

A Survey of Cadmium in Pacific Oysters: Distribution, Influencing Factors and Ways to Minimize Concentrations



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Problem Identification

- 1999 - Hong Kong rejects shipment of BC oysters > 2 ppm ML import standard
- 2003 - Hong Kong rejects shipment of Hood Canal, WA oysters
- Codex Alimentarius deliberates a 1-ppm ML for molluscan shellfish

ECONOMIC & HUMAN HEALTH CONCERNS



United States Department of Agriculture



Research Goals

- ➔ 1. Evaluate Cd distribution in west coast Pacific oysters
- 2. Evaluate impact to shellfish industry and human health
- ➔ 3. Identify factors that influence oyster Cd concentration & find ways to reduce concentrations in final product

What is Cd and why is it a human health concern?

- Naturally occurring trace element
- Concentrations higher from Pacific NW to AK
- Long biological half-life (10-30 yrs)
- Accumulates in soft tissues, esp. liver and kidneys
- Can cause kidney dysfunction, liver disease and skeletal decalcification at high enough concentrations



= 10 $\mu\text{g}/\text{day}$

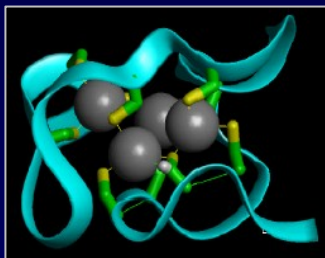


= 10 $\mu\text{g}/\text{day}$

Cadmium in Pacific oysters



= 50 μg per 40 gram oyster

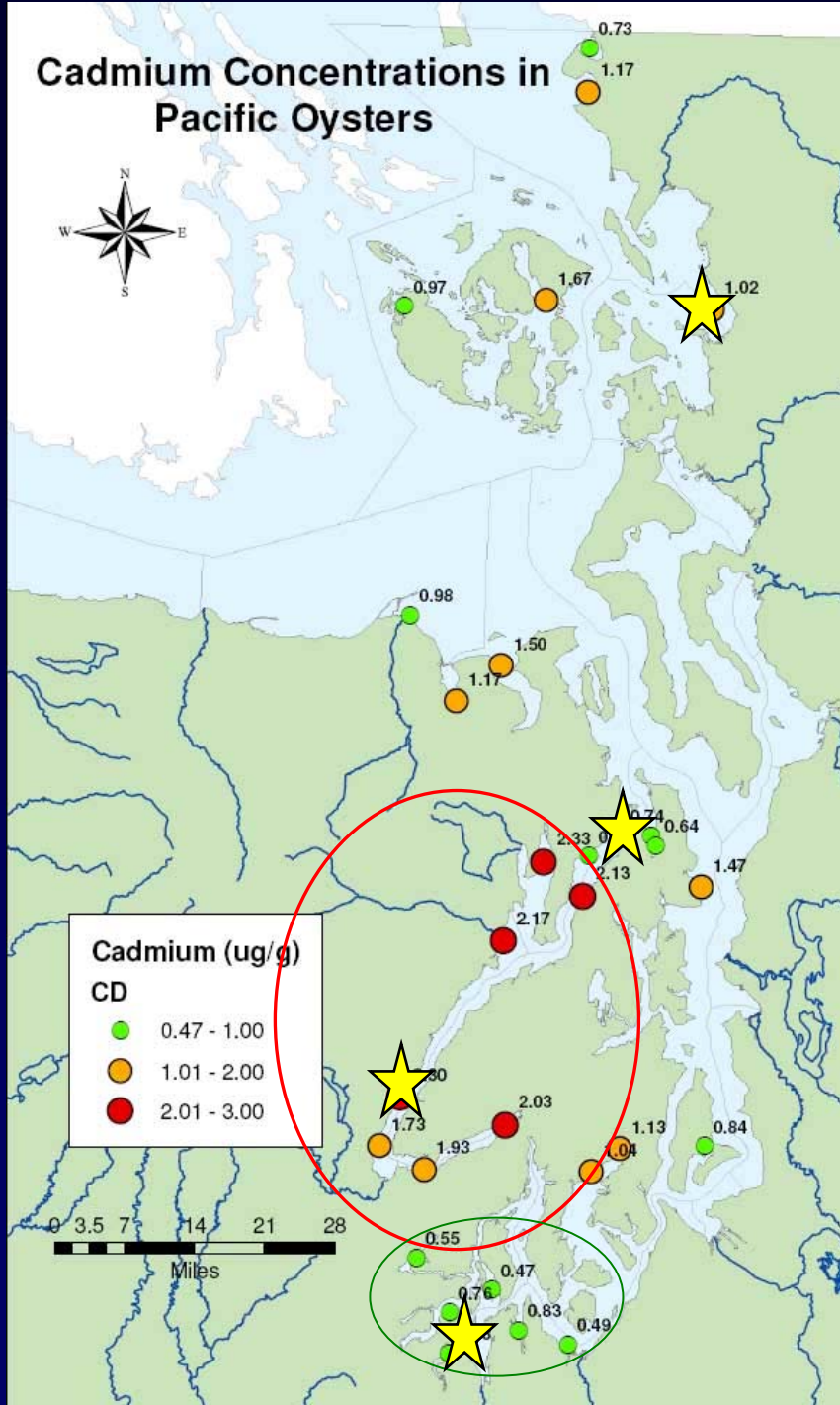


- Filter feeders
- Detoxification system
 - MT proteins

Health Canada recommends a PTWI of 420 μg Cd from all sources for 60 kg person



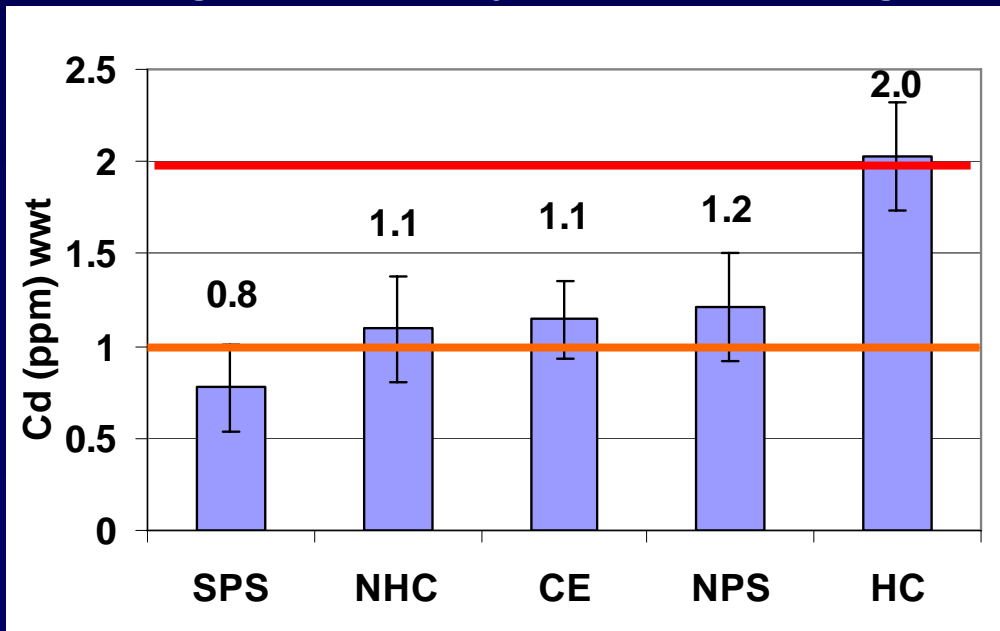
Cadmium Concentrations in Pacific Oysters



Ave: $1.25 \pm .51$ ppm
 Range: .44-2.5 ppm

13.5% > 2 ppm ML
 61% > 1 ppm ML

Average Cd in Oysters per Region



Seasonal Sampling

Oyster Tissue



- Temperature
- Salinity
- pH
- Dissolved oxygen

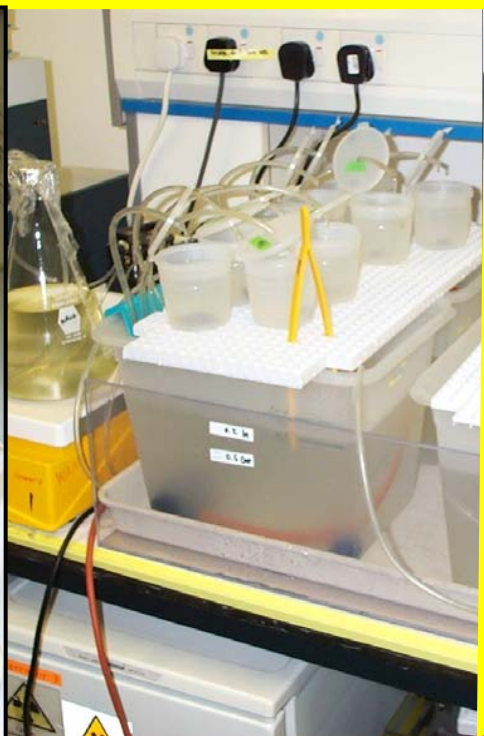
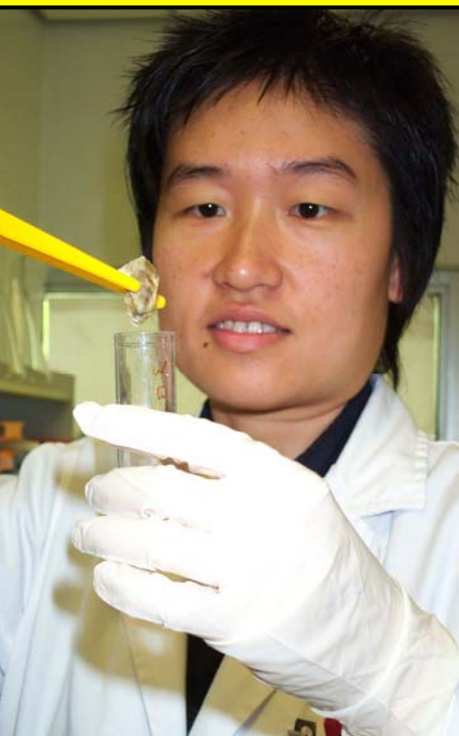
Seawater

- Total Cd/Zn
- Dissolved Cd/Zn
- Seston
- TSS
- Plankton counts and speciation

Sediments

- Cd/Zn
- TOC
- Grain Size

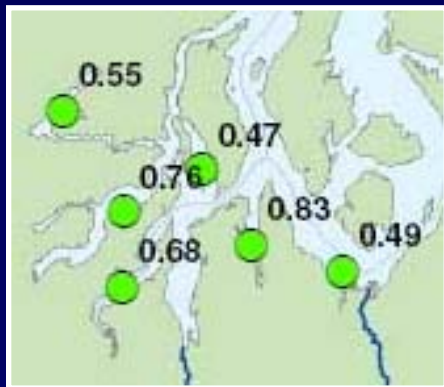




Unpopular Tip #1

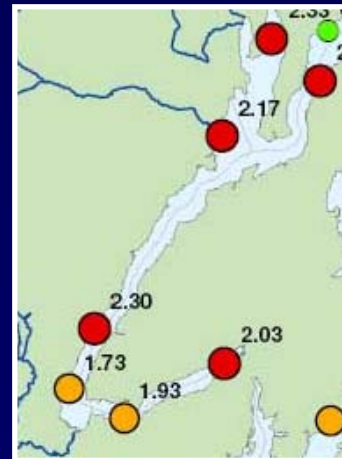
Grow / harvest at locations known to have oysters with lower Cd concentrations

What are the factors that influence Cd concentrations from region to region?



South Puget Sound

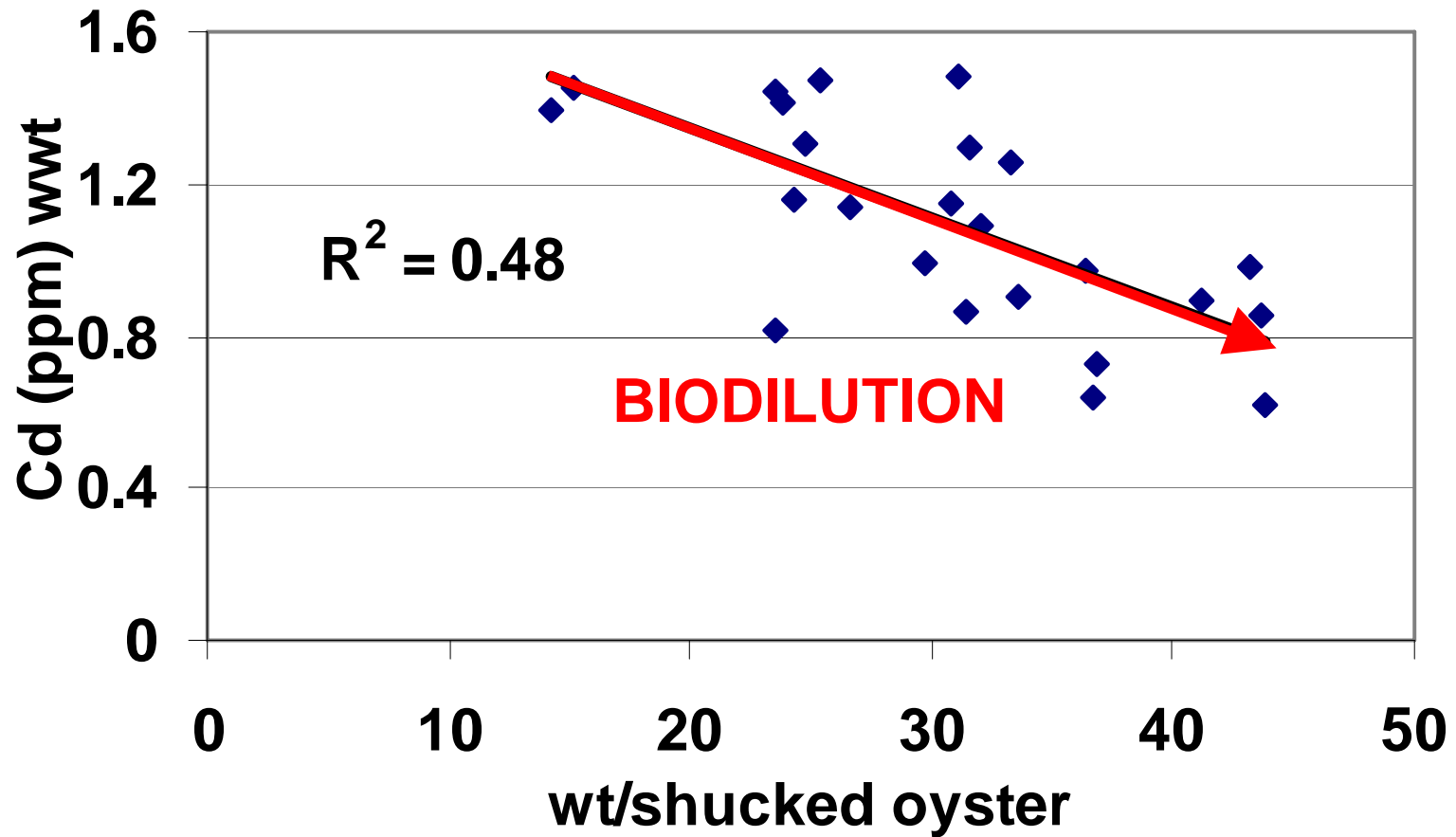
VS



Hood Canal

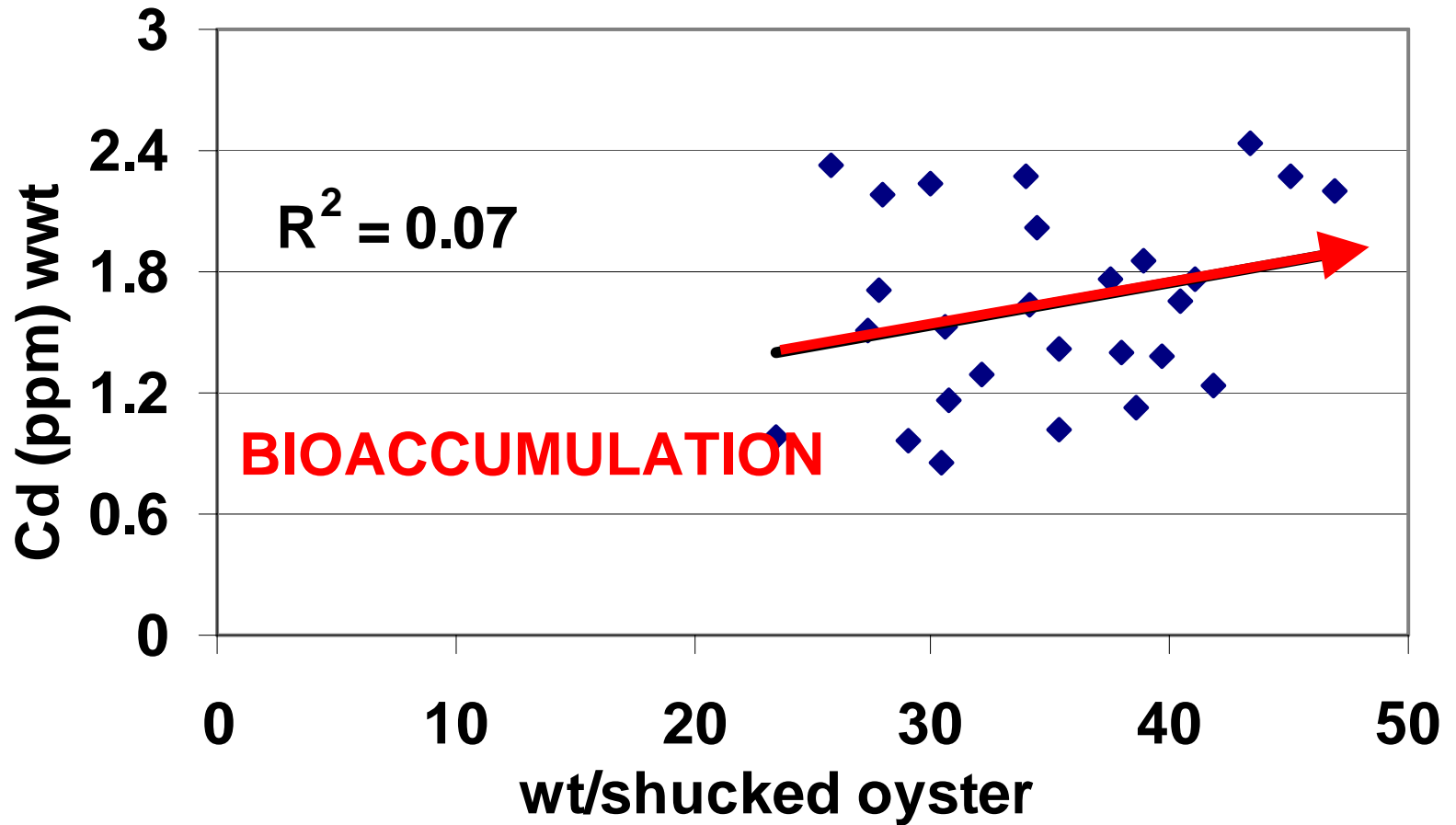
Sites with Fastest Growth Rates

Relationship between oyster wt and Cd



Sites with Slowest Growth Rates

Relationship between oyster wt and Cd



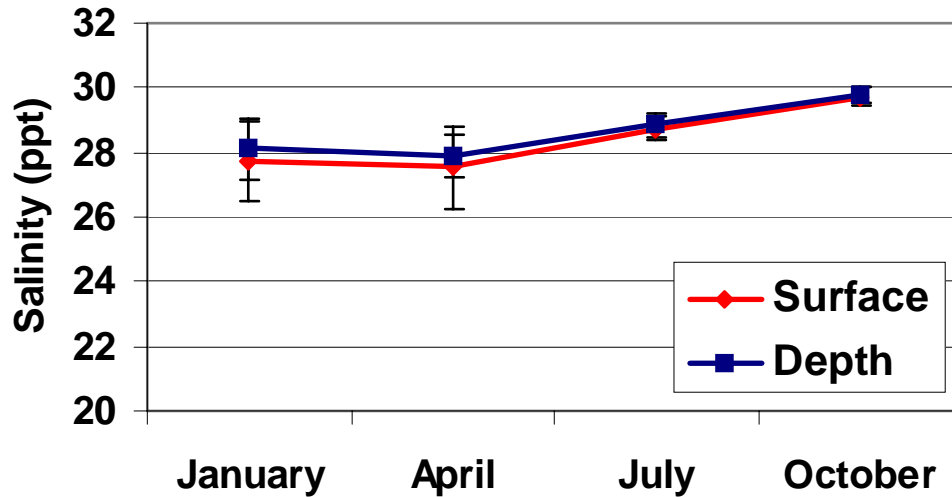
Factors that Influence Cd Uptake Rate

A decrease in salinity from 30 ppt to 20 ppt increased Cd uptake in 4 species of marine bivalves by as much as 24-400%.

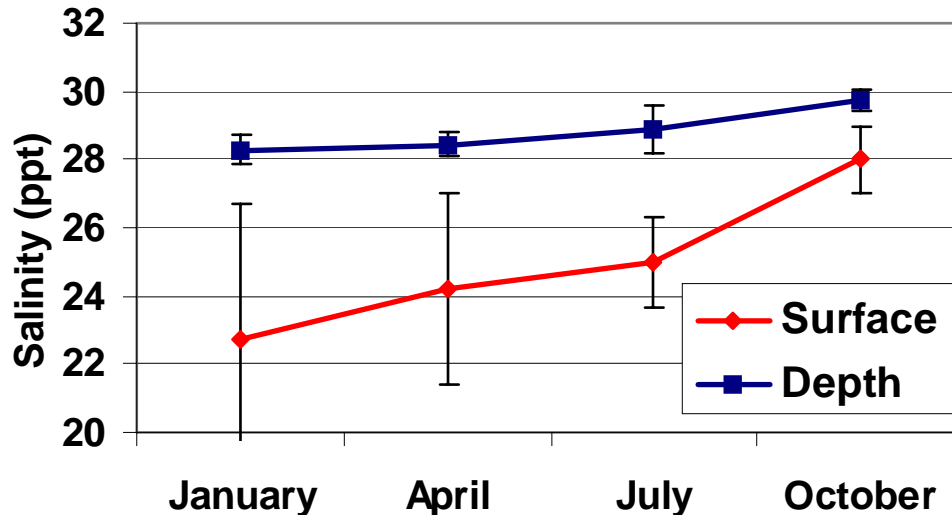
(Jackim et al. 1977)

WDOE Marine Water Monitoring Data

South Puget Sound



Hood Canal

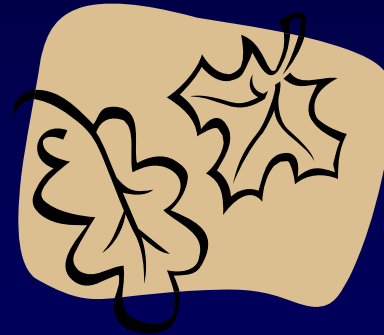


Somewhat Unpopular Tip #2

Harvest oysters in the summer and avoid fall



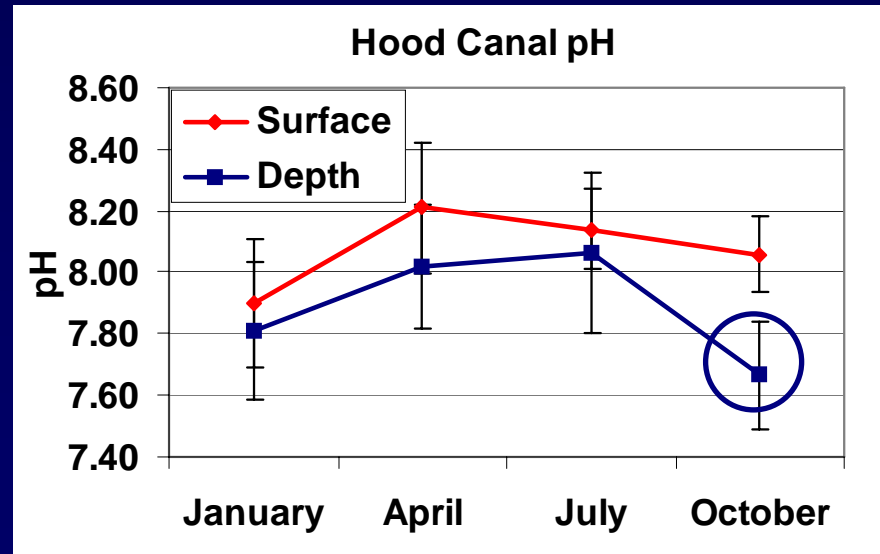
Weight increases with feeding and gamete production



Weight decreases with spawning and/or utilization of glycogen stores

After measuring influx rates and Cd accumulation in Pacific oysters from radiolabeled plankton, sediment and seawater, Dr. Wen-Xiong Wang reported....

“Most of the cadmium in the oysters was due to uptake from seawater in the dissolved phase.”



Ian Stupakoff & Dr. Wen-Xiong Wang

Potentially Popular Tip #3

Consider processing your oysters:

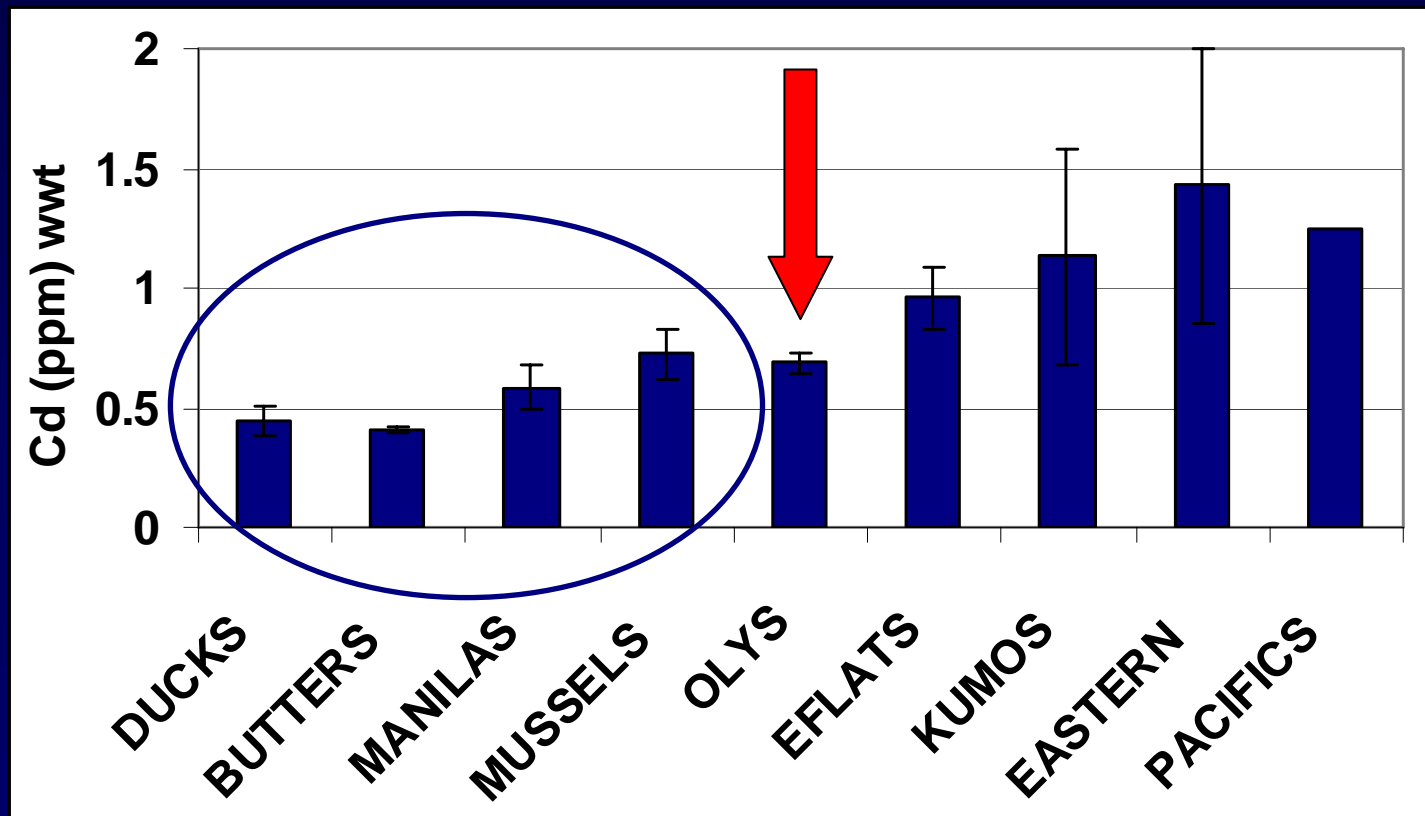
1. Traditional shucking, washing, jar packing + 10 days cold storage
2. High pressure processing + 10 days cold storage

**Research conducted by R. Rasmussen
(OSU Seafood Labs)**



Bonus Tip #4

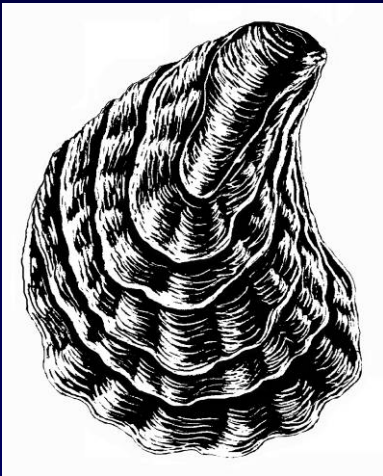
Consider growing / harvesting Olympia oysters or a different shellfish species altogether



Conclusions

- Regional differences in oyster Cd concentrations were detected
- Factors were identified that have a significant impact on Cd concentrations:
 - Growth rates, Cd in dissolved seawater, physical parameters and seasonality
- Activities to reduce Cd residues in final products may include site selection, harvesting in the summer and/or processing

Contact Information



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Human Health Study

- Exposure areas: 7
- Consumption rates
 - GEMS diet: .002 g/kg-day
 - Suquamish Tribe: **.164 g/kg-day**
 - API Community of W. WA: .118 g/kg-day
- Bioavailability: 3-5%
- Hazard Quotient = Intake / reference dose
- **No appreciable “non-cancer” risk observed for typical consumers of 3 populations studied**

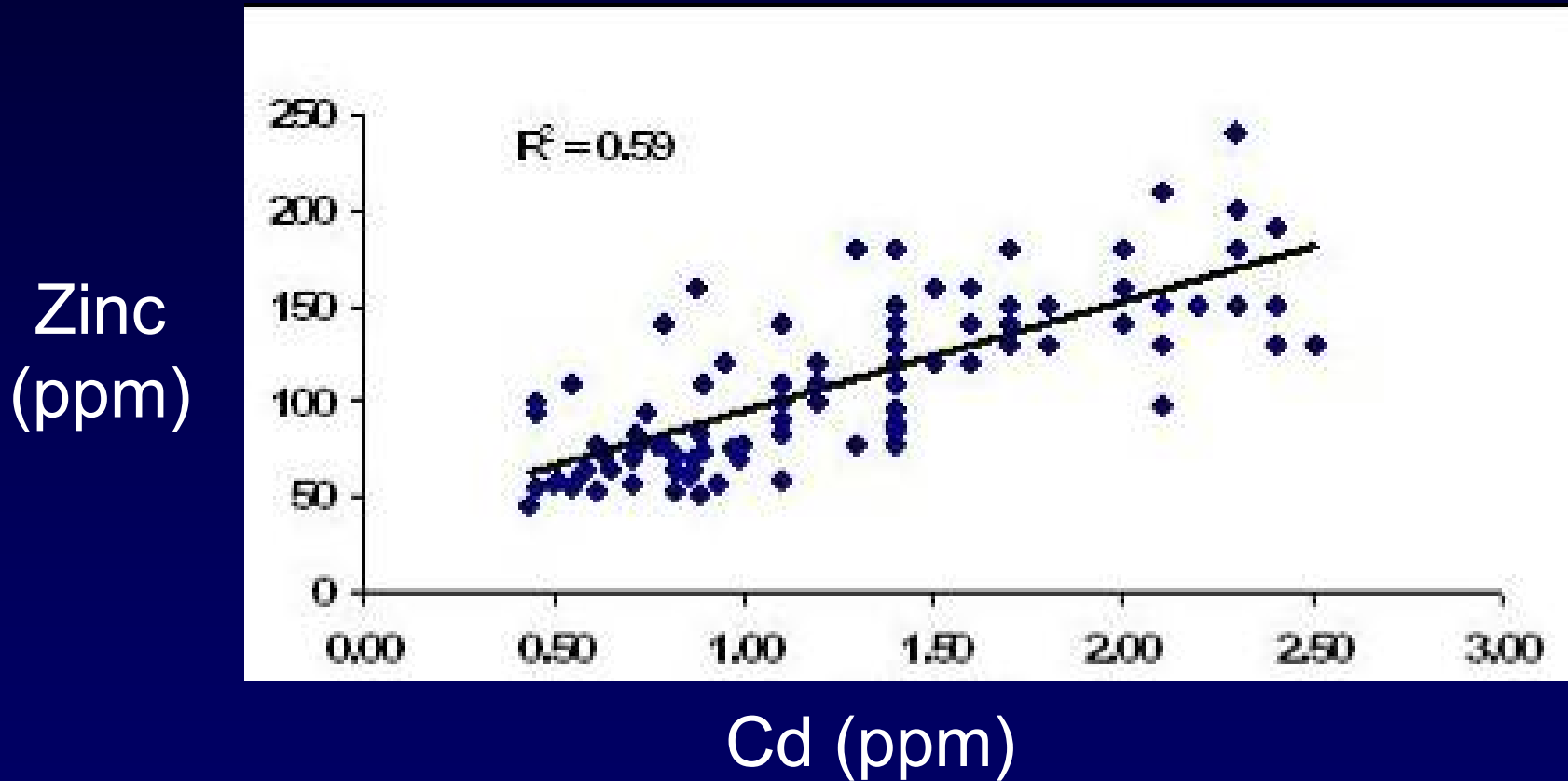


Typical consumer

Health Canada

“Chronic exposure to elevated levels of cadmium over an extended period of time may result in damage to the kidneys, although **there is no scientific evidence linking health effects to naturally occurring cadmium found in shellfish.**”

Cd & Zn Relationship in Oysters



$r_s = .78, p=0$

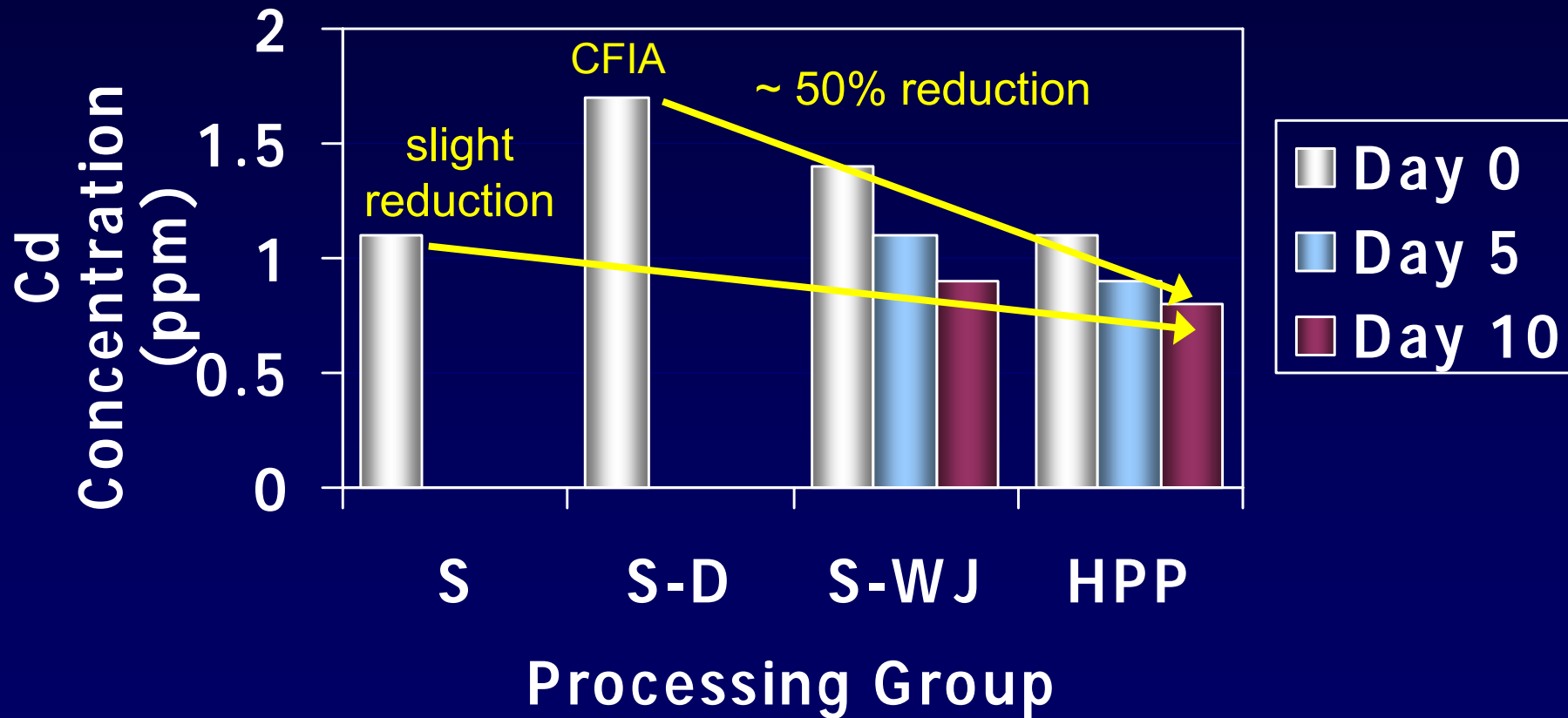
Cd in oyster fishermen after consuming New Zealand dredge oysters (Sharma 1983, McKenzie et al. 1988)

- Cd in participant's blood and urine not elevated in proportion to amount ingested
- Little Cd appeared to be absorbed and was instead excreted in feces
- Smoking found to have more pronounced effect on blood Cd levels than oyster consumption
- 5 ppm wwt, 6 dozen oysters/wk = >2000 ug
16 dozen = >5500 ug

At-risk Populations

- Elderly, diabetics, indigenous populations, malnourished, women with low iron stores
 - Individuals with low iron stores found to have greater Cd burdens (Saratug & Vahter studies)
 - Ca, protein, vit C, vit E, Se, Zn shown to decrease Cd absorption in human & animal studies
 - Cd accumulation in liver and kidneys decreased by 80% after supplementing diet w/ Ca, P, Fe, Zn
 - Diet rich in Zn believed to offer considerable protection against Cd accumulation (Sullivan 1984)

Effects of Processing and Storage on Oyster Cd Concentration



Research conducted by Rosalee Rasmussen (OSU Seafood Labs)