River Restoration:
Lessons learned around the U.S.

Martin J. Melchior
Regional Director
inter·fluve

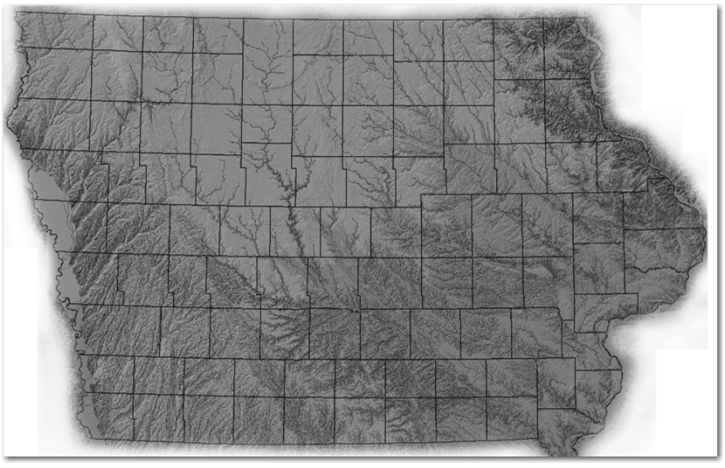
Presentation Outline

- Why do river restoration?
- River restoration possibilities
- Summary of state programs
- Prioritization and project implementation

WHY DO RIVER RESTORATION?

IMPACTS TO RIVERS

- What's wrong with our rivers that we should need to consider fixing them?



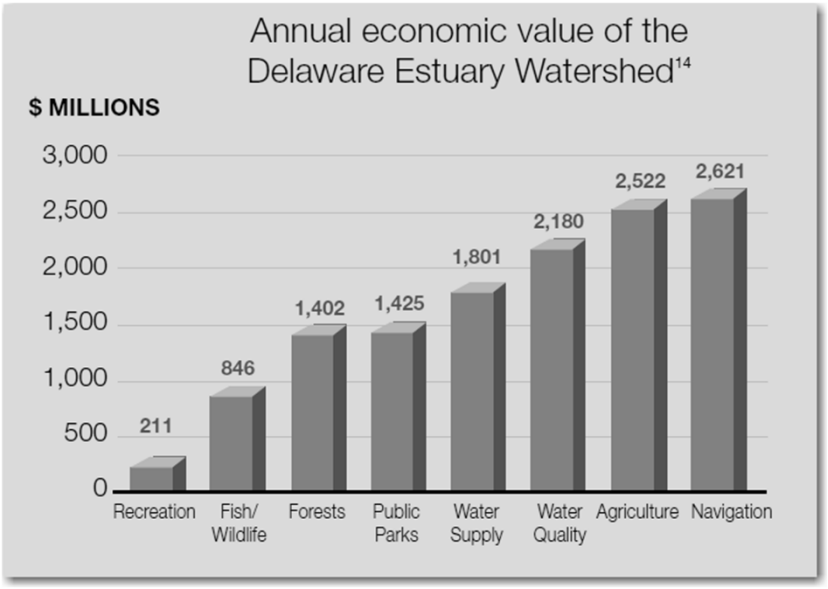
IMPACTS TO RIVERS

- In the Midwest, these are the most common impacts to river systems:
  - Ditching (straightening)
  - Dams
  - Urbanization (increased runoff/pollution)
  - Agriculture (increased runoff/pollution)
  - Forestry (increased runoff/pollution)
  - Artificial/hard armor bed and bank treatments
  - Floodplain encroachment (filling)
  - Cleaning/wood removal
  - Dredging

IMPACTS TO RIVERS

- These courses of action have resulted in:
  - Chemical pollution
  - Nutrient pollution
  - Erosion – sediment load problems
  - Extinction rates 5x that of terrestrial vertebrates
  - 1/3 of rivers listed as impaired or polluted
  - Withdrawls so extreme that rivers run dry
  - Increased flooding

THE ECONOMIC VALUE OF RIVERS



THE ECONOMIC VALUE OF RIVERS - TOURISM

- Tourism is the 3rd largest industry in WI ($13 Billion/yr) behind agriculture and timber
- Tourism is largely associated directly with rivers and lakes
- WI has the 2nd highest number of Out-Of-State Angler Days (behind FL)


Great Iowa River Canoe and Kayak Race

THE ECONOMIC VALUE OF RIVERS - LAND

- Soil loss = lost $$
- Nutrient loss = lost $$
- Increase flooding = $$$$

THE ECONOMIC VALUE OF RIVERS - LAND

- Dam removal increases land values (UW study)
- *Example* – West Bend, WI Riverside Park

THE ECONOMIC VALUE OF RIVERS - JOBS

- Restoration jobs provide a high ratio of jobs created versus money spent
- *Massachusetts* - $1 million of public investment in clean water and habitat restoration creates 12.5 full time jobs

Road construction = 7 jobs/$1M

Military spending = 8 jobs/$1M

THE ECONOMIC VALUE OF RIVERS - JOBS

- *Oregon* - $1 million of public investment creates 15-24 total jobs (Univ. of OR)
- Oregon projects from 2001 to 2010 and found the projects generated an estimated 6,483 jobs and nearly a billion dollars in economic output around the state.

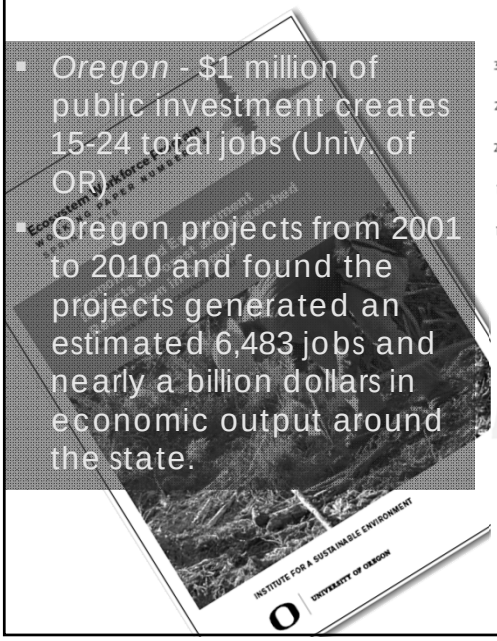


Figure 1. Average number of jobs per $1 million of investment by select sector[1]

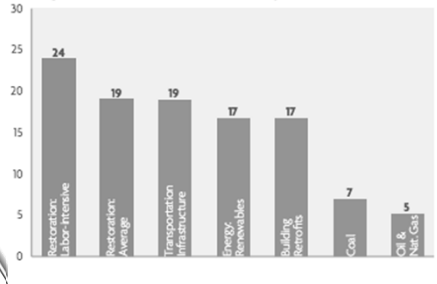
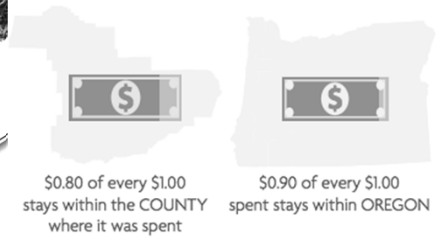
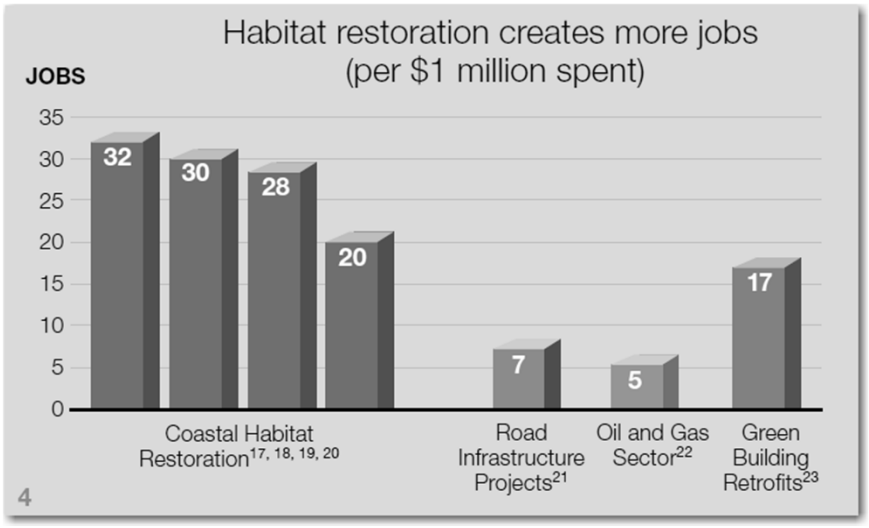


Figure 2. Restoration project funds stay local[3]



THE ECONOMIC VALUE OF RIVERS - JOBS



Courtesy NOAA 2013 – US Estuary Program

THE ECONOMIC VALUE OF RIVERS - MUNICIPAL

- Most US Cities originated on rivers and depended on river traffic for commerce
- We learned the hard way what we have lost by abusing our rivers
- We are learning now how to turn city attention toward the river again
  - E.g. Milwaukee parks, Downtown vitality
  - E.g. Racine – Once empty lake front beaches are now packed thanks to river and stormwater restoration *(90 days per year closed dropped to just 4 days in 5 years)*

WHY DO RIVER RESTORATION?

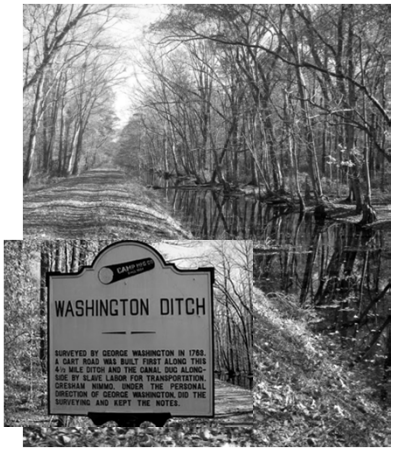
- The future of life on earth depends on the health of our natural systems
  - Rivers are a major part of the *water cycle*
  - Rivers transport whatever we put into them

From www.iowacorn.com

WHY DO RIVER RESTORATION?

- Natural recovery processes are slow following watershed restoration – we can speed it up

Whittlesey Creek (WI) – Logging and splash dams occurred 100 years ago. The system still has no habitat complexity or wood recruitment



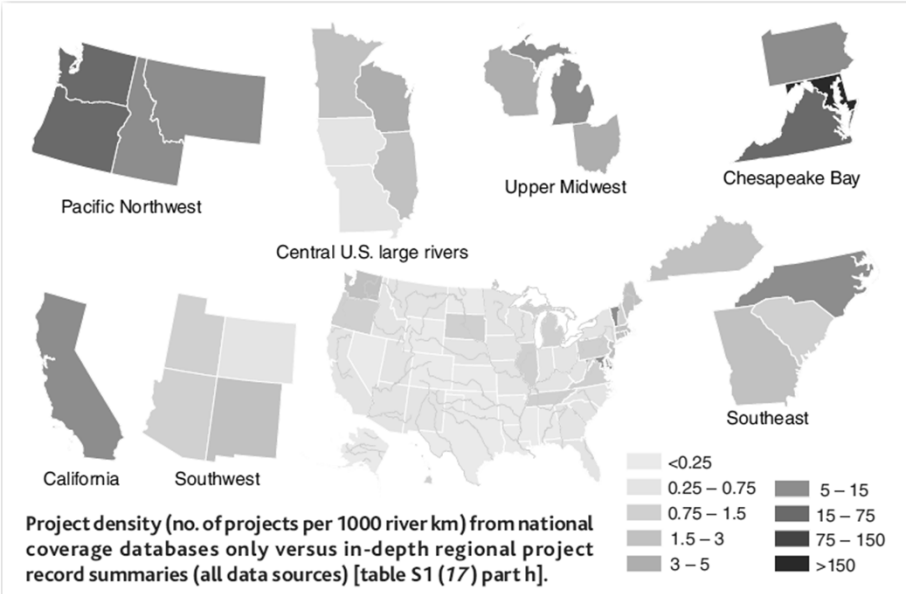
Great Dismal Swamp – 250 year old ditch remains unchanged

WHY DO RIVER RESTORATION?

- It's important to recognize what healthy versus degraded rivers tell us <u>indirectly:</u>

- If our rivers are degraded, they offer a mirror into our management of the land, air and water (canary in the coalmine)
  Eg. 10% imperviousness/disturbance in Ag watersheds = extirpation of trout

WHERE IS RIVER RESTORATION PRACTICED?



Project density (no. of projects per 1000 river km) from national coverage databases only versus in-depth regional project record summaries (all data sources) [table S1 (*17*) part h].

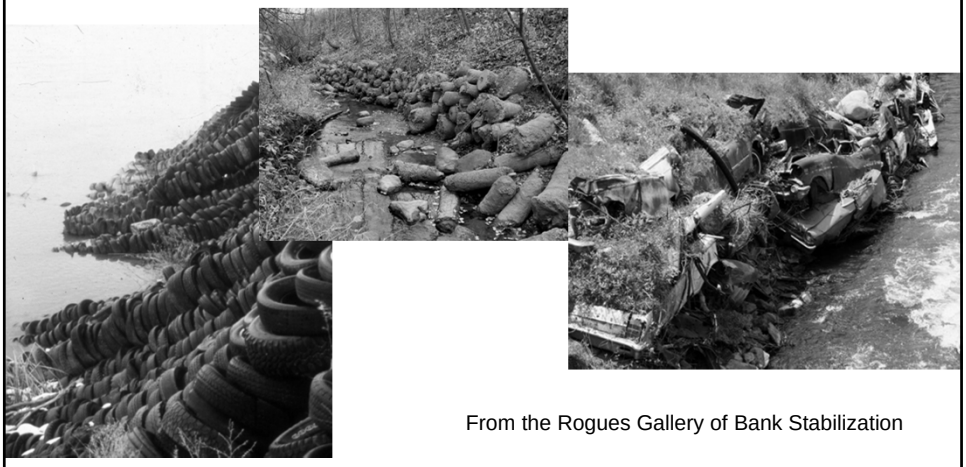
From Bernhardt et al 2005 – Synthesizing US River Restoration Efforts – Science Vol 308

How do we do river restoration?

Examples of river and stream restoration from other states

Traditional approaches

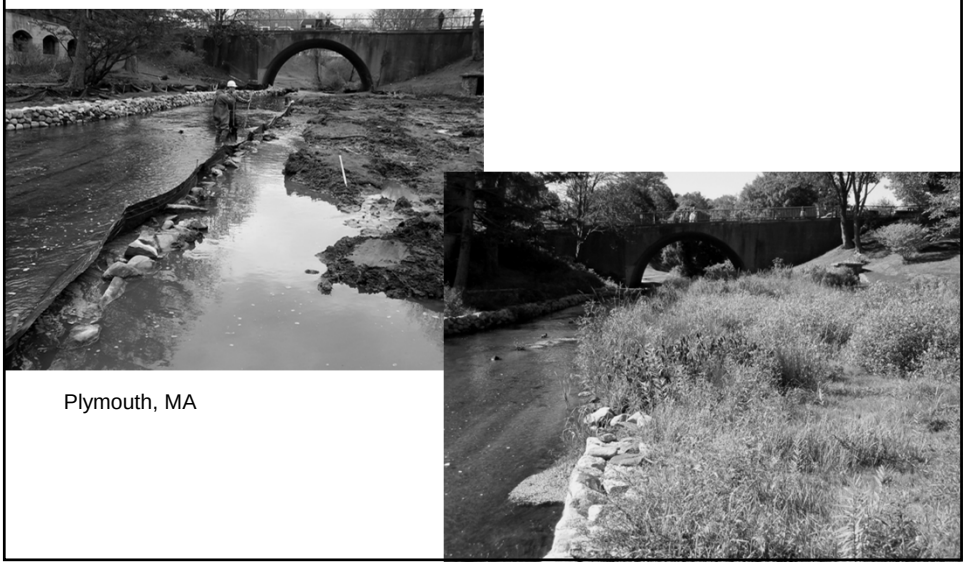
- We've come a long way in our understanding of rivers, ecosystems and connectivity. Rivers were seen as simply conduits for floodwater. That's changing.



From the Rogues Gallery of Bank Stabilization

RIPARIAN VEGETATION

- *Example* – Riparian wetlands filter incoming stormwater and transition between the stream and park features



Plymouth, MA

HABITAT RECOVERY

- *Example* – Creation of pools and riffles in a cattle damaged creek following exclusion of cattle from the stream banks and bed

Montana

SPAWNING HABITAT CREATION

- *Example* – Creation of pools and riffles near lakeshore to allow trout to naturally reproduce

Montana

SPAWNING HABITAT CREATION

- *Example* – Creation of pools and riffles near lakeshore to allow trout to naturally reproduce

Plymouth, Wisconsin

SPAWNING HABITAT CREATION

- *Wisconsin - After 2 yrs*

BANK STABILIZATION

- *Example* – Simple toe protection and upper slope grading with native vegetation

Farmington, MN

BANK STABILIZATION

- Example – There are many ways of stabilizing using bioengineering concepts. Here, stacked cells create an immobile bank for stabilizing in steep areas where no migration is allowed

Portland, OR

BANK STABILIZATION

- *Example – Dual purpose treatment* - Log placement for habitat and bank stabilization

Ashland, WI

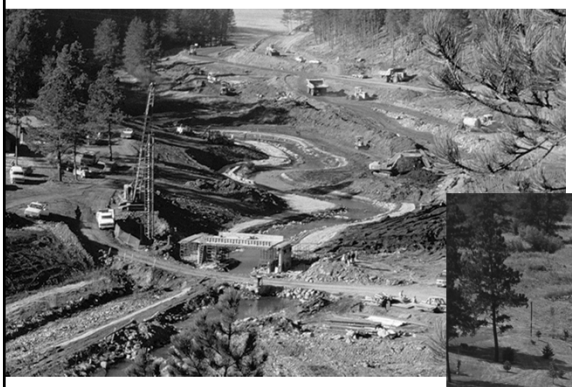
BANK RECONSTRUCTION

- *Example* – Encapsulated soils used to build new banks

New Jersey

DOT CHANNEL RELOCATION

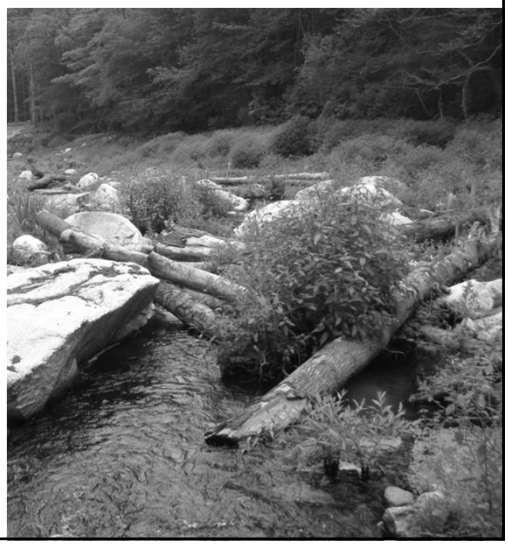
- *Example* – Channel relocation as part of a road relocation project in the Black Hills, SD



Rapid City, SD

RE-MEANDERING

- *Example* – Sawmill Pond dam removal and channel restoration (riffles, pools, large wood, boulders)



URBAN CHANNEL RECLAMATION

- *Example* – Removal of concrete and creation of a floodplain and stable, naturalized channel

Milwaukee, WI

URBAN CHANNEL RECLAMATION

- *Example* – Two stage channel restoration, including low flow (habitat) and high flow (storage) stages

Milwaukee, WI

INCISED CHANNEL RECLAMATION

- *Example* – Elevation of an incised channel to allow flood energy to dissipate on the former floodplain

Seattle, WA

Channel raised 3ft to reconnect the river with its floodplain

After

Incised Channel Reclamation

- *Example* – Elevation of an incised channel to allow flood energy to dissipate on the former floodplain

Shakopee, MN

Grade Control

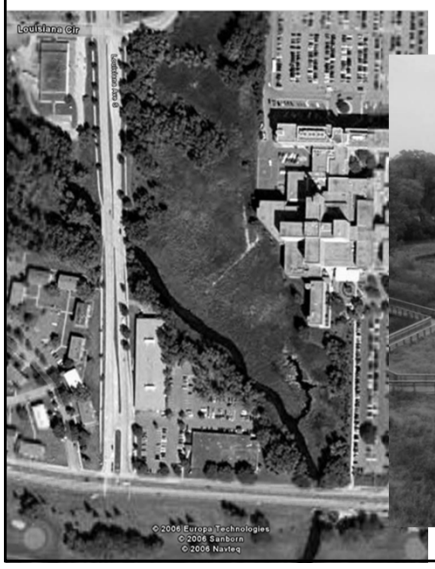
- *Example* – Constructed immobile riffle to protect a sewer pipeline under the river

GRADE CONTROL

- *Example* – Constructed step pool to control bed elevation and prevent upstream incision

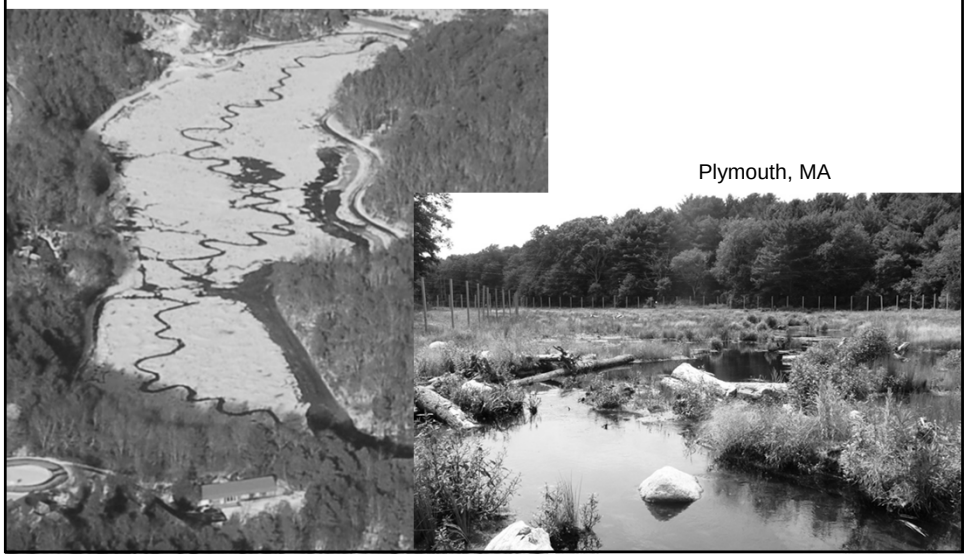
DITCH RECLAMATION

- *Example* – Meander restoration in an urban wetland stream, including wetland restoration



WETLAND CHANNEL RECLAMATION

- *Example* – Restoration of 40 acres of bog and 8,000 feet of meandering ***headwater*** wetland stream



Plymouth, MA

GOLF COURSE RELOCATION

Tahoe, CA

- *Example* – Moving a stream to accommodate golf course objectives, provide fish habitat

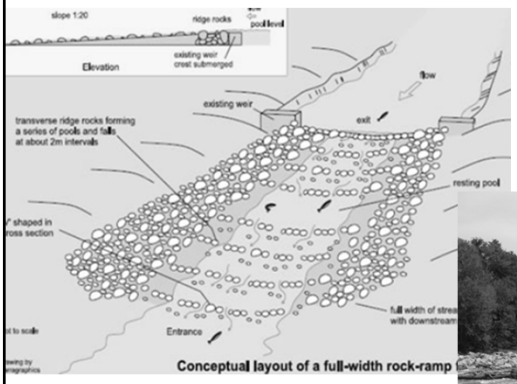
FISH PASSAGE

- *Example* – Fish bypass channel routes fish around a small dam. Constructed with riffles, pools and wood for fish and wildlife cover

Hood River, OR

FISH PASSAGE

- *Example* – Rock ramp fishway



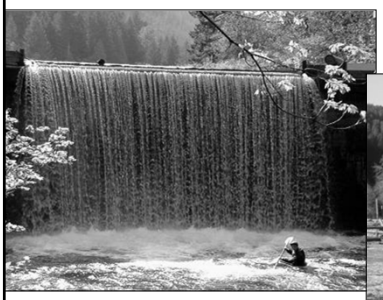
CULVERT FISH PASSAGE

- *Example* – Replacement of chronic blockage problem with a culvert that passes flood, wood and fish

Western Massachusetts

DAM REMOVAL

- *Example* – Removal of the Hemlock Dam for salmon restoration and kayak/canoe passage



Central WA

BLUFF EROSION

- *Example* – Active toe protection and passive bluff stabilization

Jordan, MN

BLUFF EROSION

- *Example* – Active toe protection and passive bluff stabilization

GULLY EROSION

- *Example* – Grade control to prevent headcut migration and soil loss in Midwestern gullies

Rochester, MN

TEST – CAN YOU TELL IT WAS BUILT?

- *A high level of proficiency can result in a fully functioning stream system in just a few years*

Alaska, but could be Iowa!

How long do projects take from assessment to completion?

- *Stream Restoration*
  - *2-4 years on average with permitting*
- *Dam Removal*
  - *3-7 years with permitting*

Best way to handcuff your own agency and ensure poor quality = Make grants that require construction in 1 year

How much do projects cost?

Inter-Fluve Ballpark Numbers

- Stream relocation ($50 - $500 per LF)
- Bank stabilization ($40 - $200 per LF)
- Small Dam Removal ($120K - $600K)
- Large Dam (<10ft) Removal > $1M

Inter-Fluve's average design contract over the past 100 projects is $60,000 but ranged up to $400K. Construction costs averaged $180,000 but ranged from $30K up to $5M

HOW MUCH DO PROJECTS COST?

NRRSS Database (roughly 20,000 projects with funding data)

Project Type	Average Cost
Land acquisition	$812,000
Floodplain reconnection	$207,000
Channel restoration	$120,000
Dam removal	$80,000
In stream habitat	$20,000
Riparian management	$15,000

Average of $1 billion per year spent over 27 states

WHAT MAKES UP A SUCCESSFUL STATE RIVER RESTORATION PROGRAM?

ESSENTIALS IN A STATE RIVER RESTORATION PROGRAM

Who leads these projects in other states?

1. Local watershed groups...
2. With assistance from dedicated state staff...
3. Who hire pre-qualified experts in design and construction

ESSENTIALS IN A STATE RIVER RESTORATION PROGRAM

Are restoration projects done in accordance with a statewide plan?

1. Rarely, states have a unified plan – OR, WA, MD, MA
2. Some states have active, well organized state plans for stream mitigation – NC, SC, VA, TN and KY
3. Most states piecemeal projects or have a general plan, but no defined, unified state plan or dedicated department

ESSENTIALS IN A STATE RIVER RESTORATION PROGRAM

What entities/stakeholders need to be involved in the completion of a successful project?

1. If you want big $$$, you need to have multiple cooperating partners
    1. Landowner
    2. Watershed groups
    3. Non-profits (Am Rivers, TU, Iowa Rivers Rev.)
    4. State agency
    5. Federal agency (NRCS, USFWS, USFS, NOAA)
    6. Municipality
    7. Permitters
    8. Design and construction providers

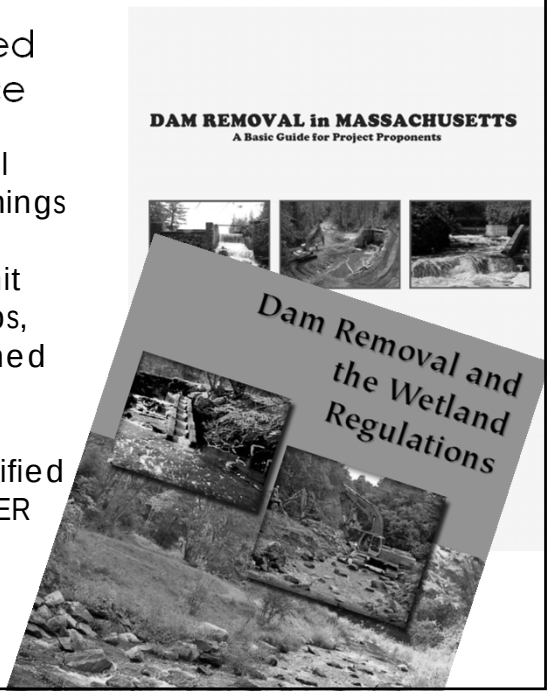
ESSENTIALS IN A STATE RIVER RESTORATION PROGRAM

Summary from staff at successful programs - Mass. DER, MDDNR, OR/WA, American Rivers

1. Dedicated restoration staff with goals
2. Adequate funding of the program
3. Adequate funding of projects
4. Watershed group initiation and assistance
5. Technical Guidance from the State
6. Enforceable Dam Safety Laws
    - Owners must inspect and either repair or remove dams
    - Owners are made aware of their personal liability
7. Qualified designers

MA – A well organized program of guidance

- Annual Dam Removal Project Manager trainings
- Presentations to permit staff, Non-profit groups, Town boards, watershed groups, etc.
- Assessment from qualified assistance (internal DER staff+ consultants /engineers)



State of Restoration in the West

Oregon, Washington, California

1. Federal funding for projects (eg. NOAA)
2. Rate payers pay for most of the projects (eg. water, sewer, trash)

Bonneville Dam, Columbia River

Restoration in the Midwest

Minnesota, Michigan

1. Mainly fish habitat - until recently, most work was done by DNRs but that's changing as more money and liability is on the line
   - Lunker structures predominant
   - Threshold channel or "Lock in place" design
2. Natural channel design – DNR is interested in more geomorphic based design
3. Occasional dam removals
4. Funding is extremely poor compared to coastal states

RESTORATION IN THE MIDWEST

Minnesota, Michigan

1. Although no defined program exists, MNDNR and MIDNR have several full time staff members devoted to river restoration/habitat restoration (WI doesn't)
2. Prioritization procedure ranks incoming projects:
    1. Fragmented habitat restoration
    2. Remeandering/natural channel restoration
    3. Dam removal
    4. Dam modification

RESTORATION IN THE MIDWEST

Minnesota Funding Sources

1. Broad range – up to 11 different funding sources
2. Lessard Council funding (State conservation tax)
3. Dam safety program (funds removal or modification)
4. State bond fund
5. USFWS
6. Flood damage reduction – both pre-emptive and post flood
7. Clean Water Act funding

Restoration in Chesapeake Bay

Maryland

1. EPA determines TMDLs with Maryland DNR
   (Required by law – Section 303(d) of the Clean Water Act)
2. Counties develop Watershed Implementation Plans (WIP) based on the TMDLs (also required by CWA)
   - Includes general goals, prioritized list
   - Some specific project objectives
3. Implementation Funding
   - General fund (income & property taxes)
   - Chesapeake and Coastal Trust Fund ($65M/year from car rental and gas tax)
   - NOAA/USFWS

Restoration in the Southeast

North Carolina, SC, Kentucky, TN, VA, WV

1. Banks buy mitigation credits
   1. Purchase degraded stream reaches
   2. Restore the stream
   3. Sell the credits
2. Commodity market has driven the cost of restoration down
3. Restoration done by inexperienced practitioners, and done cheaply, although this is improving rapidly
4. Has resulted in a high degree of failure
5. Only possible because they <u>allow</u> damage

DRIVERS

Do other states begin projects with goals for water quality improvement, or is that just an outcome of how the projects are done?

1. Short answer = usually water quality is a driver, but not always
2. Wisconsin example – Targeted runoff management grant program must target specific pollutant reduction
3. Maryland example – TMDL targets for sediment and nutrients are tackled by reducing bank erosion
4. Generally, water quality funding far outpaces habitat funding

DRIVERS GET US BACK TO THE QUESTION: WHY DO RIVER RESTORATION?

- The most commonly stated goals or drivers in the NRRSS database:
  1. Enhance water quality
  2. Manage riparian zones
  3. Improve in-stream habitat
  4. Fish passage
  5. Bank stabilization

DRIVERS

How important is recreation use and access as a driver for restoration projects?

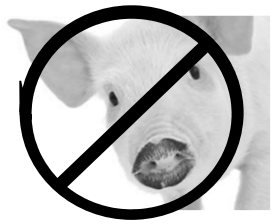
1. OR/WA/CA – Surprisingly, paddling sports have low level of influence
2. WI – Not much funding except from boat gas tax and license fees
3. Inter-Fluve experience – Paddle sport representatives are always present but not a large voice. They are generally in favor, but not as organized as watershed or fishing groups.

EFFECTIVE RIVER RESTORATION

- Combined watershed/stream approach
  - Start with uplands/wetlands in headwaters
  - Start upstream and work your way downstream
  - This embodies the combination of watershed restoration and stream restoration and tackles both simultaneously
  - Think big

EFFECTIVE RIVER RESTORATION

- Combined watershed/stream approach
  - Start with uplands/wetlands in headwaters
  - Start upstream and work your way downstream
  - This embodies the combination of watershed restoration and stream restoration and tackles both simultaneously
  - Think big



NEED FOR MONITORING FUNDING

Of the 37,000 projects in the NRRSS Database, only 10% showed any kind of post project monitoring

HOW DO YOU PRIORITIZE PROJECTS?

- *Scott County, MN example*
  - *MN River watershed*
  - *Extensive bank erosion, bluff and ravine problems*
  - *Haphazard spending of money on whoever signed up first*
- *Start with geomorphic based watershed assessment*

Project Priority Matrix

- Each potential project scored on customized metrics
- Easily sorts and prioritizes hundreds of projects
- Flexible

Table 1: Metrics for scoring potential projects.

Metric Score:	*1*	*3*	*5*	*7*
Infrastructure risk	No risk to infrastructure with no action, or no infrastructure present	Low to moderate infrastructure risk and minimal risk to public safety with no action, or inf. value <$100,000	Infrastructure at moderate but not immediate risk, moderate public safety risk, or infrastructure value <$200,000	Infrastructure at high or immanent risk of failure with no action. Public safety at risk or infrastructure value >$200,000
Erosion/channel stability	Minimal improvement to overall stream stability and function, <250 ft of channel bank	Low to moderate improvement of 250-1000 ft of channel bank	Moderate improvement 1000-2500 ft of channel bank	Significant improvement to overall stream stability and function or >2500 ft
Project complexity	Groundwater and surface water issues, professional specialty design services required, heavy oversight, major earthwork, EAW/EIS permitting	Surface water restoration, engineering plans required, earthwork involved, significant permitting	Moderately complex, no specialty engineering required, minor earthwork, some basic permitting	Elementary solution, shelf design, volunteer and hand labor implementation, no permits
Location	Mouth to lower ¼ of watershed	Lower 1/4 to 1/2 of watershed	1/2 to upper 3/4 of watershed	Upper 3/4 to headwaters
Sediment/nutrient loading	No load reduction resulting	Some minor reduction in sediment pollution, increased filtration of nutrients	Moderate reduction in bank erosion and surface runoff entering stream through buffer or other BMPs > 30 ft	Major erosion control through significant BMP installation, stormwater detention, infiltration or buffer filter.
Project cost	> $300K	$201 - $300K	$51 - 200K	$0 - $50K

Project Priority Matrix

- Rank projects by either one, several or all metrics
- Separates projects also by type

Appendix I: Potential projects on the mainstem of Sand Creek. Project type codes: B = bank stabilization; G = grade control; C = culvert or other crossing; N = natural channel restoration/relocation; F = floodplain management; I = infrastructure; R = riparian management.

Project Number	Station Number	Project type	*Inf. Risk*	*Channel stability*	*Project Complexity*	*Location*	*Sed/ Nutrient Loading*	*Cost*	*Aesthetic impact*	*Fish passage*	*Public Education*	*In-stream Ecological*	*Riparian Ecological*	*Total Score*
PP01	9100	I	1	5	3	1	5	1	7	7	7	7	7	**51**
PP02	28200	N	1	5	3	1	5	3	5	1	7	3	3	**37**
PP03	35200-35500	R	1	3	7	1	3	7	3	1	3	3	4	**36**
PP04	35000	G, N, B	1	5	3	1	5	3	5	1	5	5	5	**39**
PP05	37700-38200	R	1	3	7	1	3	7	3	1	3	3	4	**36**
PP06	50000	G	1	2	6	3	2	7	1	1	1	3	1	**28**
PP07	51700	B	5	1	5	3	1	5	7	1	5	3	1	**37**
PP08	52600	B	5	1	5	3	1	5	5	1	5	3	1	**35**
PP09	53200	I, N	1	1	3	3	1	3	7	7	7	5	5	**43**
PP10	53600	I	5	5	2	3	1	1	7	7	7	7	5	**50**
PP11	54900	G, B	3	3	5	3	5	5	3	1	1	3	3	**35**

Prioritization (Scott County, MN)

- Bluff and ravine erosion accounted for most of the sediment load
- Target effective practices – Scott County <u>stopped funding bank erosion</u> and focused efforts on:
  - WASCOB and other hydrologic control
  - Bluffs and ravines (180 degree shift in policy based on geomorphic evidence)

SUMMARY

- Rivers are a mined natural resource with a wide variety of benefits to humankind.
- Rivers are a rare example of a mined resource that can be restored.
- Restoration has a higher job creation ratio than extractive, non-renewable industries (oil and gas).
- Other states have viable river restoration program templates. Those templates were a product of trial and error. We can learn from them.
- It's up to each state to decide how important river restoration is to them. States that have committed to a program have shown results.