

# The Effects of Processing Methods on Cadmium Levels in Pacific oysters (*Crassostrea gigas*)



Rosalee S. Rasmussen, M.S.  
Michael T. Morrissey, Ph.D.  
Oregon State University Seafood Lab,  
Astoria, OR

# Pacific oysters are an important seafood commodity worldwide

## Top 20 World Aquaculture Species 1990 – 2004

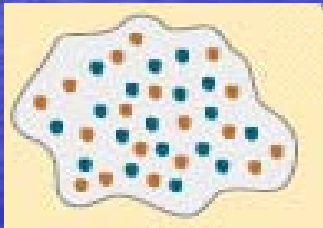
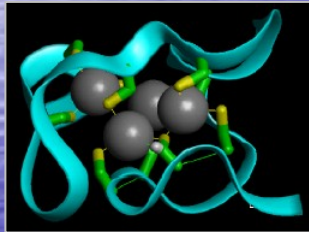
Thousand Metric Tons

	SPECIES	1990	1999	2000	2001	2002	2003	2004
1	Pacific cupped oyster	1,190	3,602	3,911	4,108	4,235	4,377	4,429
2	Silver carp	1,520	3,381	3,450	3,918	3,850	3,833	3,979
3	Grass carp	1,048	3,271	3,383	3,462	3,595	3,733	3,877
4	Common carp	1,140	2,593	2,683	3,069	3,139	3,240	3,388
5	Japanese carpet shell	298	1,870	1,694	2,091	2,357	2,604	2,860

Source: FAO FishStat (H.M. Johnson, 2006 Annual Report on the United States Seafood Industry)



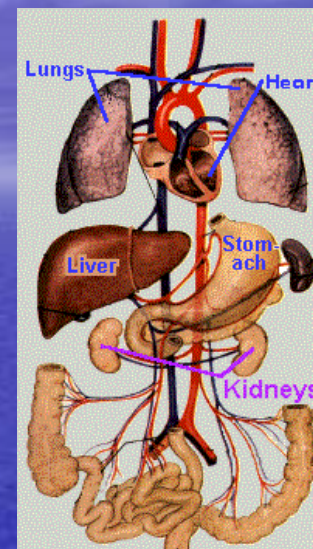
# Cadmium in Pacific oysters



- Filter feeders – high exposure to trace metals
- Detoxification system
  - Metallothioneins and lysosomes
- Pacific oysters contain a type of metallothionein with increased metal binding capacity

# Cadmium Toxicology

- Has a long biological half-life (10-30 yrs)
- Can accumulate in soft tissues, esp. liver and kidney
- Can cause: kidney dysfunction, liver disease, lung cancer, and skeletal decalcification
- Humans are exposed through smoking tobacco and food consumption



# Cadmium in Pacific oysters

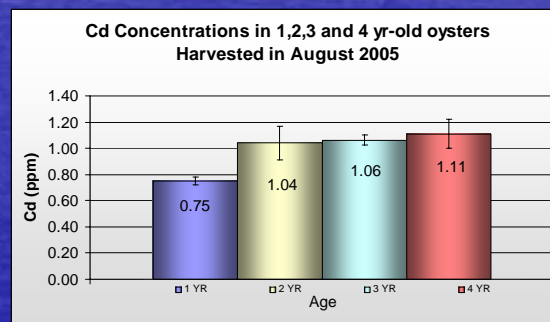
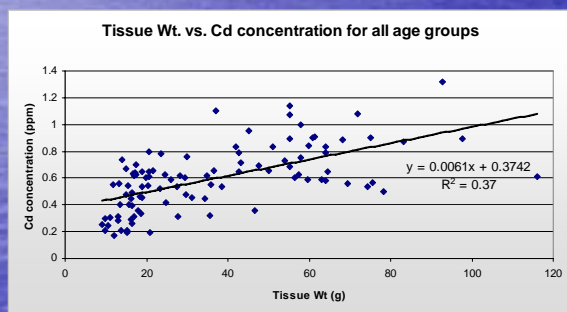
- Hong Kong, Australia and New Zealand have conservative oyster Cd limits of 2 ppm (wet wt)
- Pacific oysters can exceed this limit:

Survey location	Ave Cd	% over 2 ppm	N
Washington State, USA <sup>1</sup>	1.2	17	92
British Columbia, Canada <sup>2</sup>	2.6	60	81

- Some Pacific oyster shipments have been rejected by Hong Kong due to excessive Cd

# OSU Seafood Lab Research

- Previous work has shown some effects of age and tissue weight on Cd in oysters



- The effects of processing and storage on the Cd levels in oysters have not been extensively studied.

# Could processing alter Cd?



- Processing methods have been shown to alter properties of seafood
  - Hg, lipid, moisture, and protein content



- Potential processing steps that could alter Cd in oysters include:
  - HPP or shucking, draining nectar, washing and jar-packing, jarred storage



# Preliminary Study

- 3-yr-old oysters (n=120) of similar size and from the same growing bed
- 4 groups: Shucked (S); Shucked and drained (SD); Shucked, drained, washed, jarred (SW-J); High pressure processed (HPP), drained, washed, jarred



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# Objective of Current Work:

*Conduct a more extensive study to determine the effects of processing and storage on Cd in oysters.*



# Methods: Sample Collection

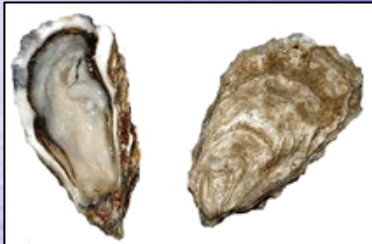


- 160 Pacific oysters were harvested in 2006 from Willapa Bay, WA.
  - All oysters were the same age (2.75 yr) and from the same growing bed.
- Oysters were randomly sorted into 4 groups based on processing steps.
- Oysters were analyzed in composites of 5.

## Group S

n=20  
4 composites

Shucked



## Group S-D

n=20  
4 composites

Shucked



Drained



## Group S-WJ

n=60  
12 composites

Shucked



Drained



Washed



Jarred

## Group HPP

n=60  
12 composites

HPP



Drained



Washed



Jarred



# Group S-WJ



# Group HPP



300 MPa  
90 sec



Washed in  
aerated water at  
13.3°C for 3 min

# Methods: Jarring

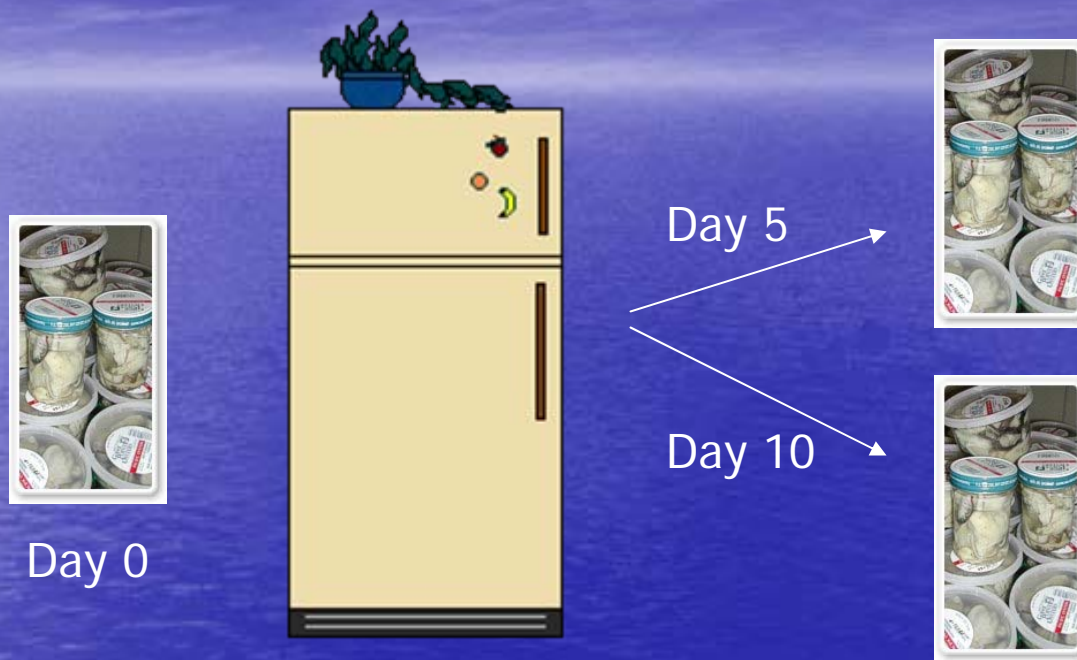


Following washing, oysters in groups S-WJ and HPP were placed in jars in groups of 5.



All oyster-filled jars were topped off with tap water.

# Methods: Jarred Storage



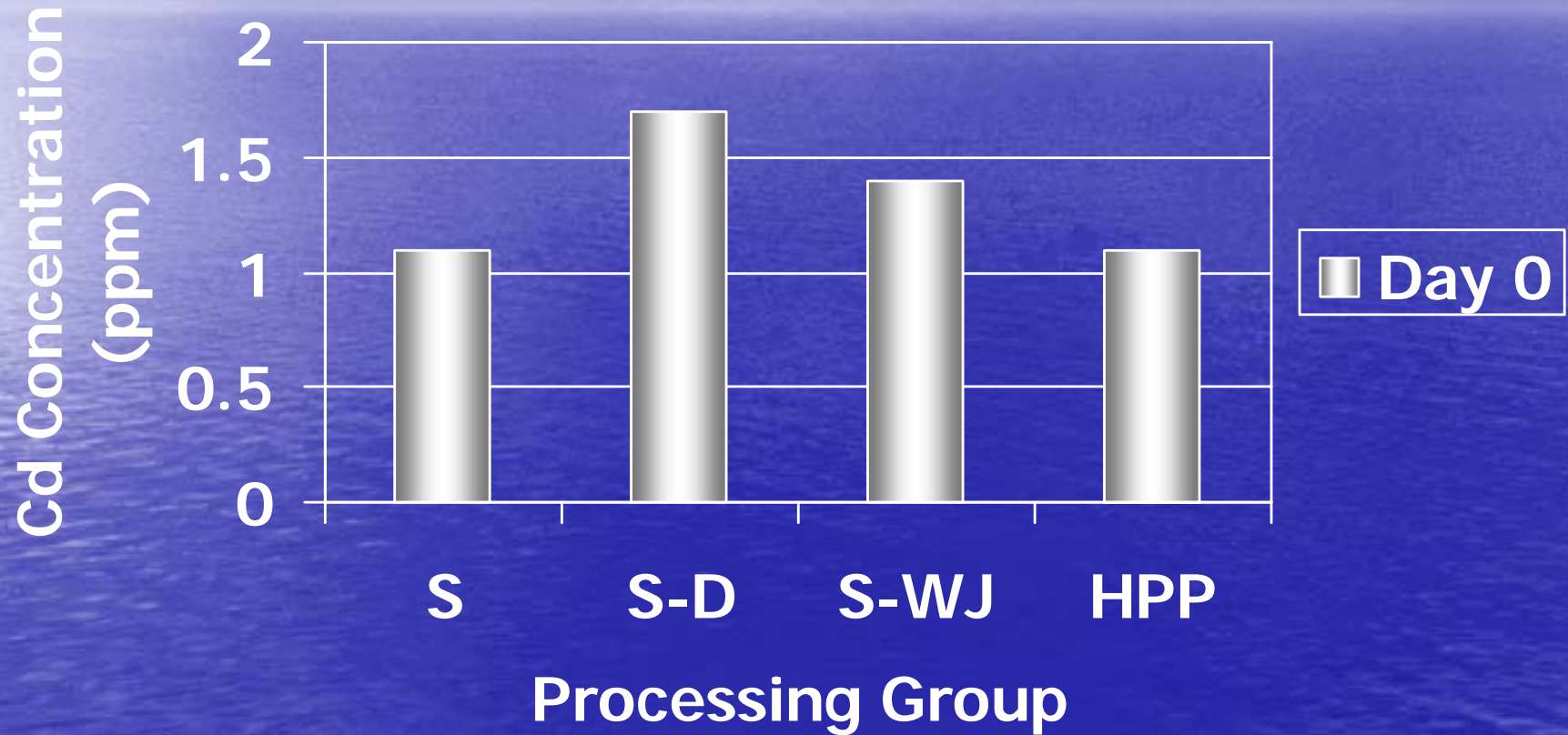
Groups S-WJ and HPP: oyster tissue and water in jars were analyzed for Cd levels at days 0, 5, and 10 of refrigerated storage.

# Sample Prep and Cd Analysis

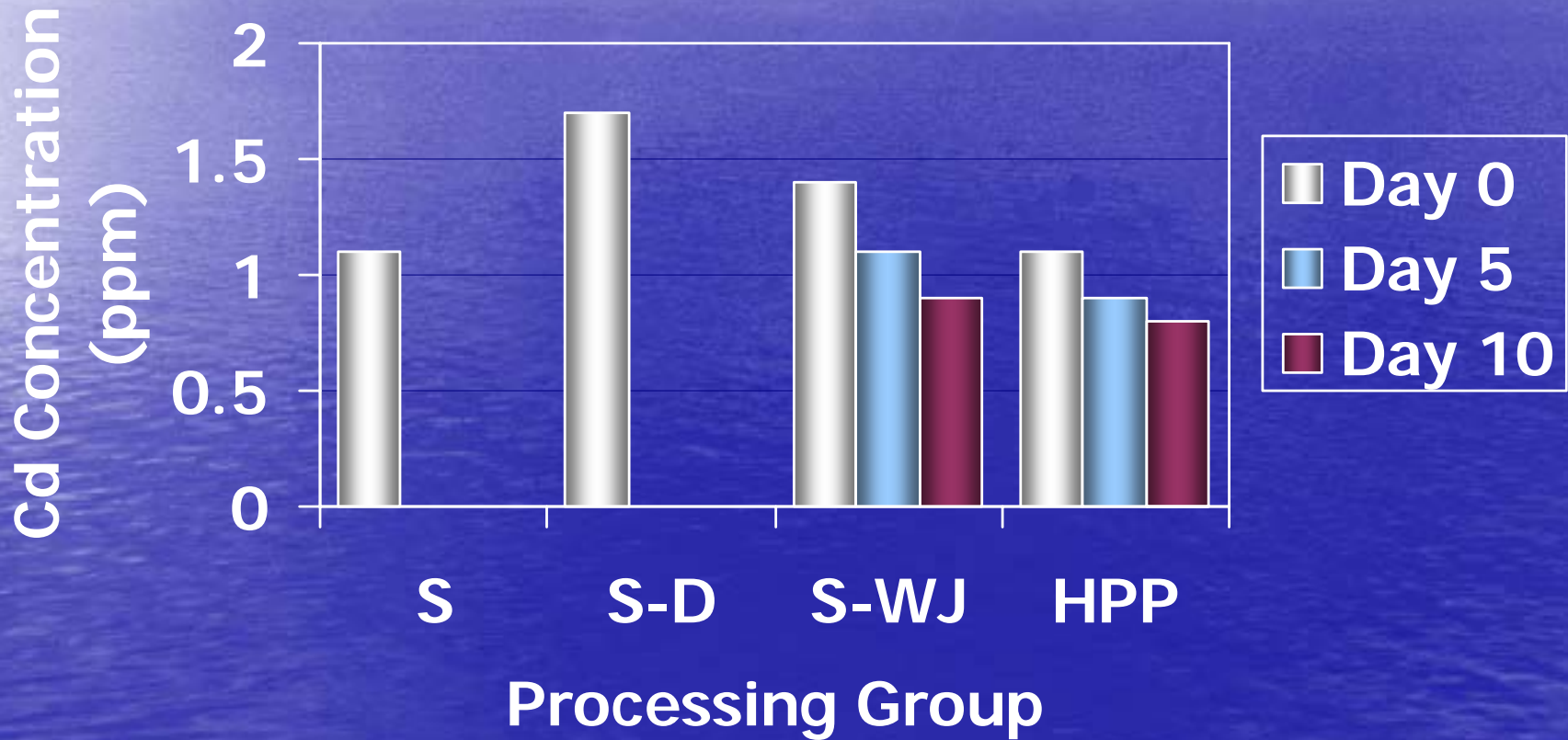
- Group S oysters were analyzed without draining (tissue + nectar).
- Oysters in all other groups were drained of excess fluid prior to analysis.
- Each composite sample was homogenized.
- Samples were analyzed for Cd with ICP-AES, according to the U.S. EPA Office of Solid Waste Manual (SW-846) Method 3050B.
- Analysis took place at AM Test Laboratories, in Redmond, WA.



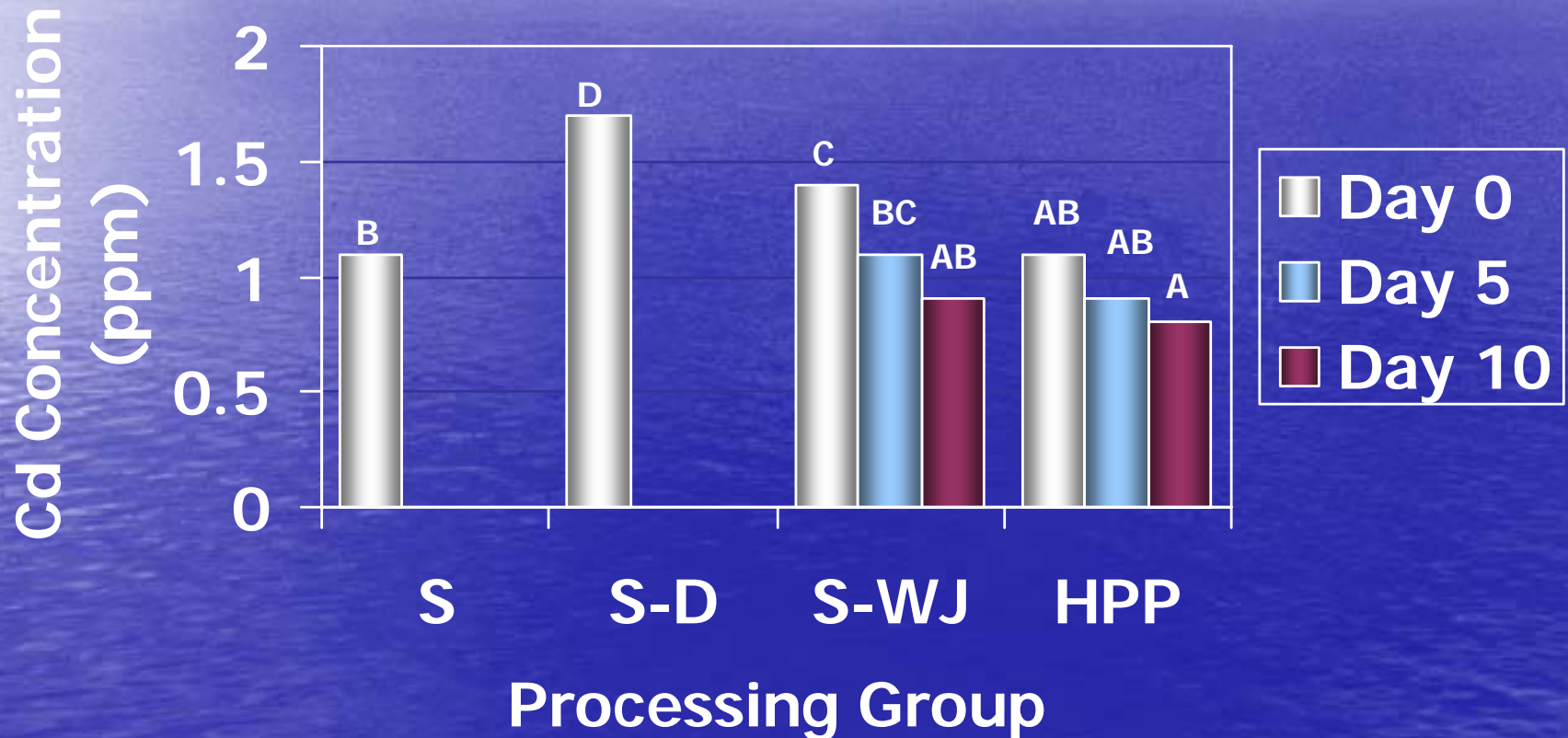
# Effects of Processing on Oyster Cd Concentration



# Effects of Processing and Storage on Oyster Cd Concentration



# Effects of Processing and Storage on Oyster Cd Concentration



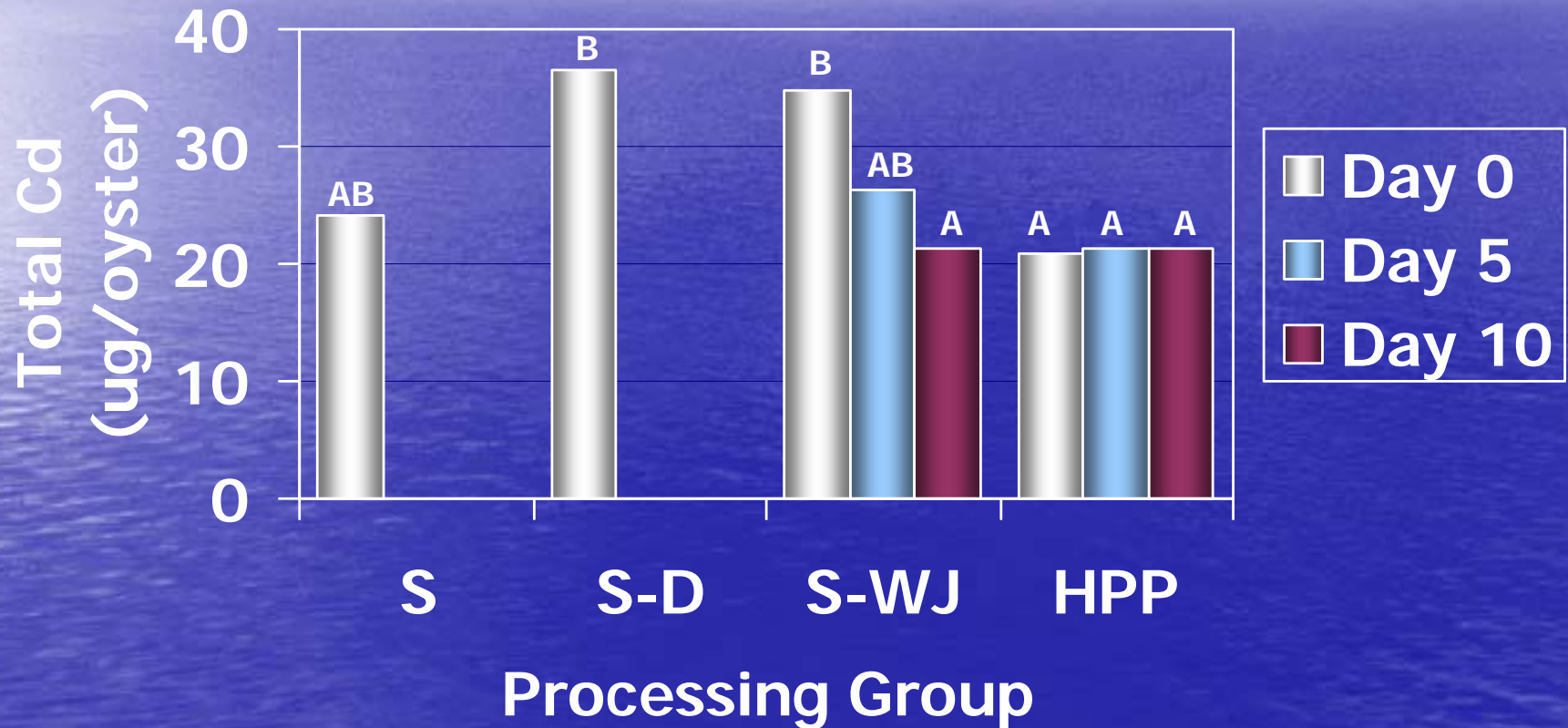
*Values labeled with a different letter are significantly different ( $p < 0.05$ ) according to one-way analysis of variance (ANOVA), Tukey's test, comparing all composite samples.*

# Oyster tissue weights

Processing Group	Oyster tissue weights (g/oyster)	
	Ave Initial Wt.	Ave Final Wt.
<b>S-WJ</b>		
Day 0	25.0 <sup>a</sup>	26.2 <sup>b</sup>
Day 5	18.0 <sup>a</sup>	22.7 <sup>b</sup>
Day 10	18.0 <sup>a</sup>	23.9 <sup>b</sup>
<b>HPP</b>		
Day 0	20.3 <sup>a</sup>	19.1 <sup>a</sup>
Day 5	22.2 <sup>a</sup>	23.9 <sup>b</sup>
Day 10	23.3 <sup>a</sup>	25.8 <sup>a</sup>




*Values in the same row with a different superscript lowercase letter are significantly different ( $p < 0.05$ ) according to a paired sample t-test comparing initial and final weights.*

# Effects of Processing and Storage on Total Cd in Oysters



*Values labeled with a different letter are significantly different ( $p < 0.05$ ) according to one-way analysis of variance (ANOVA), Tukey's test, comparing all composite samples.*

# Results Summary

Method	Observation	Implication
Washing and Jarring 	↓ [Cd] ↑ Weight (slight) ⊖ Total Cd	Cd dilution from water uptake
Jarred Storage 	↓ [Cd] ↑ Weight ↓ Total Cd	Cd dilution from water uptake and release of Cd
HPP 	Initially: ↓ [Cd] ↓ Total Cd Jarred storage: ⊖ [Cd] or Total Cd	HP-treatment causes Cd dilution by uptake of nectar and release of Cd

# Significance to Industry

*HPP, washing, and jar-packing*



35% Reduction in [Cd]

Day 0

<2 ppm

3 ppm

53% Reduction in [Cd]

Day 10

<2 ppm

4.3 ppm

# Significance to Industry

*Traditional shucking, washing, and jar-packing*



18% Reduction in [Cd]

Day 0

<2 ppm

2.4 ppm

47% Reduction in [Cd]

Day 10

<2 ppm

3.7 ppm



# Conclusions

- Results indicate that processing and storage of oysters may help to reduce Cd levels.
- Methods may be sufficient for oysters with borderline (2-4 ppm) but not high Cd levels.
- Study is not conclusive - more research should be carried out to verify these results.

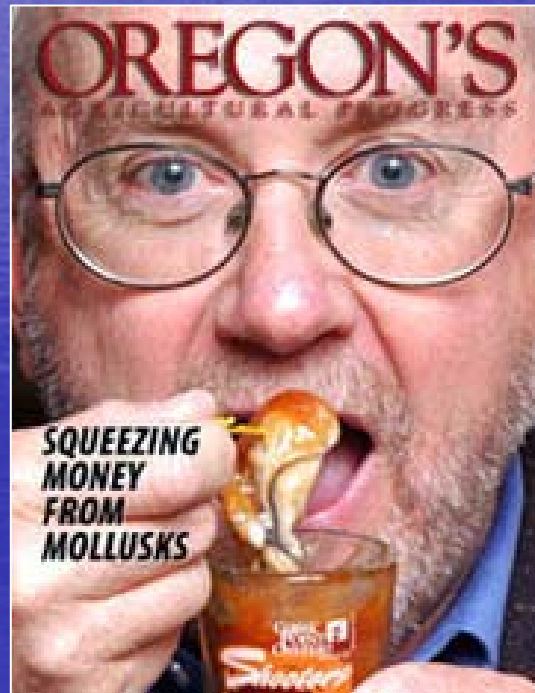
# Acknowledgements

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**Oregon State**  
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**OSU**

**Coastal Oregon Marine  
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Seafood Research and Education Center**



Dr. Morrissey says:  
"Siento no poder asistir a  
la conferencia pero sé  
que todo va a salir muy  
bien. Buena suerte,  
amigos!"



¿Preguntas?