# Effectiveness Monitoring of Brownsville Dam Removal

http://home.netcom.com/~horse/digitarium.html

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# http://rivers.bee.oregonstate.edu/index.html

# project objectives

- Analyze and propose dam removal monitoring guidance – environmental “experiment designs”
- Document extent, magnitude, and drivers of changes in Calapooia with dam removal
- Provide foundation for long-term projections in Calapooia

## change detection and small dam removal

- lack of effect or lack of effective methods?
- Statistical significance - do means mean anything? - Testing hypotheses about probabilities and predictability of geomorphic and biological responses
- Ecological significance – using reliable biotic and abiotic indicators (e.g. responsiveness to disturbance/restoration, feasibility of measurement)

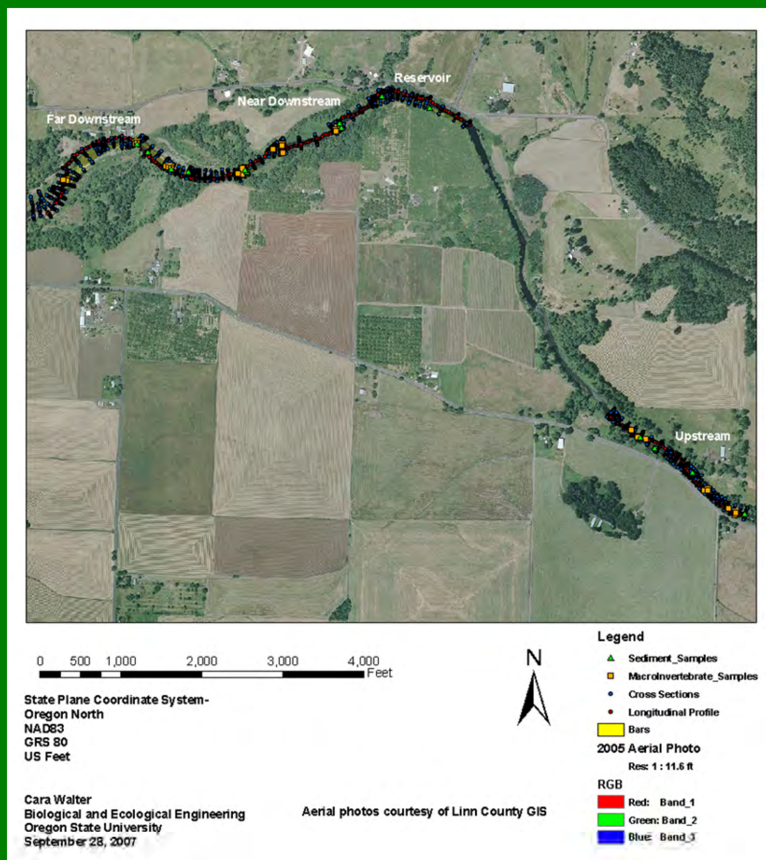
# dam removal as environmental experiments

Advantages
- broad scale trend development
- validation of conceptual and numerical models
- identification of dominant processes and scales
- real-world examples and observations

Disadvantages
- uncontrolled – challenges in hypothesis testing
- spatial and time frames for expectations and recovery are unpredictable
- risk – of wasting money, damaging infrastructure, being wrong…

# study layout

- Upstream
- Reservoir
- Downstream1
- Downstream 2



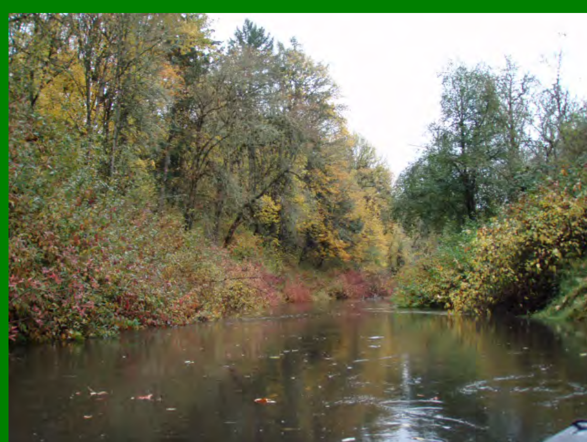
# beyond a black BACI box

- BACI – Before-After-Control-Impact
- problems with BACI for environmental experiments
  - US/DS not independent
  - short/absent pre-removal
  - highly background variability
  - unspecific indicators
  - Insufficient sampling

# ecological significance – understanding the links



field observations numerical models physical models



# the (un)usual suspects

- physical
  - substrate size distribution – bulk samples, pebble counts
  - discharge – historical record extension and gaging
  - bedload and suspended sediment discharge
  - channel geometry, facies/features –total station

- biological
  - coarse vegetation (ODFW)
  - benthic macroinverts (modified EMAP)
  - habitat quality (ODFW)

- socio-economic

## the unusual suspects –
## evidence from invertebrate traits

<u>Hydrologic disturbance</u>

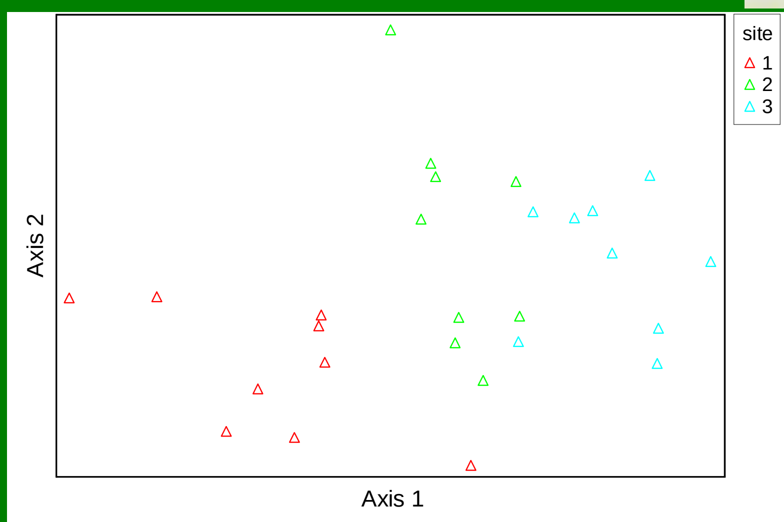
- Reproductive cycle
- Lifespan
- Body size
- Body shape
- Dispersal

<u>restoration disturbance</u>

- Reproductive cycle
- Lifespan
- Development rate
- Adult ability to exit
- Drift
- Habitat and trophic preferences

Tullos et al. (2008)

# pre-removal invert traits




Site 3 - upstream control,

Site 2 - immediately downstream of the dam removal

Site 1 - farthest downstream reach.

pre-removal habitat

relative to watershed?

relative to Willamette Valley?

**OREGON DEPARTMENT OF FISH AND WILDLIFE** **Calapooia**

**HABITAT INVENTORY** Report Date: 2/12/2008 Survey Date: 8/10/2007

**REACH** **T14S-R02W-S04NW** **REACH**

**HABITAT DETAIL**

| Habitat Type | Number Units | Total Length (m) | Avg Width (m) | Avg Depth (m) | Total Area ($m^2$) | Large Boulders (#>0.5m) | | Substrate Percent Wetted Area S/O | Snd | Grvl | Cbl | Bldr | Bdrk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GLIDE | 4 | | | 0.35 | | 3 | | 5 | 1 | 51 | 43 | 0 | 0 |
| POOL-LATERAL SCOUR | 4 | | | 2.53 | | 20 | | 15 | 10 | 35 | 24 | 3 | 13 |
| RIFFLE | 2 | | | 0.15 | | 0 | | 5 | 0 | 46 | 49 | 0 | 0 |
| RIFFLE W/POCKETS | 1 | | | [illegible] | | 5 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| **Total:** | 11 | | | 1.08 | | 28 | **Avg:** | 9 | 4 | 44 | 37 | 1 | 5 |

**OREGON DEPARTMENT OF FISH AND WILDLIFE** **Calapooia**

**HABITAT INVENTORY** Report Date: 2/12/2008 Survey Date: 8/13/2007

**REACH** **T14S-R02W-S04NE** **REACH**

**HABITAT DETAIL**

| Habitat Type | Number Units | Total Length (m) | Avg Width (m) | Avg Depth (m) | Total Area ($m^2$) | Large Boulders (#>0.5m) | | Substrate Percent Wetted Area S/O | Snd | Grvl | Cbl | Bldr | Bdrk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GLIDE | 2 | | | 0.45 | | 0 | | 18 | 10 | 38 | 25 | 0 | 10 |
| POOL-LATERAL SCOUR | 2 | | | 1.77 | | 0 | | 20 | 9 | 30 | 38 | 0 | 4 |
| RIFFLE | 1 | | | 0.24 | | 0 | | 10 | 5 | 30 | 55 | 0 | 0 |
| **Total:** | 5 | | | 0.95 | | 0 | **Avg:** | 17 | 9 | 33 | 36 | 0 | 5 |

**OREGON DEPARTMENT OF FISH AND WILDLIFE** **Calapooia**

**HABITAT INVENTORY** Report Date: 2/12/2008 Survey Date: 8/10/2007

**REACH** **T14S-R02W-S03SW** **REACH**

**HABITAT DETAIL**

| Habitat Type | Number Units | Total Length (m) | Avg Width (m) | Avg Depth (m) | Total Area ($m^2$) | Large Boulders (#>0.5m) | | Substrate Percent Wetted Area S/O | Snd | Grvl | Cbl | Bldr | Bdrk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GLIDE | 5 | | | 0.31 | | 0 | | 1 | 0 | 62 | 32 | 0 | 5 |
| POOL-LATERAL SCOUR | 3 | | | 1.31 | | 0 | | 5 | 0 | 58 | 31 | 0 | 7 |
| RIFFLE | 2 | | | 0.19 | | 0 | | 0 | 0 | 53 | 35 | 0 | 13 |
| RIFFLE W/POCKETS | 1 | | | 0.15 | | 1 | | 5 | 0 | 40 | 40 | 0 | 15 |
| **Total:** | 11 | | | 0.55 | | 1 | **Avg:** | 2 | 0 | 57 | 33 | 0 | 8 |

# analysis of methods and responses - sediment sampling

**2007 Bulk Samples Summary Table**

| | | D50 | | D84 | | D16 | | D16/D84 | |
|---|---|---|---|---|---|---|---|---|---|
| Reach Name | Site Name | subsurface | surface | subsurface | surface | subsurface | surface | subsurface | surface |
| Upstream Bars | DS Bar | 32 | 27 | 51 | 79 | 7 | 3.4 | 7.3 | 23.2 |
| | US Bar | 7 | 9 | 102 | 94 | 1.9 | 2.8 | 53.7 | 33.6 |
| Upstream Riffles | RI 1 | 24 | 22 | 63 | [illegible] | 3.3 | 3.3 | 19.1 | 30.3 |
| | RI 3 | 30 | 40 | 70 | 100 | 2 | 5 | 35.0 | 20.0 |
| Reservoir Bars | RI 1 | 50 | 100 | 80 | 107 | 19 | 39 | 4.2 | 2.7 |
| | RI 3 | 7.2 | 13 | 40 | 43 | 1.6 | 1.7 | 25.0 | 25.3 |
| Reservoir Excavator | 0-2 feet | 100 | - | 103 | - | 65 | - | 1.6 | - |
| | 2-4 feet | 59 | - | 102 | - | 19 | - | 5.4 | - |
| | 3-6 feet | 59 | - | 99 | - | 32 | - | 3.1 | - |
| | 8-9 feet | | | | | | | | |
| Downstream 1 Bars | DS | 26 | 24 | 100 | 75 | 1.7 | 1.8 | 58.8 | 41.7 |
| | US | 7.1 | 5.7 | 34 | 70 | 2.7 | 1 | 12.6 | 70.0 |
| Downstream 1 Riffles | RI 1 | 21 | 28 | 71 | 101 | 3 | 3.5 | 23.7 | 28.9 |
| | RI 3 | 24 | 23 | 58 | 73 | 4.5 | 5 | 12.9 | 14.6 |
| Downstream 2 Bars | DS | 30 | 26 | 52 | 57 | 6.5 | 1.4 | 8.0 | 40.7 |
| | US | 33 | 26 | 87 | 72 | 4.5 | 3.7 | 19.3 | 19.5 |
| Downstream 2 Riffles | DS R1 | 29 | 24 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | UP R3 | 35 | 67 | 58 | 104 | 8.3 | 38 | 7.0 | 2.7 |

# Informing removal outcomes - sediment transport

<u>Uncertainty and accuracy</u>

- predictive equations
- evacuation rates
- fate of stored sediment

# Hydrology of the Calapooia

Kelly Kibler

PhD – Water Resources Engineering

# Gauging the Calapooia at Brownsville:
## River Discharge (Q)

- What is Q?
  - measure of the volume of water that flows past a given point in the river per unit of time
  - units- cubic feet per second (cfs)
- Why measure Q?
  - aquatic habitat
  - sediment transport

# Brownsville Gauging Station

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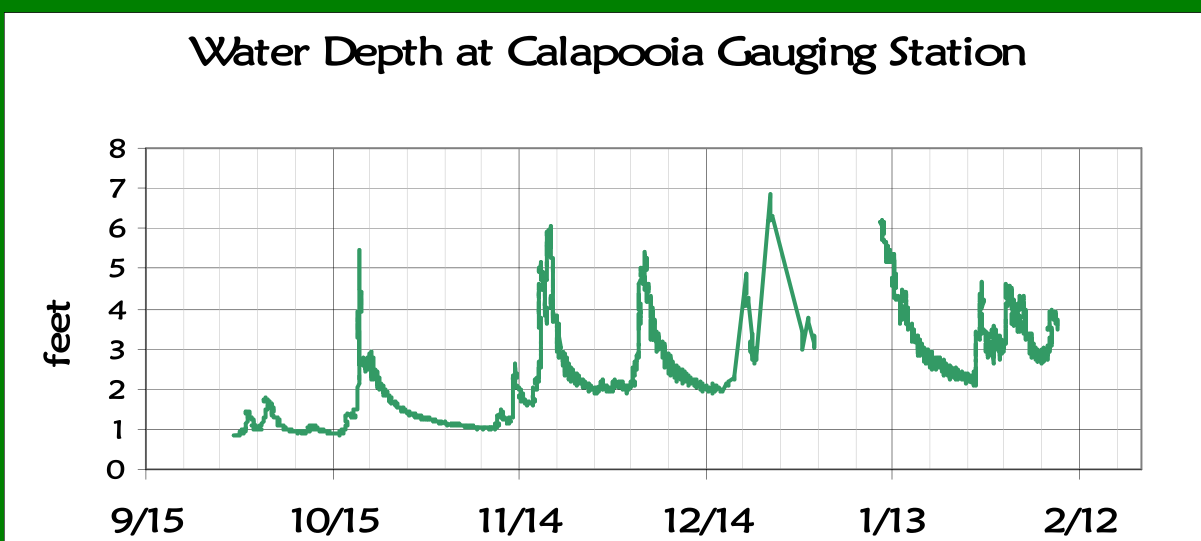
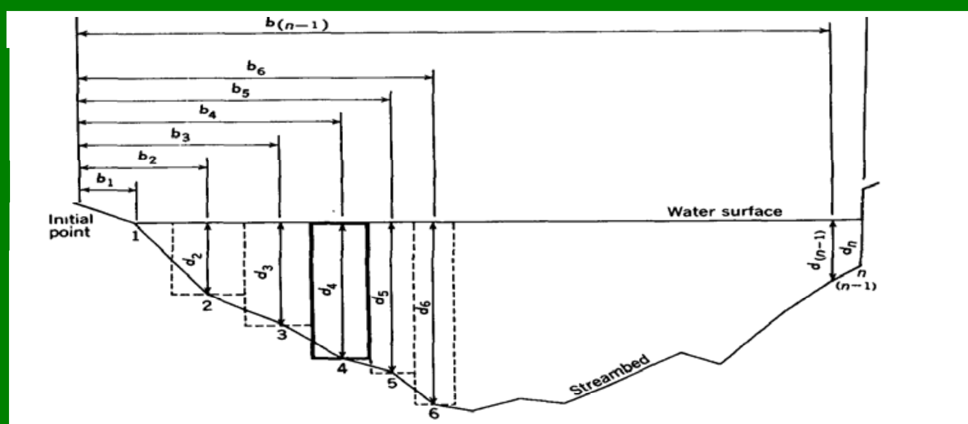
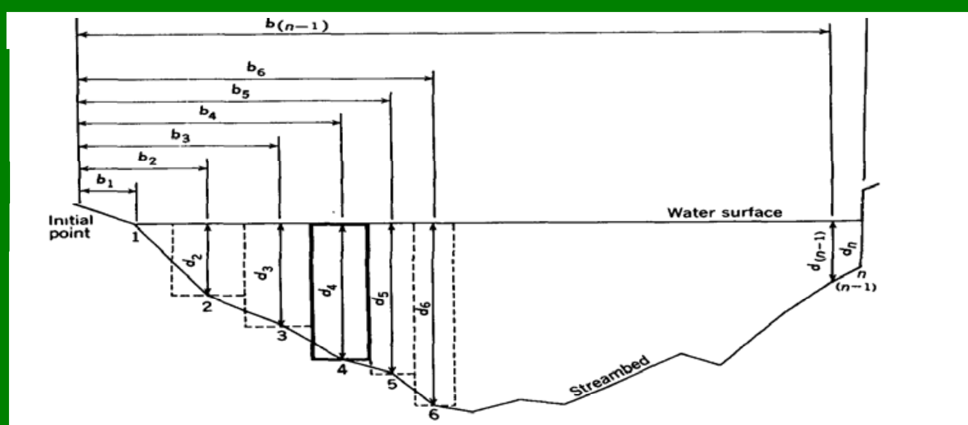


# USGS Mid-section method



# USGS Mid-section method




Area X velocity = Q

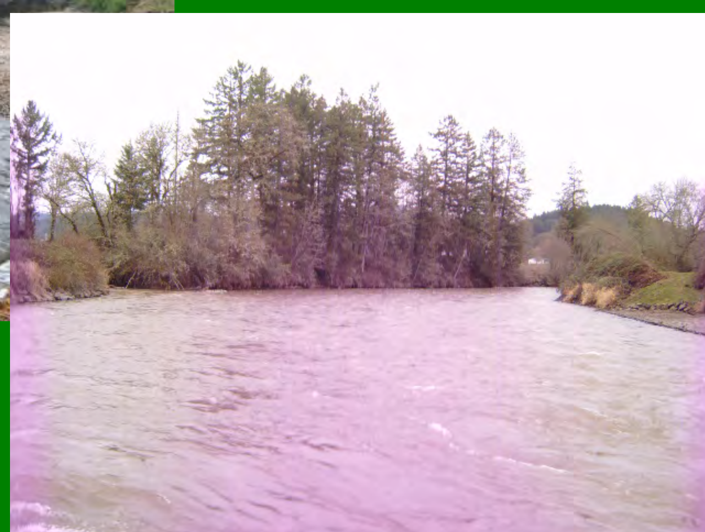
feet$^2$ X ft/second = cfs

$\sum$Qsection =Qriver

# Calapooia at low Q

Easy to wade

Calapooia at high Q- <u>unsafe</u> <u>to wade</u>



# Calapooia at high Q-

unsafe to wade-
but we can use the bridge.

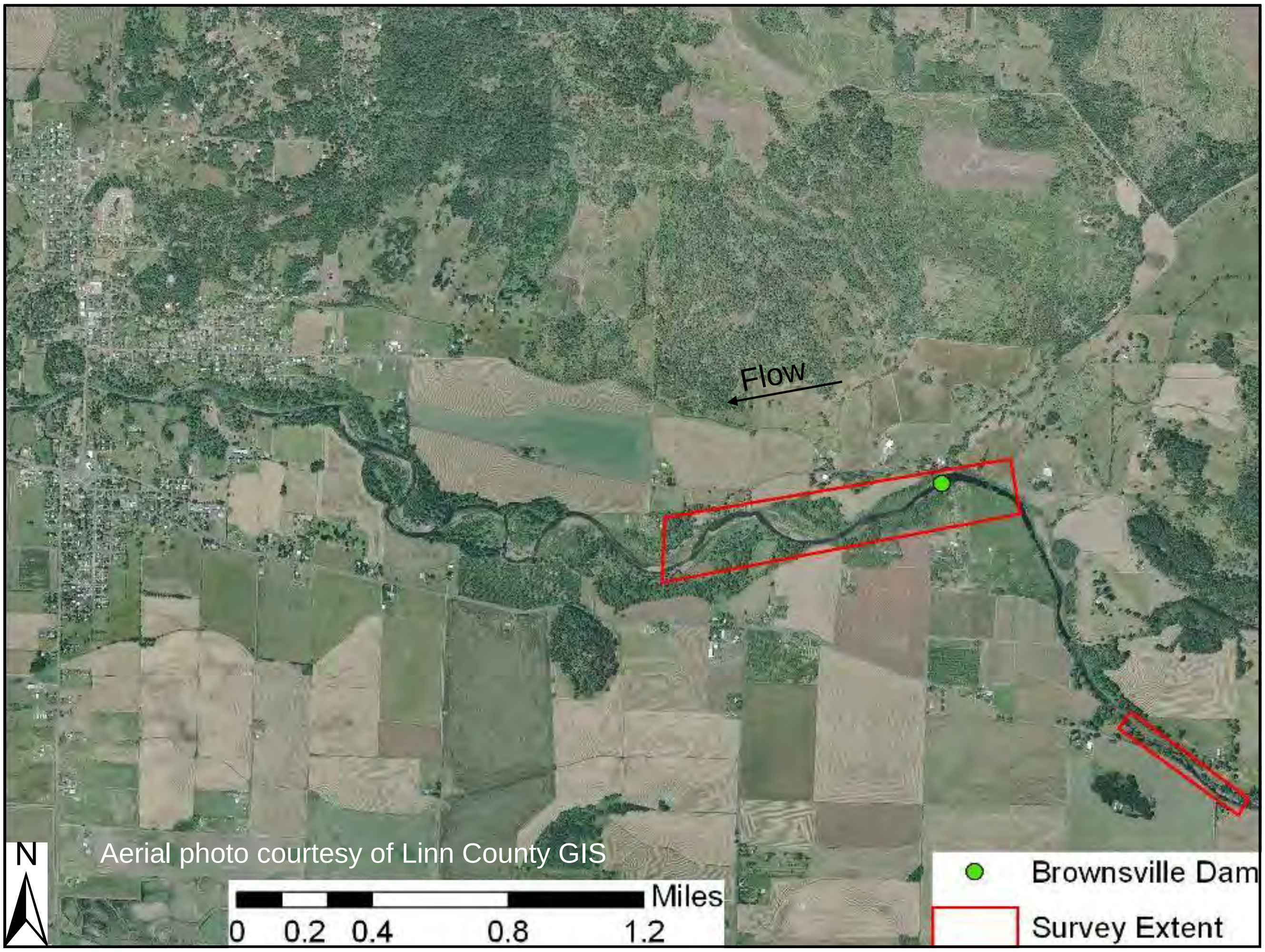
# Bridge gauging equipment

# Bridge gauging equipment

Our plan:
measure Q
once a week

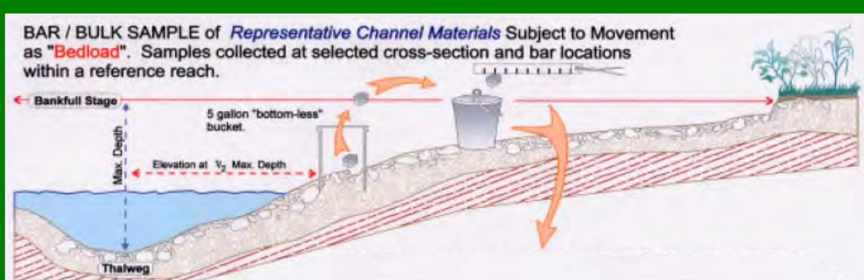
## Historical and post-removal channel change

Cara Walter
MS – Water Resources Engineering



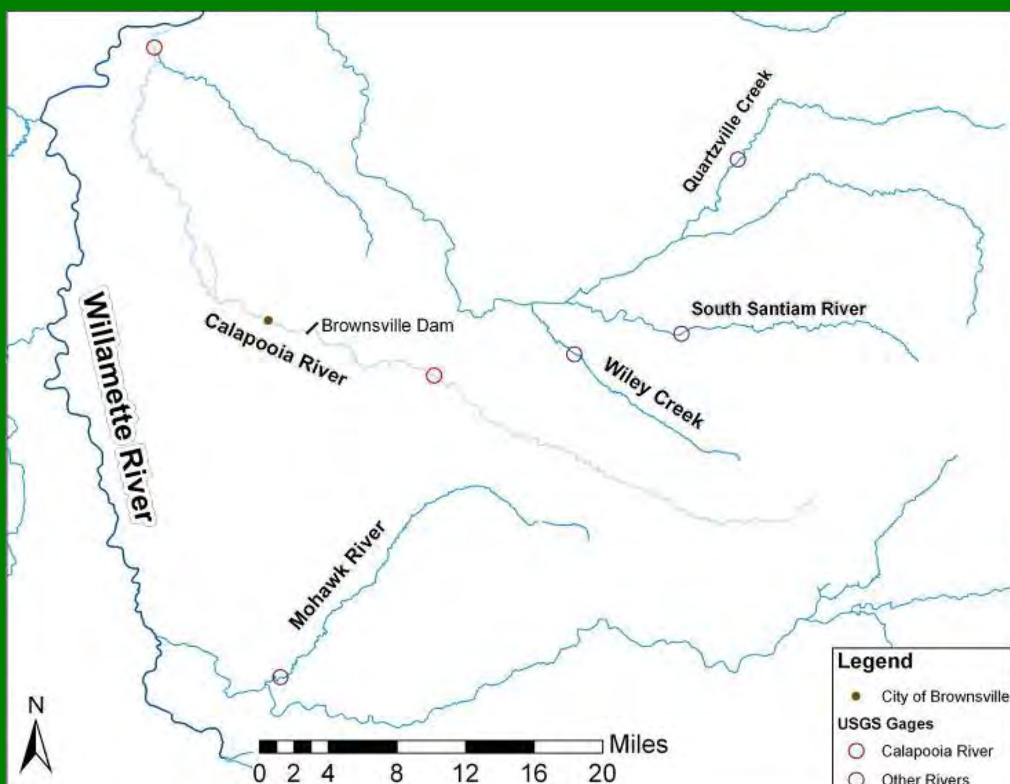
Flow
N
Aerial photo courtesy of Linn County GIS
Miles
0
0.2
0.4
0.8
1.2
Brownsville Dam
Survey Extent

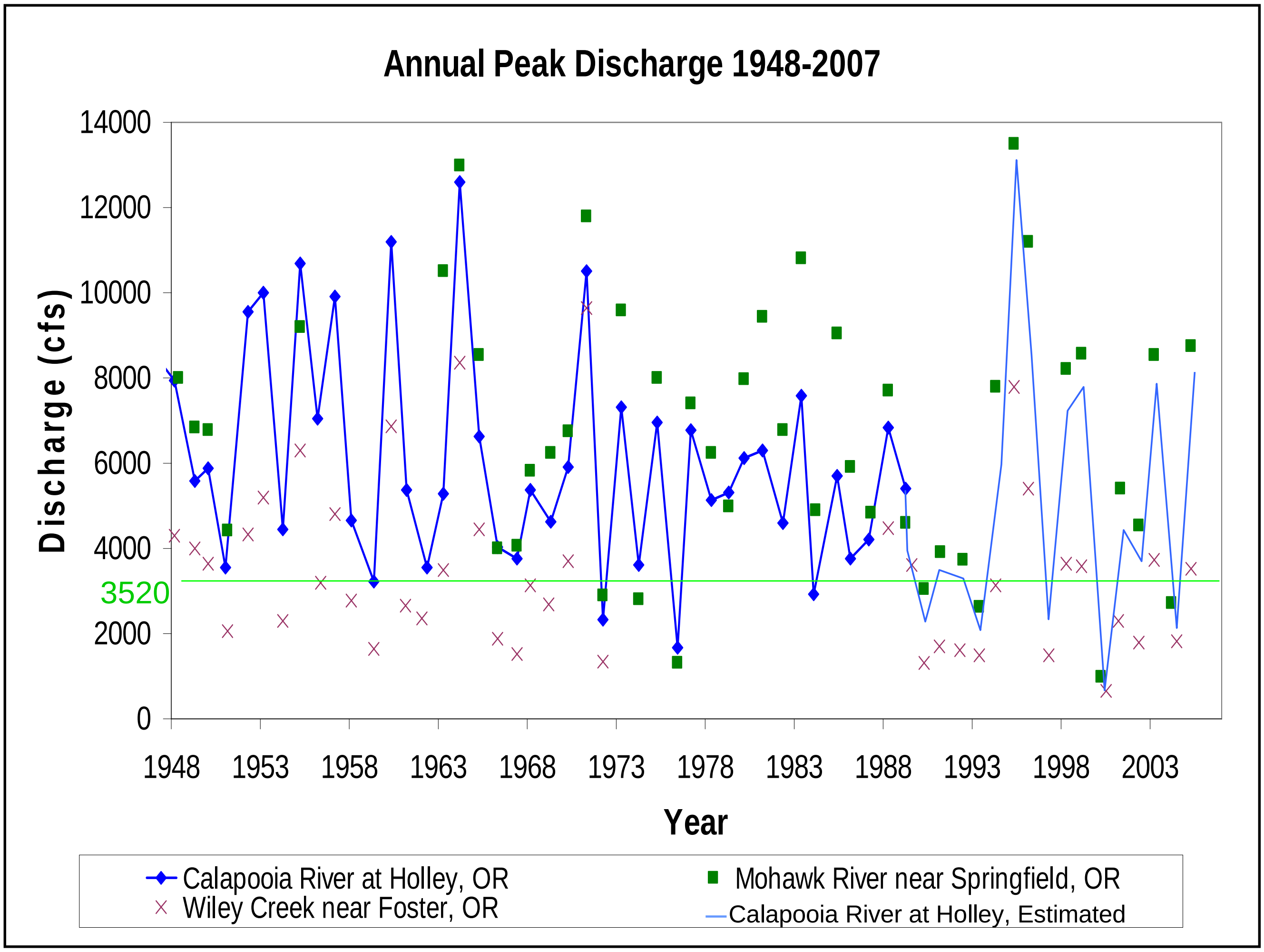
# Field Measurements



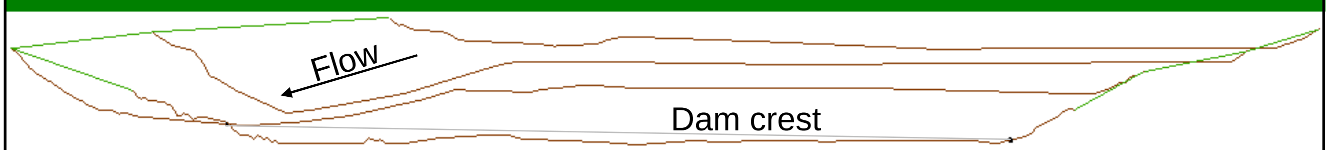

N
Aerial photo courtesy of Linn County GIS
0 500 1,000 2,000 3,000 4,000
Feet
Sediment_Samples
Survey Points

# Discharge Comparison




Annual Peak Discharge 1948-2007
Discharge (cfs)
14000
12000
10000
8000
6000
4000
3520
2000
0
1948
1953
1958
1963
1968
1973
1978
1983
1988
1993
1998
2003
Year
Calapooia River at Holley, OR
Mohawk River near Springfield, OR
Wiley Creek near Foster, OR
Calapooia River at Holley, Estimated

# Reservoir Channel Changes

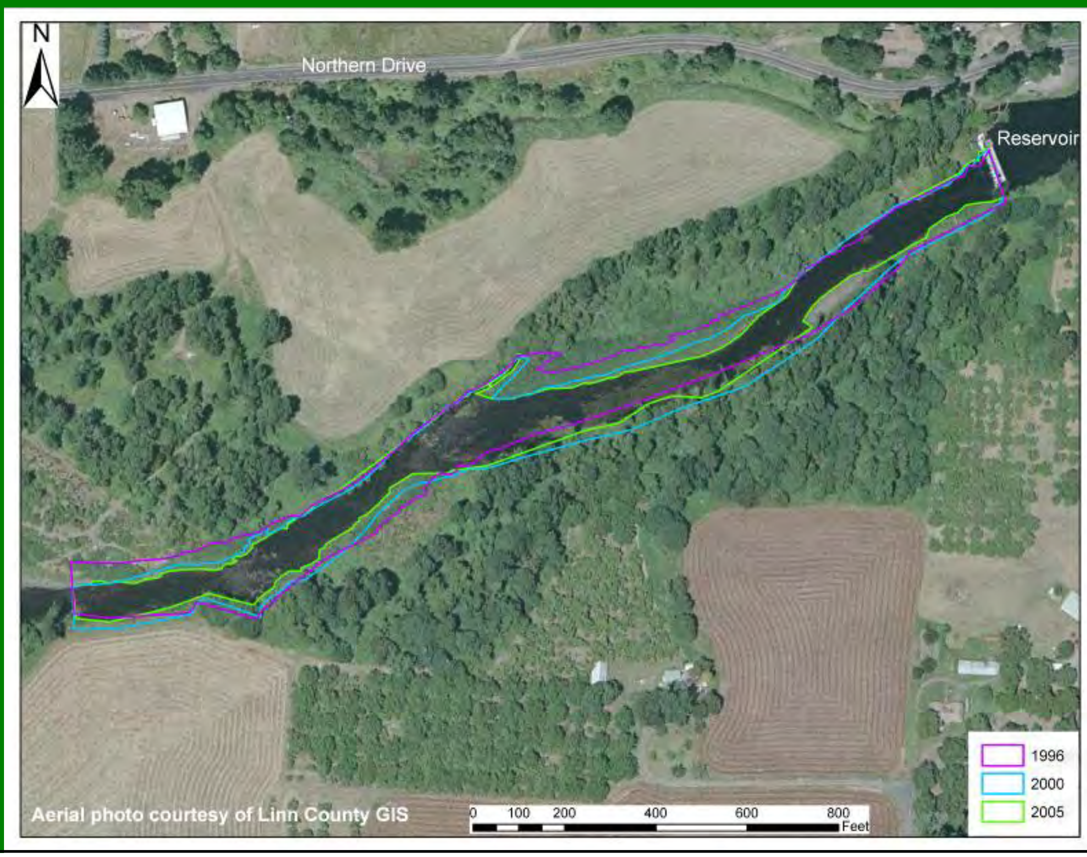

11-07-2007


12-12-2007

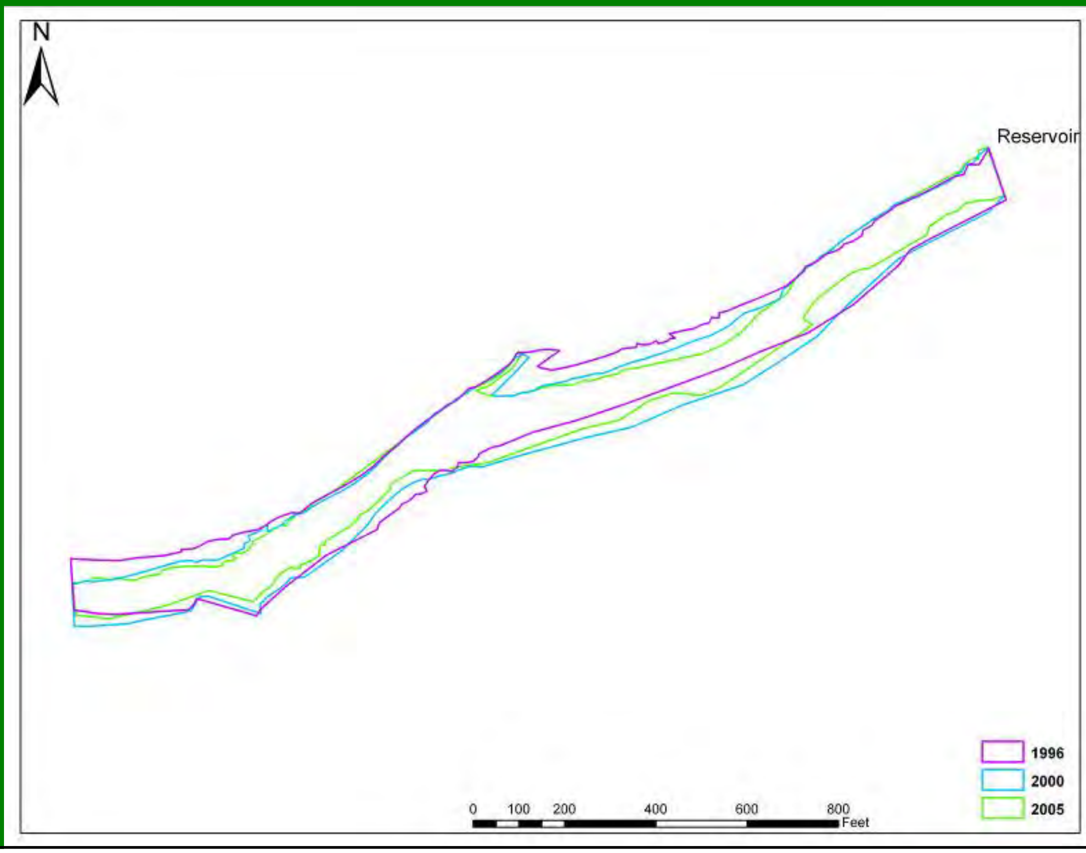

1-11-2008


2-08-2008

# Downstream Channel Changes



# Downstream Channel Changes




10-08-2007


10-08-2007


11-07-2007


2-08-2008

# Socio-economic Impacts of Removal

Denise Elston

MS – Water Resources Science and Policy

# Why Brownsville?

- It is one of the first in the nation under the National Oceanic and Atmospheric Administration's new Open Rivers Initiative (ORI)
- Partnerships, working together for healthy streams and community benefits
- Establishes monitoring and provides an opportunity to look at the whole story over a longer period of time

## What Makes This Study Important

- Currently, no comprehensive social impact analysis on small dam removal
- The opportunity to design a “template” for other removals
- Learn what makes successful community participation in future dam removals

# What is a Social Impact Analysis (SIA)?

- It is "the process of analyzing, monitoring, and managing the intended and unintended consequences, both positive and negative, of planned interventions"

(International Association for Impact Assessment pamphlet, 2006)

## Components of Analysis

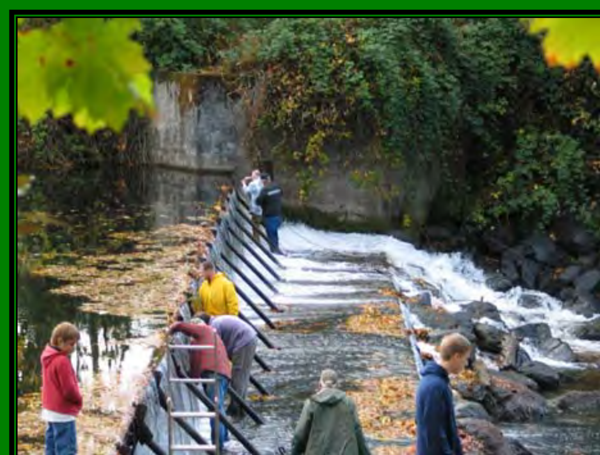
- Develop a baseline
- Identify appropriate social indicators
- Identify appropriate economic indicators
- Operationalize (measure) the indicators
- Ensure methods and assumptions are transparent and replicable

# What are Indicators?

- Variables which are considered in a study to provide information that could be used to determine social impacts that might exist in a particular community.
- A measure of the well-being of society and of its citizen

# Potential Impacts of Dam Removal

- Health and Social Well-being
- Quality of the Living Environment
- Economic and Material Well-being
- Cultural Effects
- Family and Community
- Institutional, Legal, Political, and Equality



# Impacts and Indicators

| Health and Social Well-Being Impacts | Quality of the Living Environment (Livability) Impacts | Economic Impacts and Material Well-Being Impacts | Cultural Impacts | Family and Community Impacts | Institutional, Legal, Political, and Equity Impacts |
|---|---|---|---|---|---|
| Uncertainty -being unsure of the effects or meaning of dam removal | Leisure and recreational activities and opportunities | Standard/Cost of living | Cultural integrity-degree to which local culture is respected and likely to persist | Changes in social networks | Participation in decision-making |
| Feeling about the removal that may result in formation of interest groups | Perceived and actual quality of the living environment | Property values-real estate sales | Experience of being culturally marginalized-e.g., structural exclusion of certain groups | Changes in demographic structure of the community | Changes in land ownership, tenure, or legal rights |
| Annoyance -experiences due to disruption of life | Aesthetic qualities | Replacement costs of environmental services | Loss of cultural or natural heritage- areas of recreational value | Community identification and connection-sense of belonging, attachment to place | Impact equity-distribution of social and economic impacts across the community |
| Dissatisfaction -due to failure of removal to deliver promised benefits | Perception of personal safety, hazard exposure, and fear of crime | Occupational status and type of employment-temporary local jobs generated by the project | Change in cultural traditions | Perceived and actual community cohesion | Access to and utilization of legal procedures and advice throughout project |
| (Location for) delinquent behavior | | Access to public goods/services | | Social differentiation and inequality-creation of perceived or actual differences between groups | |
| | | | | Changes in social tension-conflict within the community | |

**Impact: Economic and Material Well-Being**

**Indicators: Property values; real estate sales**

**Example Measurement: Changes in housing prices; changes in numbers of day house on market before sale**

**Impact: Health and Social Well-Being**

**Indicator: Uncertainty; being unsure of the effects or meaning of dam removal**

**Example Measurement: Change in knowledge about dam removal**

**Impact: Quality of the Living Environment (Livability)**

**Indicator: Leisure and recreational activities and opportunities**

**Example: Measurement: Changes in angling types and rates**

**Impact: Cultural Effects**

**Indicator: Cultural practices and traditions**

**Example Measurement: Changes in location of community activities**

**Impact: Family and Community**

**Indicator: Social tension and/or conflict within the community**

**Example Measurement: Changes in number of disagreements in public meetings**

**Impact: Institutional, Legal, Political, and Equity**

**Indicator: Participation in decision-making**

**Example Measurement: Changes in meeting attendance**

# What Happens Next