

# Valuing Fisheries Benefits from Instream Flows Using the Hedonic Price Method

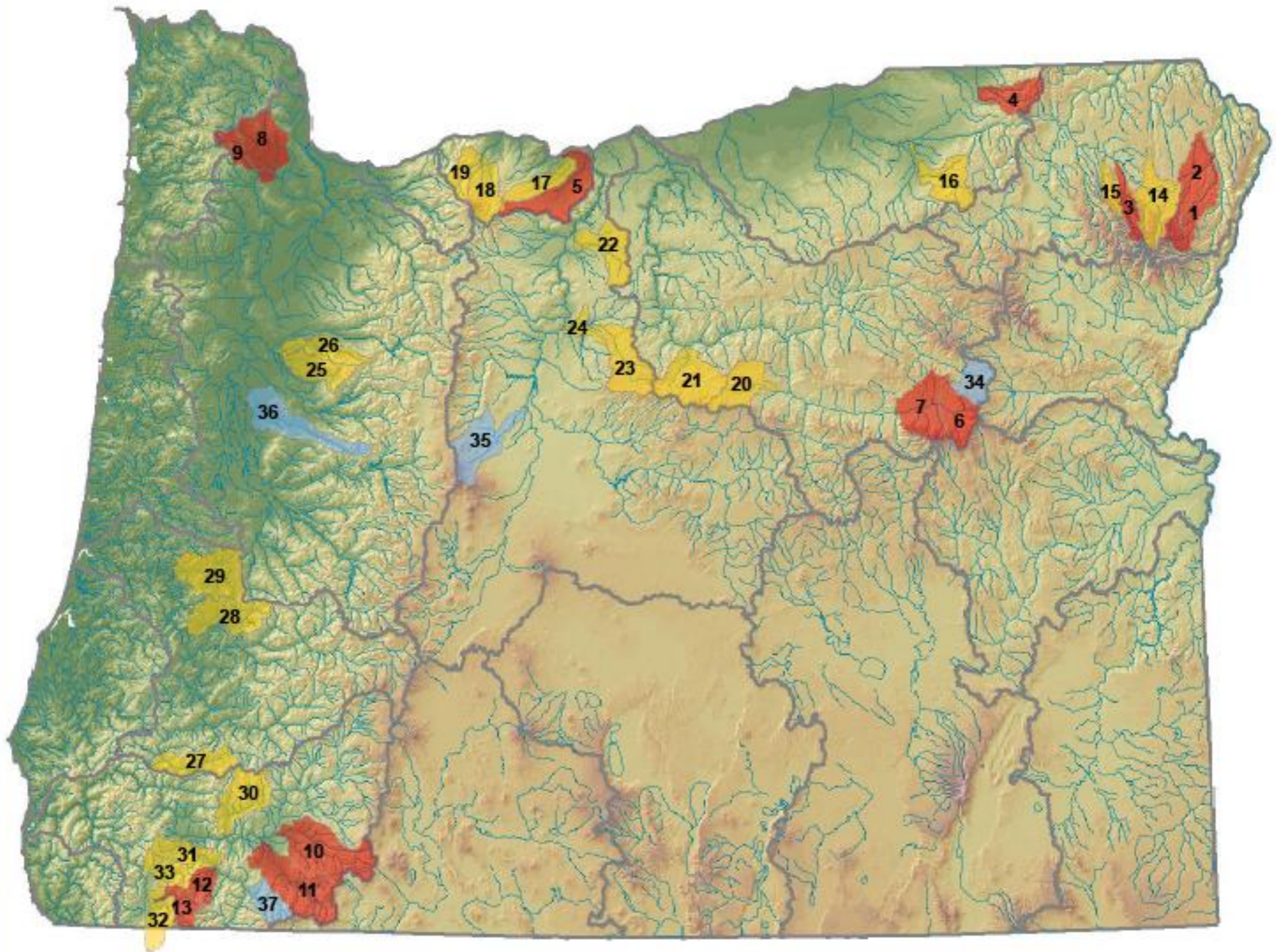
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# Motivating Questions

- Does the price paid for water rights vary by:
  - quantity of water protected?
  - transaction type?
  - if fish are anadromous or resident?
  - status of fish under the ESA?

# Oregon Water Trust

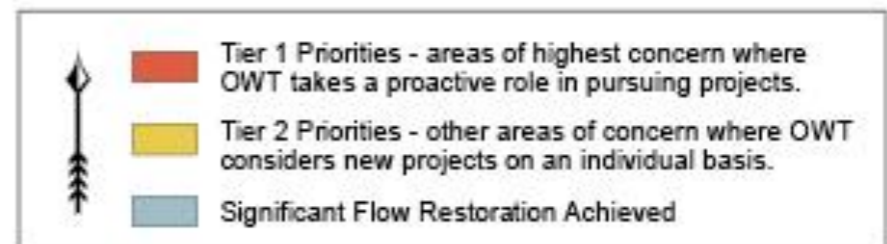
- First water trust in the United States
- Uses a scientific, market-based, cooperative approach
- Focuses on small to medium-sized flow-limited streams in basins with important fisheries
- Pioneered many flow restoration tools



**Watershed prioritization process considers where:**

- 1) flow is a significant limiting factor for salmon, steelhead and bull trout, and
- 2) opportunity for restoration exists, and
- 3) local partnerships are present.

Methodology is further defined in the OWT prioritization document.



# Deal Types: 1994-2007

| Transaction Type                   | Number of Transactions | Annualized Cost per cfs (2007 dollars) |
|------------------------------------|------------------------|--|
| <i>State Approved Transactions</i> |                        |  |
| Permanent Transfer                 | 19                     | \$1,910                                |
| Standard Lease                     | 106                    | \$5,302                                |
| Split Season Lease                 | 3                      | \$4,262                                |
| Time-Limited Transfer              | 2                      | \$5,001                                |
| Conserved Water                    | 4                      | \$6,592                                |
| <i>Contractual Agreements</i>      |                        |  |
| Forbearance Agreement              | 2                      | \$4,132                                |
| Stored Water Contract              | 2                      | \$596                                  |
| Water Use Agreement                | 13                     | \$4,693                                |
| Minimum Flow Water Use Agreement   | 2                      | \$11,638                               |

# Fish Species

| Species               | Number of Transactions Where Species is Present | Percentage of Transactions Where Species is Present |
|-----------------------|---|---|
| <i>Anadromous</i>     |   |   |
| Coho Salmon           | 73  | 48%   |
| Fall Chinook Salmon   | 60  | 39%   |
| Spring Chinook Salmon | 68  | 44%   |
| Summer Steelhead      | 101   | 66%   |
| Winter Steelhead      | 84  | 55%   |
| <i>Resident</i>       |   |   |
| Redband Trout         | 2   | 1%  |
| Bull Trout            | 38  | 25%   |

# Methodology: Hedonic Price Method

- Revealed preference approach
- The price of a good traded on a market depends on its characteristics
- Provides an estimate of an “implicit” price while holding other characteristics constant

# Hedonic Price Function

- $P_i = P(Q_i, F_i, T_i, L_i, O_i)$ 
  - $P_i$  : Annualized price paid per cfs (\$2007)
  - $Q_i$  : Amount of water protected (cfs)
  - $F_i$  : Fish presence
  - $T_i$  : Transaction type
  - $L_i$  : County/location
  - $O_i$  : Other control variables

# Application

- 153 transactions
- Dependent variable: annualized price per cfs
- Control variables remain the same across models, vary how we define the fish variable
  - .Model A: anadromous and resident species
  - .Model B: listings under the ESA

# Model A: Anadromous and Resident Fish

- Does the price paid per cfs vary if anadromous and/or resident fish are in the stream protected by the transaction?
  - Anadromous
  - Resident and anadromous
  - Resident

# Model A: Anadromous and Resident Fish

| Variable                   | Estimated Coefficient<br>(robust standard errors) |
|----------------------------|---|
| Only Anadromous Fish       | 2,764.10***<br>(902.84)                           |
| Resident & Anadromous Fish | 5,701.18**<br>(2,370.67)                          |

$R^2 = 0.68$   
Number of Observations = 153  
\*\*\* significant at 1%, \*\* significant at 5%, \*significant at 10% level  
*Note: Resident Fish is the excluded category*

# Model B: Listings under the ESA

- Does the price paid per cfs change if a listed fish species is in the stream protected by the transaction?
  - Anadromous listed
  - Anadromous not listed
  - Resident & Anadromous listed
  - Resident & Anadromous not listed
  - Resident listed
  - Resident not listed

# Model B: Listings under the ESA

- Does the price paid per cfs change if a listed fish species is in the stream protected by the transaction?
  - Anadromous listed
  - ~~Anadromous not listed~~
  - Resident & Anadromous listed
  - Resident & Anadromous not listed
  - ~~Resident listed~~
  - Resident not listed

# Model B: Listings under the ESA

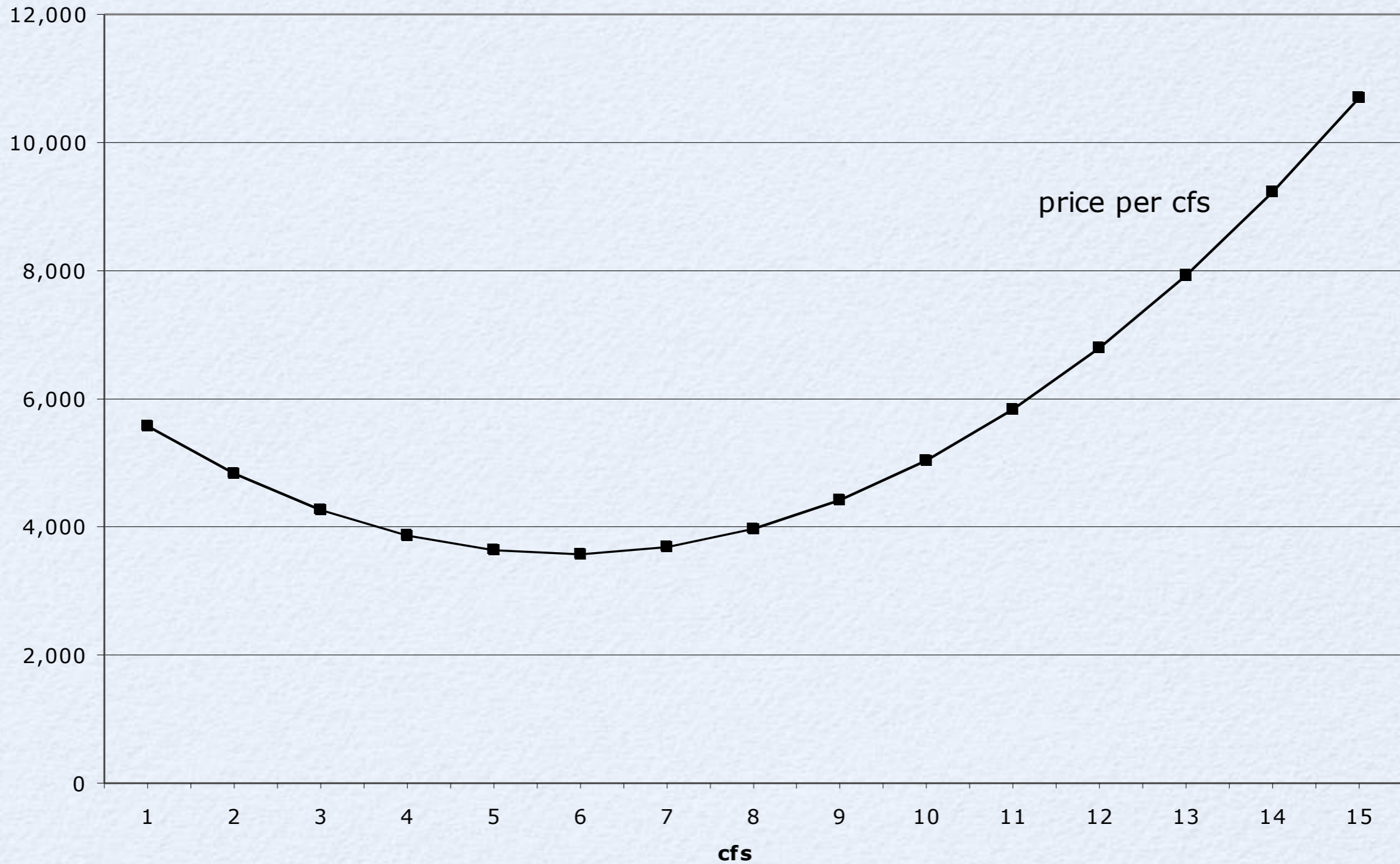
| Variable   | Estimated Coefficient<br>(robust standard errors) |
|--|---|
| Only Anadromous Fish<br>Present (at least one listed)  | 2,656.22***<br>(940.95)                           |
| Resident and Anadromous<br>Fish (at least one listed)  | 5,849.25**<br>(2,369.12)                          |
| Resident and Anadromous<br>Fish (no listed species)  | 4,841.94*<br>(2,619.20)                           |
| R <sup>2</sup> = 0.68<br>Number of Observations = 153<br>*** significant at 1%, ** significant at 5%, *significant at 10% level<br><i>Note: Resident not listed is the excluded category</i> |   |

# Control Variables: Flow

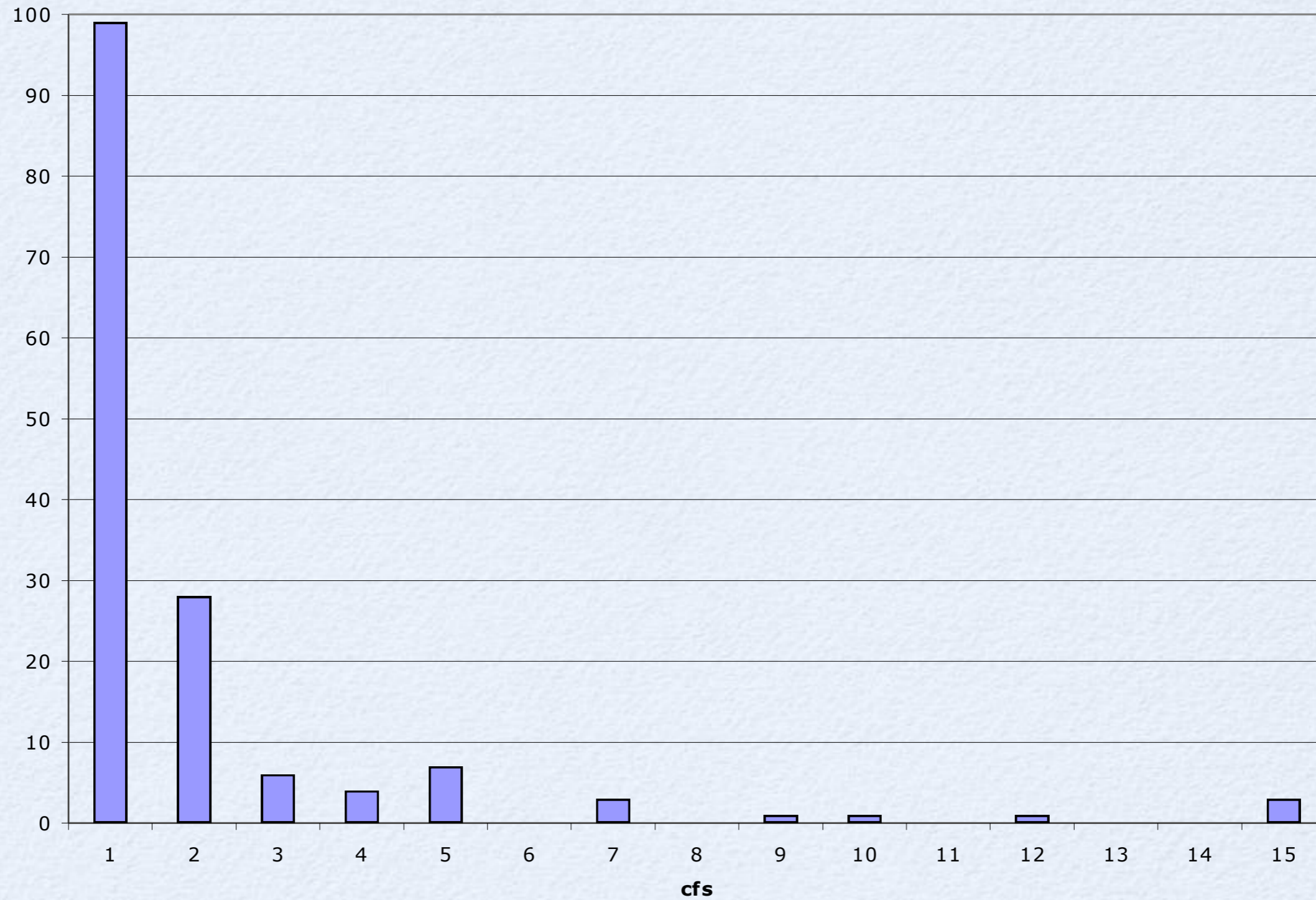
| Variable                            | Estimated Coefficient<br>(robust standard errors) |
|-------------------------------------|---|
| Total Flow in Deal                  | -996.02**<br>(426.25)                             |
| Total Flow in Deal Squared          | 85.13***<br>(32.15)                               |
| Seniority<br>(Priority Date < 1910) | -267.33<br>(481.69)                               |
| Number of Days Instream Per<br>Year | 7.63<br>(7.12)                                    |

R<sup>2</sup> = 0.68  
Number of Observations = 153  
\*\*\* significant at 1%, \*\* significant at 5%, \*significant at 10% level  
*Note: Results for Model B*

# Predicted Price Per CFS



# Number of Transactions



# Control Variables: State Approved Transactions

| Variable                | Estimated Coefficient<br>(robust standard errors) |
|-------------------------|---|
| Standard Lease          | 1,793.16<br>(1,502.72)                            |
| Split Season Lease      | 1,951.78<br>(1,633.53)                            |
| Conserved Water Project | 5,478.48**<br>(2,228.66)                          |
| Time-Limited Transfer   | 3,576.85**<br>(1,670.39)                          |

R<sup>2</sup> = 0.68  
Number of Observations = 153  
\*\*\* significant at 1%, \*\* significant at 5%, \*significant at 10% level  
*Note: Permanent Transfers is the excluded category, results for Model B*

# Controls: Contractual Transactions

| Variable                         | Estimated Coefficient<br>(robust standard errors) |
|----------------------------------|---|
| Forbearance Agreement            | 3,440.14<br>(2,145.68)                            |
| Stored Water Contract            | 6,016.82**<br>(3,002.46)                          |
| Water Use Agreement              | -338.64<br>(1,861.95)                             |
| Minimum Flow Water Use Agreement | -178.68<br>(2,132.62)                             |

R<sup>2</sup> = 0.68  
Number of Observations = 153  
\*\*\* significant at 1%, \*\* significant at 5%, \*significant at 10%  
*Note: Permanent Transfers is the excluded category, results for Model B*

# Control Variables: Other

| Variable                                 | Estimated Coefficient<br>(robust standard errors) |
|--|---|
| Oregon Water Trust<br>Priority Watershed | 1,325.22*<br>(747.57)                             |
| Year of Transaction                      | -307.38***<br>(74.60)                             |
| Deal Length ( $\leq 1$ year)             | 3,316.60**<br>(1,397.12)                          |
| Deal Length (2 to 9 years)               | 2,621.60*<br>(1,407.47)                           |

$R^2 = 0.68$

Number of Observations = 153

\*\*\* significant at 1%, \*\* significant at 5%, \*significant at 10% level

*Note: Excluded category is Deal Length  $\geq 10$  years, results for Model B*

# Conclusions

- Preliminary results
- Price per cfs varies by fish species and status under the ESA
- Major funding source is the Columbia Basin Water Transactions Program which receives its funding by Bonneville Power Administration in cooperation with the Northwest Power and Conservation Council
- Values?

# Questions?

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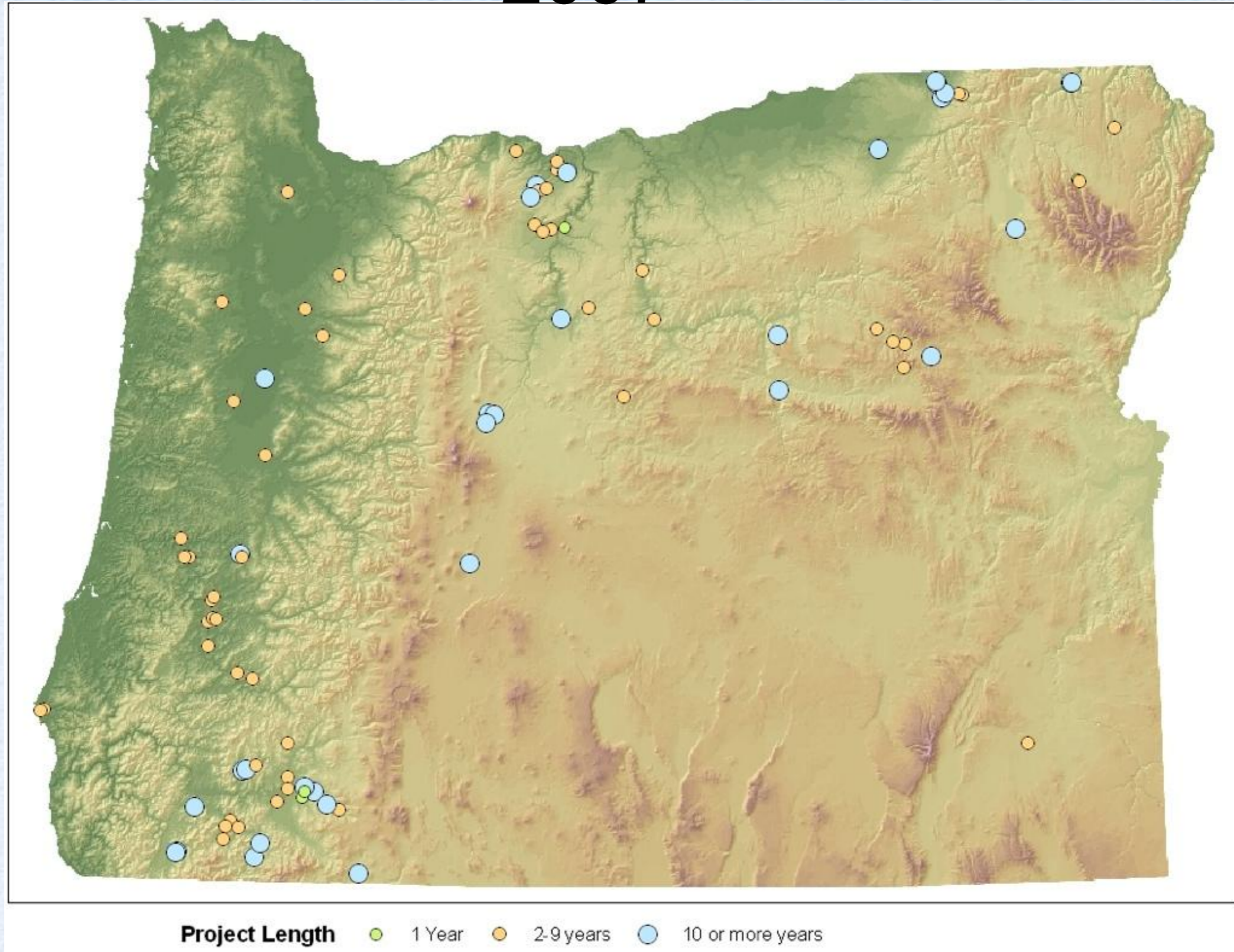
Coordinator/Project Manager: [kim@owt.org](mailto:kim@owt.org)

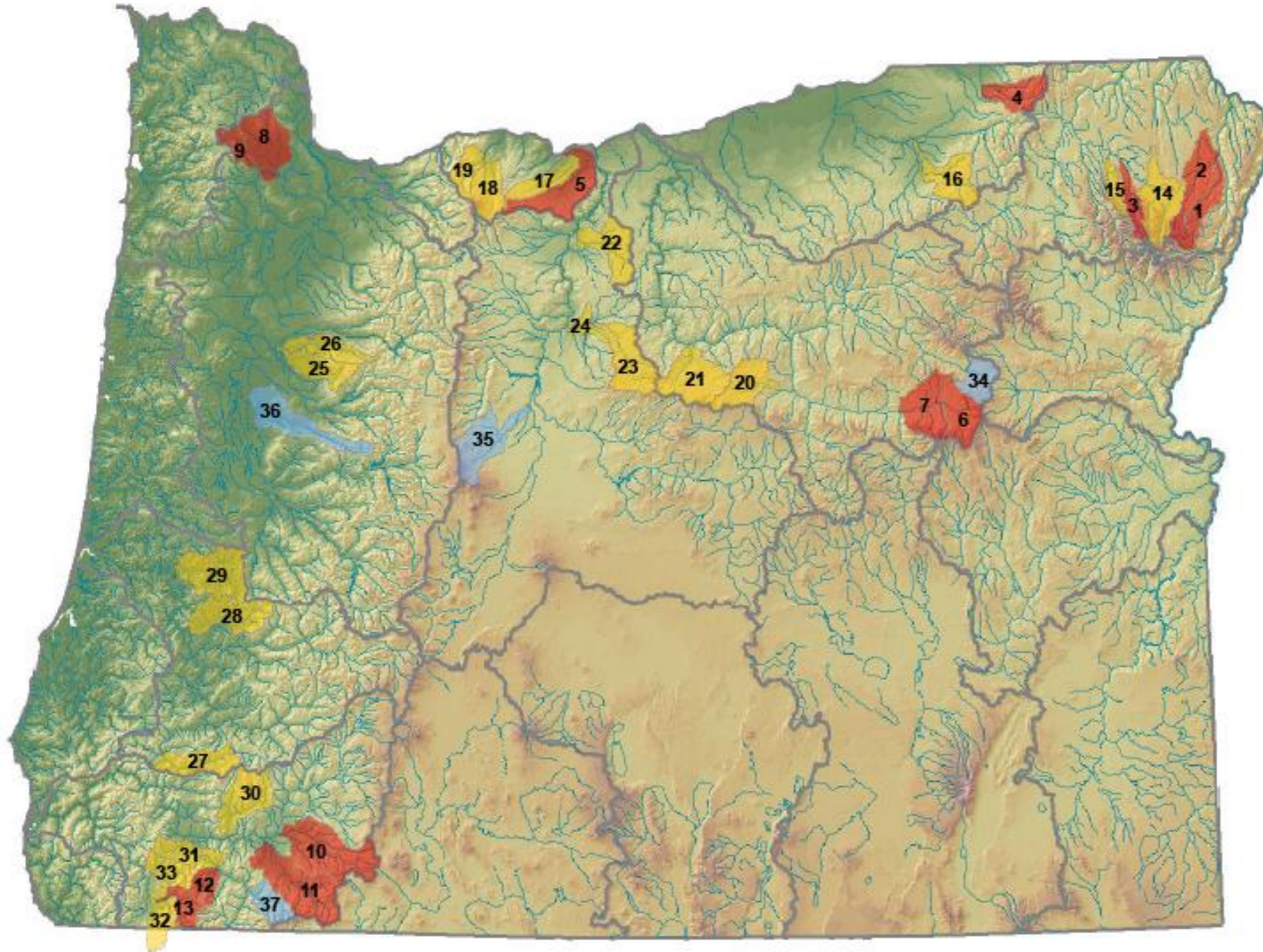
Oregon Water Trust: [www.owt.org](http://www.owt.org)



*Neal Creek Hood River, Oregon*

# Oregon Water Trust Paid Transactions: 2007





**Watershed prioritization process considers where:**

- 1) flow is a significant limiting factor for salmon, steelhead and bull trout, and
- 2) opportunity for restoration exists, and
- 3) local partnerships are present.

Methodology is further defined in the OWT prioritization document.

|  |   |
|--|---|
|  | Tier 1 Priorities - areas of highest concern where OWT takes a proactive role in pursuing projects. |
|  | Tier 2 Priorities - other areas of concern where OWT considers new projects on an individual basis. |
|  | Significant Flow Restoration Achieved   |

| Priority Watersheds              |                          |       |
|----------------------------------|--------------------------|-------|
| Number*                          | Watershed                | Score |
| <b>Tier 1</b>                    |                          |       |
| 1                                | Big Sheep Creek          | 28    |
| 2                                | Little Sheep Creek       | 28    |
| 3                                | Lostine River            | 28    |
| 4                                | Upper Walla Walla River  | 25    |
| 5                                | Fifteenmile Creek        | 24    |
| 8                                | Upper John Day River     | 27.5  |
| 7                                | Strawberry Creek         | 28    |
| 8                                | Dairy Creek              | 24    |
| 9                                | Gales Creek              | 24    |
| 10                               | Little Butte Creek       | 24.5  |
| 11                               | Bear Creek               | 23    |
| 12                               | Williams Creek           | 24.5  |
| 13                               | Sucker Creek             | 24.5  |
| <b>Tier 2</b>                    |                          |       |
| 14                               | Upper Wallowa River      | 28    |
| 15                               | Bear Creek               | 28    |
| 18                               | Mckay Creek              | 25    |
| 17                               | Fivemile Creek           | 25.5  |
| 18                               | East Fork Hood River     | 25    |
| 19                               | West Fork Hood River     | 25    |
| 20                               | Mountain Creek           | 24    |
| 21                               | Bridge Creek             | 24    |
| 22                               | Buck Hollow Creek        | 24.5  |
| 23                               | Upper Trout Creek        | 24.5  |
| 24                               | Lower Trout Creek        | 24.5  |
| 25                               | Crabtree Creek           | 25.5  |
| 28                               | Thomas Creek             | 25.5  |
| 27                               | Middle Cow Creek         | 24.5  |
| 28                               | Calapooya Creek          | 23    |
| 29                               | Elk Creek                | 23    |
| 30                               | Evans Creek              | 24.5  |
| 31                               | Lower Applegate River    | 24.5  |
| 32                               | East Fork Illinois River | 24.5  |
| 33                               | Deer Creek               | 23    |
| <b>Significant Flow Restored</b> |                          |       |
| 34                               | Upper MF John Day River  | 28    |
| 35                               | Wychuss Creek            | 22    |
| 38                               | Calapooia River          | 24    |
| 37                               | Little Applegate River   | 24.5  |

\*This numbering system does not imply ranking of watersheds