE sediment guidelines from DMEF document

## Polycyclic aromatic hydrocarbons (PAHs)

NMFS	1000 ppb total dry wt, derived for marine fish; salmon show DNA damage, immunosuppression, at 5000 ppb
CoE DMEF	5200 ppb LPAH, 12000 ppb HPAH, screening 29000 ppb LPAH, 69000 HPAH, maximum allowable

# NMFS threshold data vs CoE sediment guidelines from DMEF document

## Polychlorinated biphenyls (PCBs)

NMFS	120-360 ng/g as a tissue threshold level, salmon specific Currently, average values in LCR chinook outmigrants are 265 ng/g. Lipid normalization needed (usually in 1-3% range).
CoE DMEF	sediment screening level (150 ng/g dry). Maximum allowable (3100 ng/g dry) increases risk of effects.

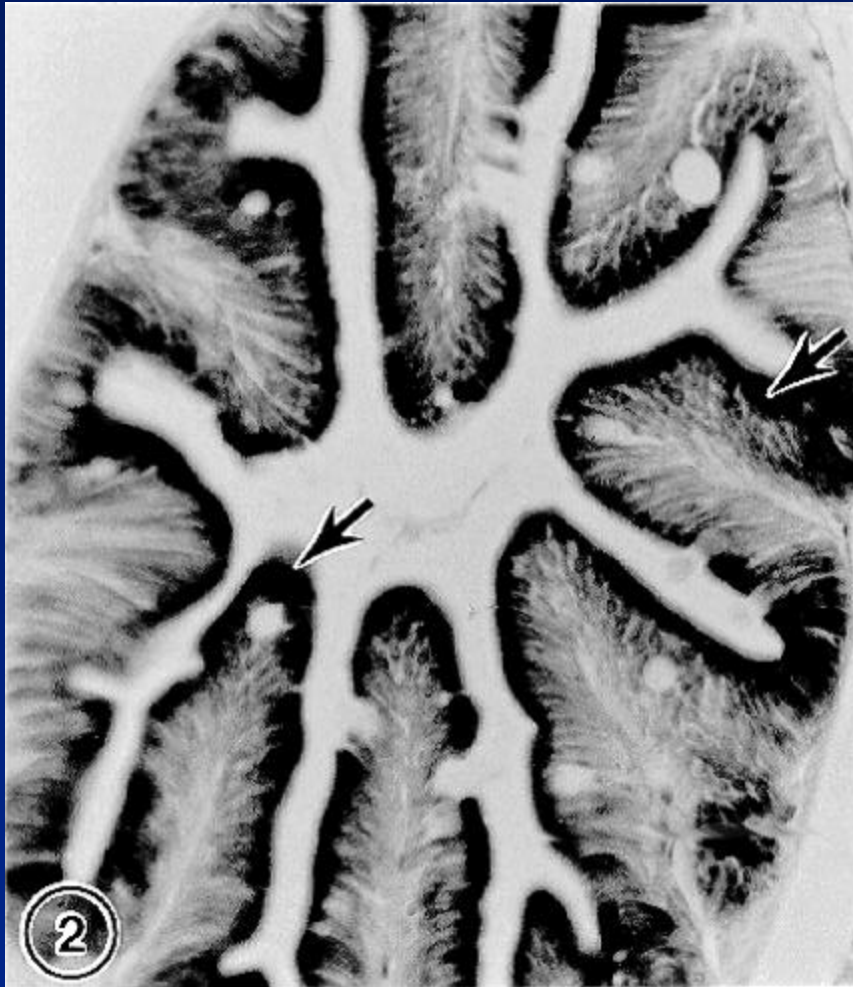
# DDTs?

- Consistently elevated in juvenile salmon from LCR compared to other west coast estuaries.
- No NMFS sediment and tissue threshold evaluation, as was done for PCBs, PAHs, and TBTs.
- DDT is an insecticide, thus impacts on prey base are cause for concern (1-2 ppb effects level predicted; Pavlou et al., 1987).

## **Other uncertainties--**

- **Low TOC levels in sediments, and low lipid levels in outmigrant fish, tend to increase bioavailability and toxicity of any hydrophobic contaminants which may be present.**
- **Bulk sediment analyses may not accurately reflect exposure and bioaccumulation.**
- **Route of exposure for juvenile salmon is likely both through diet as well as water column.**

# Induction of CYP1A in juvenile chum salmon from the Hylebos Waterway



Intestine



Gill

# **Summary of issues and concerns:**

- **Outmigrant salmon are currently exposed to contaminants in the LCR, body burdens are approaching levels of concern, and sources are not known.**
- **Additional incremental exposure of salmon is a cause for concern.**
- **Characterization of sediments in the channel, especially the potential for buried depositional sediments, in the SEIS.**
- **The LCR has a broad toxics signature, and dredging operations should be considered in the aggregate (e.g. recent Oregon forestry decision).**

**“The weight of evidence required should depend on the weight of the decision”**

Mount, USEPA, SETAC, 1997

**2 listed Pacific salmon ESUs are utilizing the LCR  
This gives considerable weight to the decision”**

Anonymous, Vancouver, WA, 2001

## **A suggestion for moving forward:**

- **Verify our assumptions through monitoring of the dredging project.**
- **Establish, in concert with NMFS and FWS, adaptive management procedures in the event that our assumptions are incorrect.**
- **Establish a regional multi-agency approach for assessing the status of toxic contaminants in salmon in the LCR, which can be used to assess this and future dredging projects.**