

# Synthesizing U.S. River Restoration Efforts

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Impacts of loss of free-flowing rivers on global freshwater megafauna

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Zeb Hogan <sup>e</sup>, Klement Tockner <sup>f,g</sup>, Sonja C. Jähnig <sup>a,h</sup>

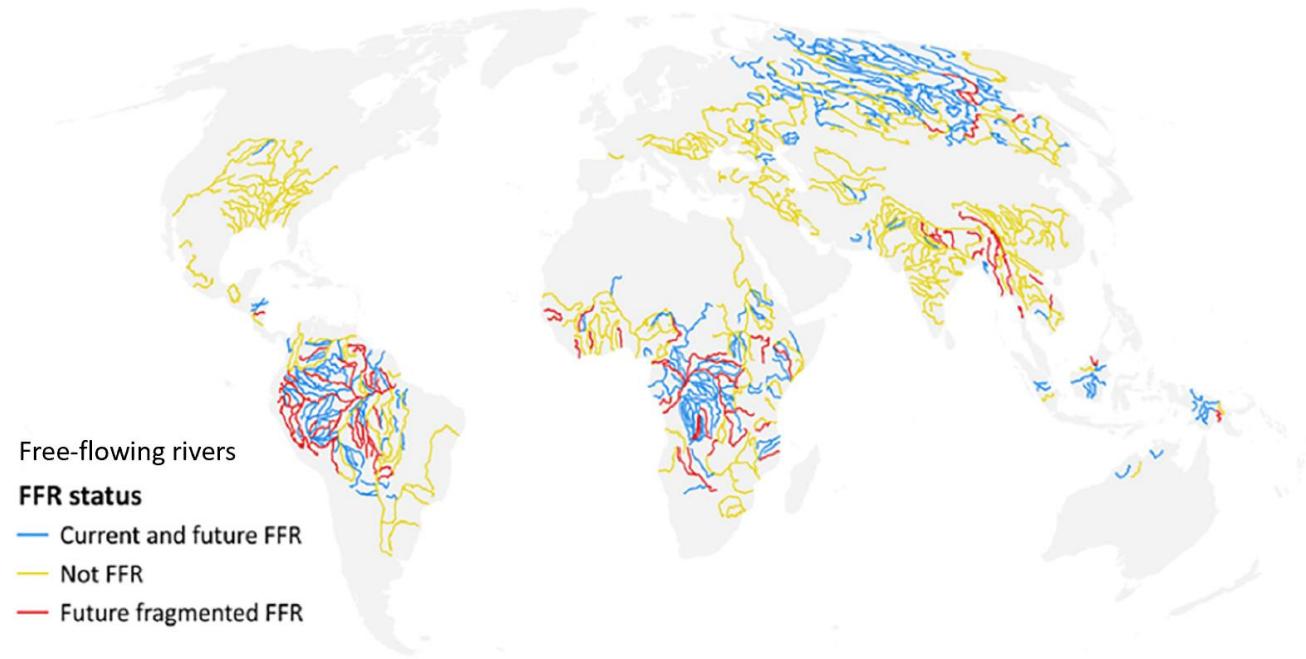


Fig. 5. Free-flowing status of rivers longer than 500 km that provide habitat for threatened freshwater megafauna (i.e., listed as Critically Endangered, Endangered, or Vulnerable in the IUCN Red List; [IUCN, 2019](https://www.iucnredlist.org)).

# Introduction

- Degradation of running waters is at an alltime high
- 1/3 of the rivers in the US are listed as impaired or polluted
- Drought => Flow interruption
- Extinction rates of freshwater fauna are five times that for terrestrial biota

Fortunately, stream and river restoration can lead to species recovery, improved inland and coastal water quality, and new areas for wildlife habitat and recreational activities



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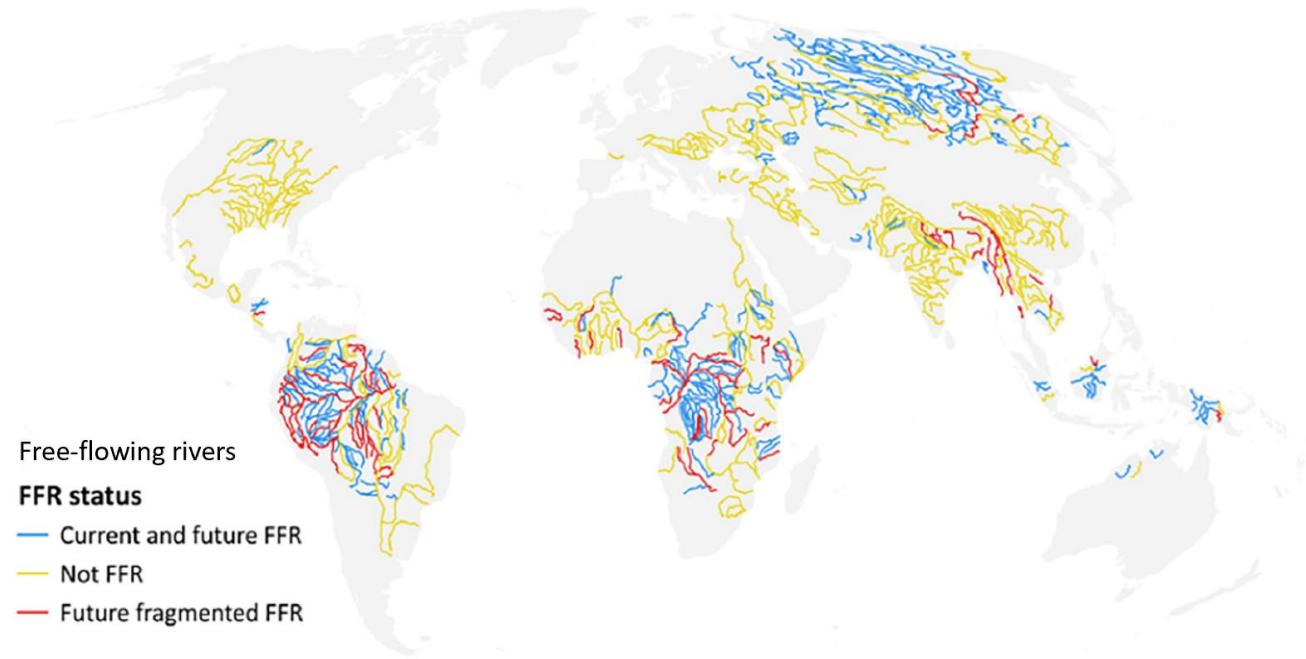


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Build a database of river restoration across the United States with the goal of determining the common elements of successful projects

# Data acquisition

National River Restoration Science Synthesis (NRRSS)

No judgments were made of the validity of the terms “stream restoration” or “project.”

Regardless of project size, restoration method, implementer, or perceived success or failure of the project

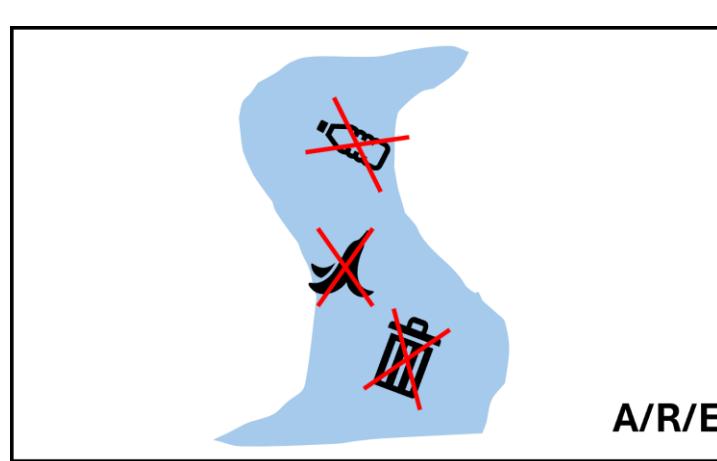
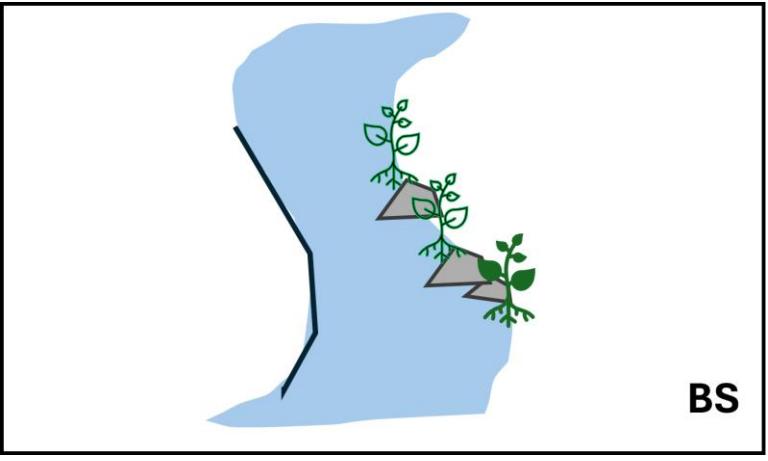
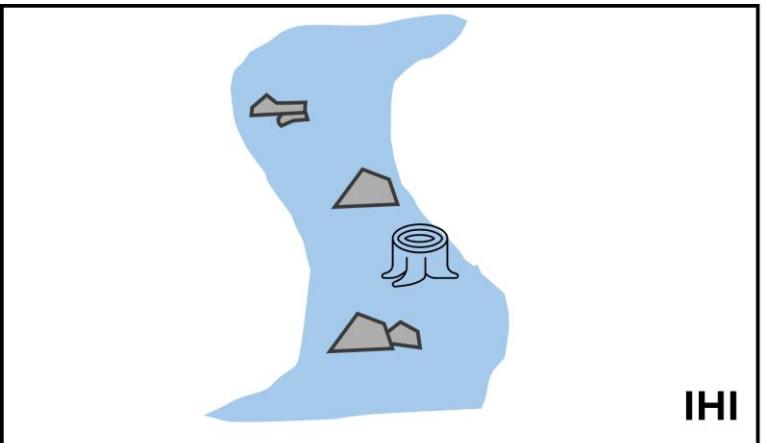
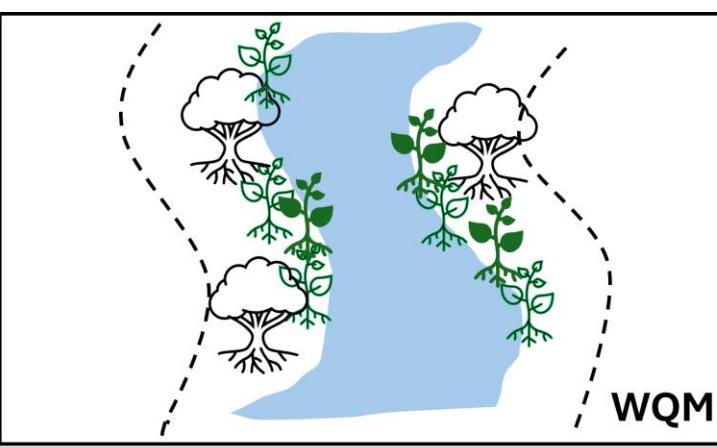
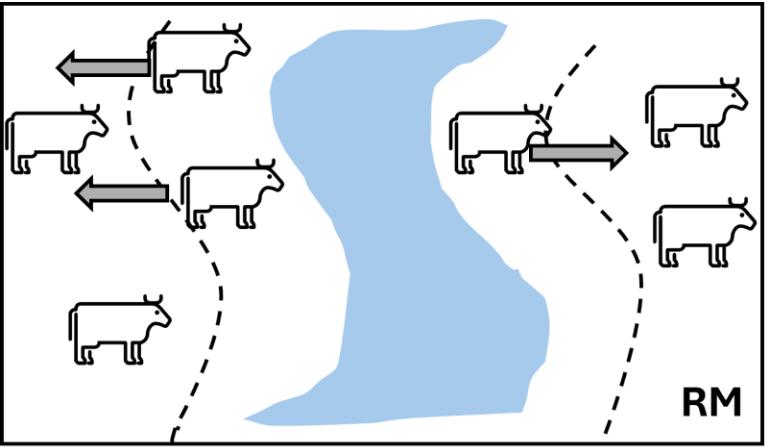
37,099 projects from all 50 states

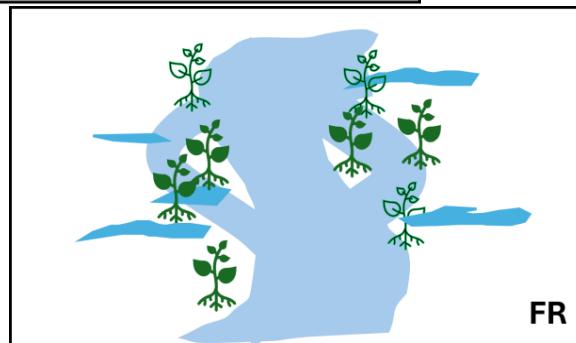
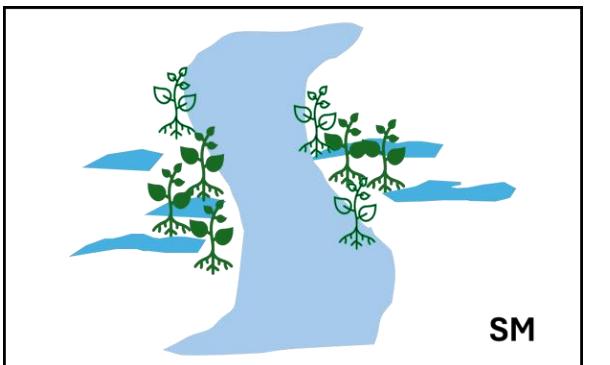
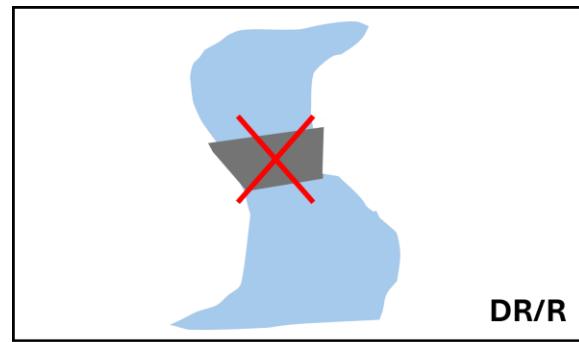
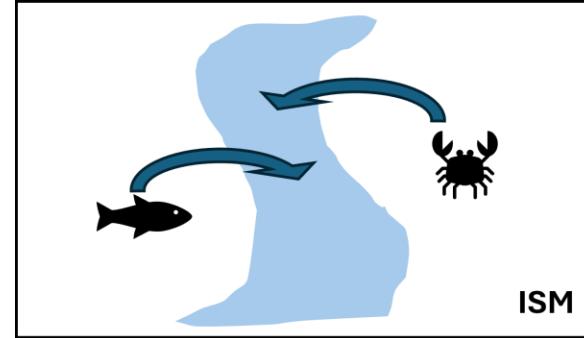
# Defining Restoration

A priori 13 categories of restoration was defined and each project classified according to its stated goal

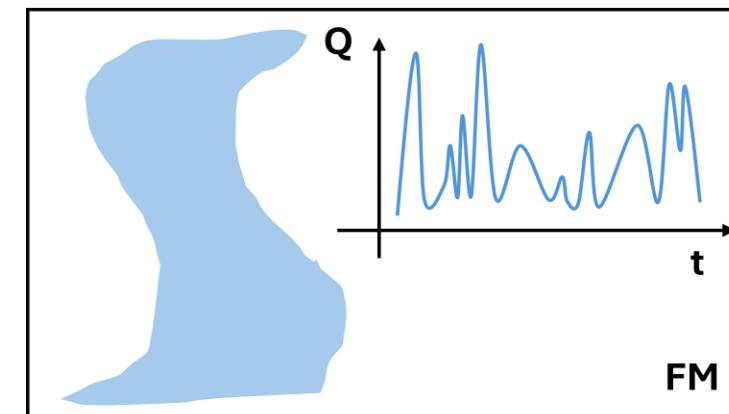
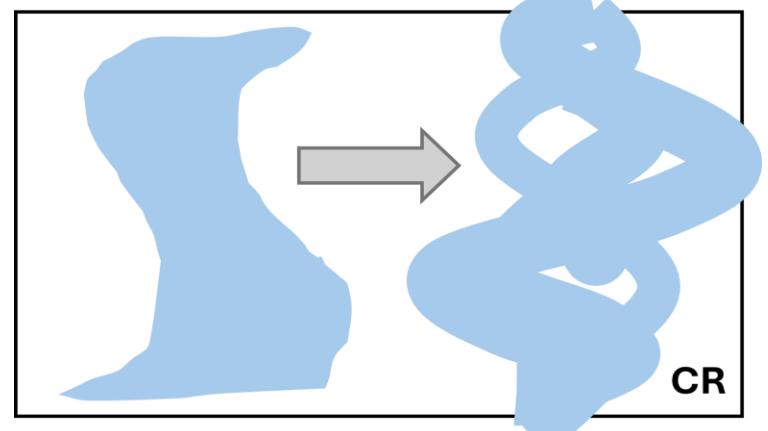
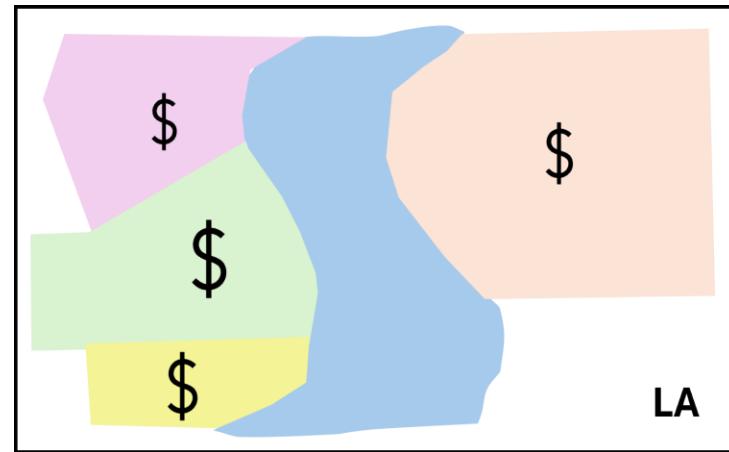
<b>NRSS goal category</b>	<b>Examples of common restoration activites</b>
Riparian management (RM)	Livestock exclusion
Water quality management (WQM)	Riparian buffer creation/maintenance
Instream habitats improvement (IHI)	Boulders /woody debris added
Fish passage (FP)	Fish ladders installed
Bank stabilization (BS)	Revegation, bank grading
Aesthetic/recreation/education (A/R/E)	Cleaning (eg., trash removal)
Instream species management (ISM)	Native species reintroduction
Land acquisition (LA)	
Dam removal/retrofit (DR/R)	Revegetation
Channel reconfiguration (CR)	Bank or channel reshaping
Stormwater management (SM)	Wetland construction
Flow modification (FM)	Flow regime enhancement
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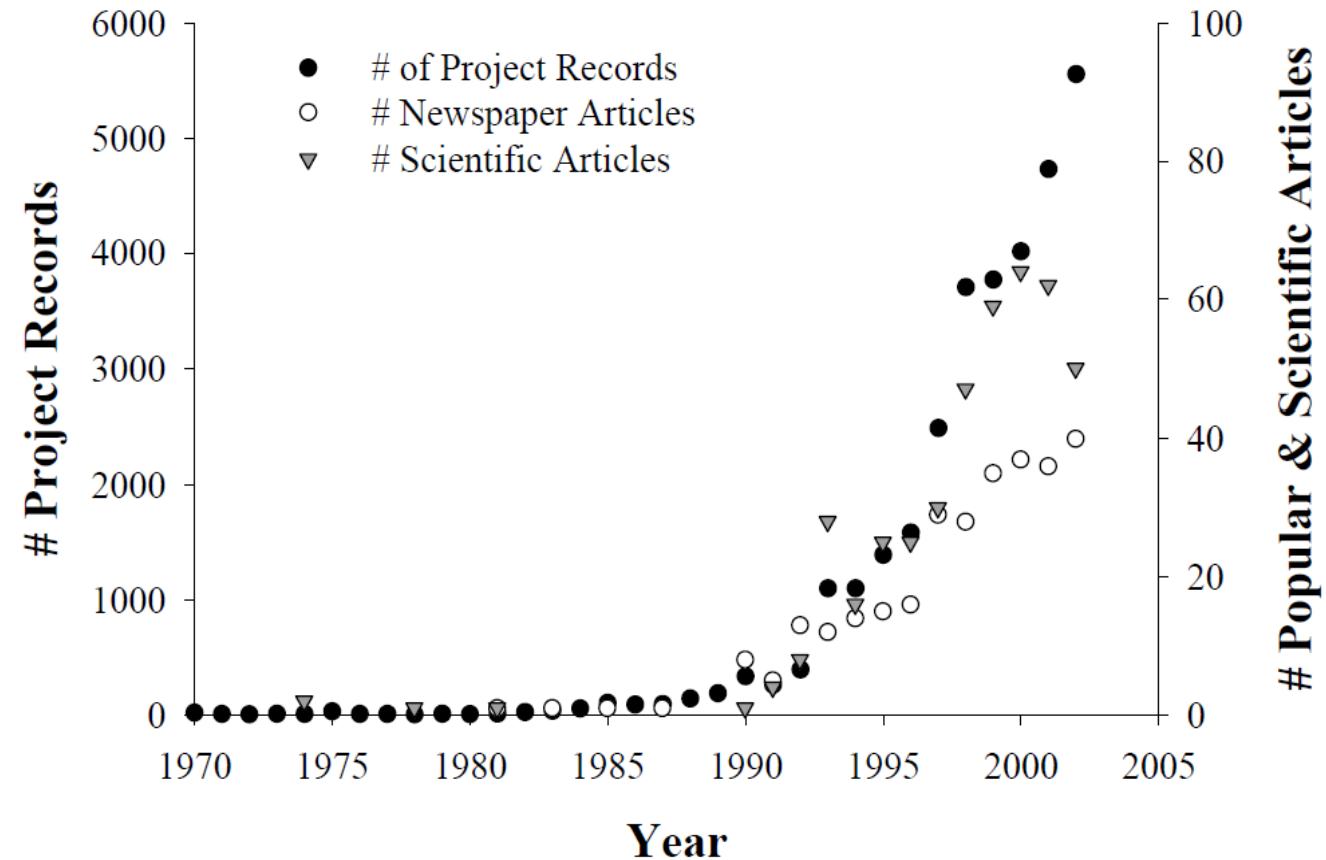


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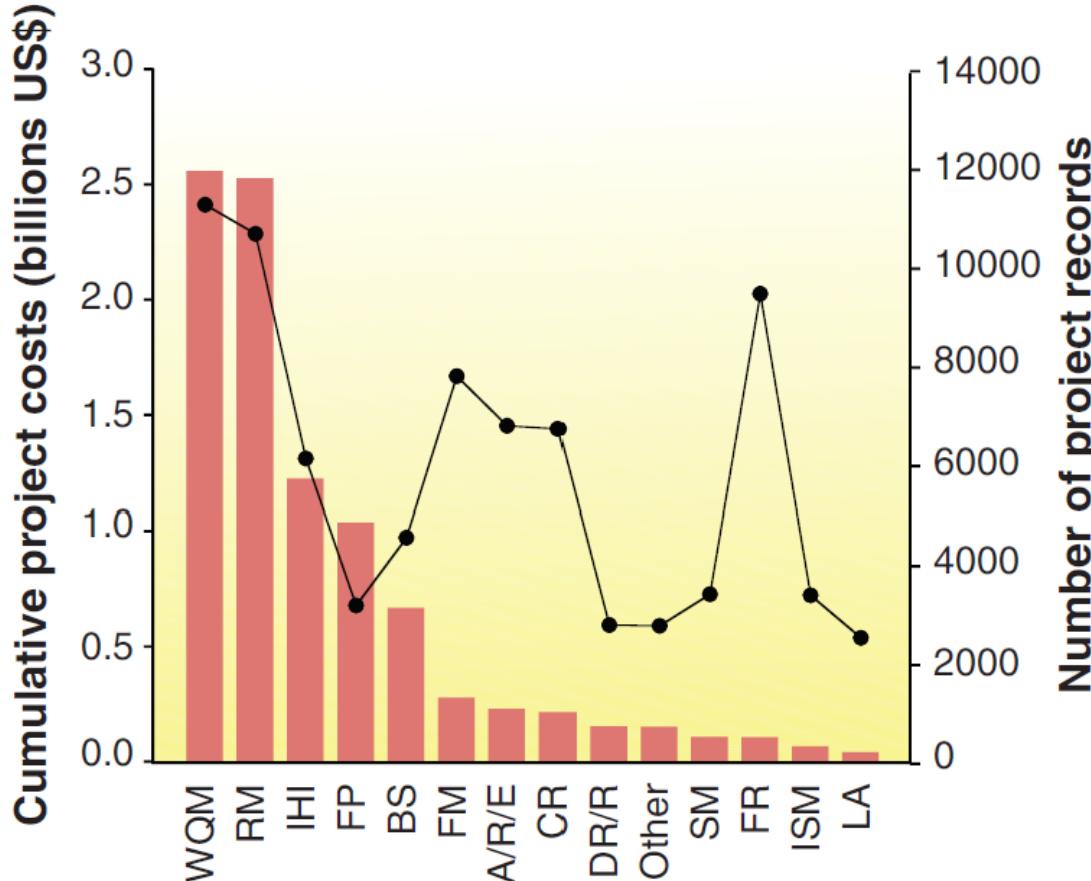
# Efforts in restoration projects

The number of river restoration projects **increased exponentially** during the last decade, paralleling the increase in **news media** and **scientific reports**.



Efforts = **how restoration dollars were allocated**, that depends on the region, the goals, the monitoring

# Efforts in restoration project



Distribution of projects within each restoration goal category. Abbreviations of categories are in table below.

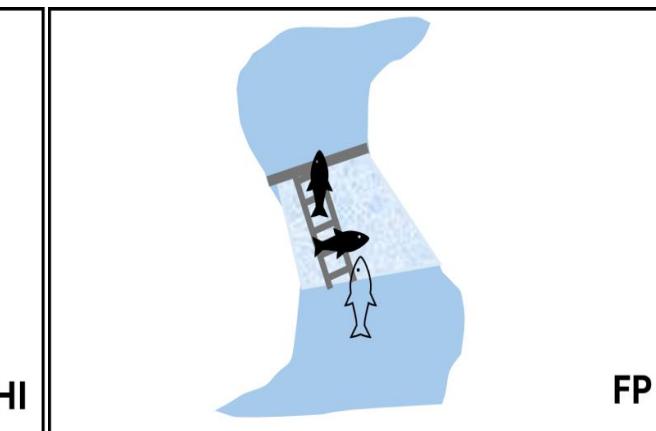
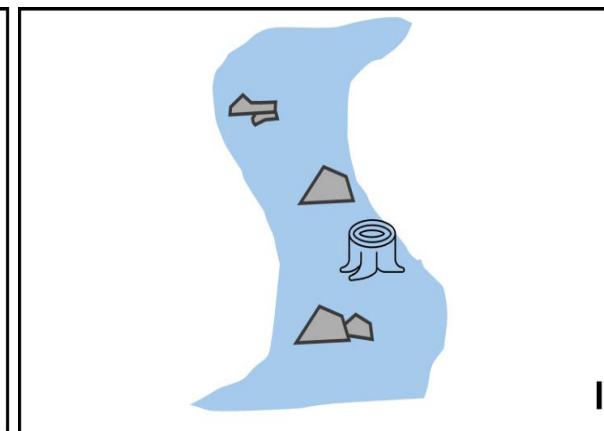
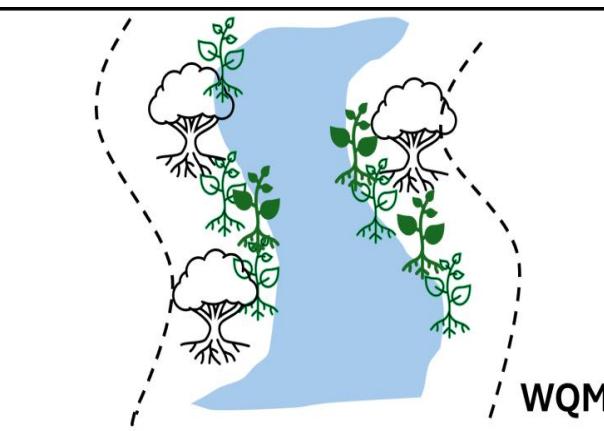
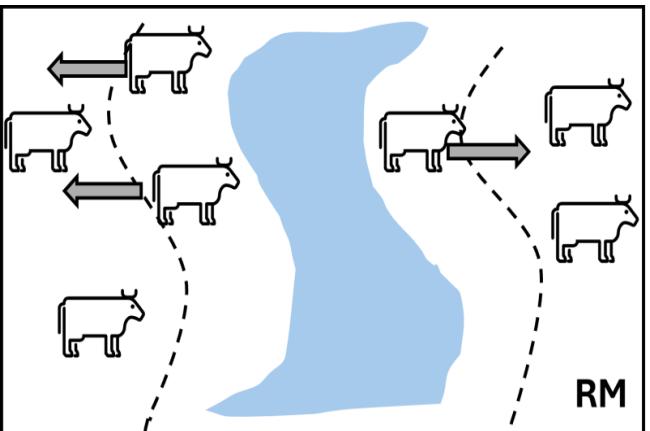
Most commonly stated goals for river restoration in the United States

- 1) To enhance water quality (WQM)
- 2) To manage riparian zones (RM)
- 3) To improve in-stream habitat (IHI)
- 4) For fish passage and (FP)
- 5) For bank stabilization (BS)

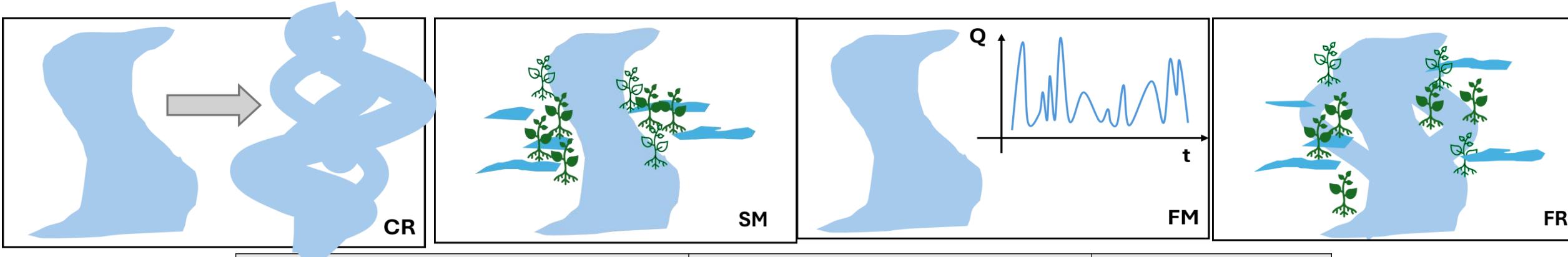
Mostly projects **small in scale**, median costs **<\$45k**  
Fewer projects **larger in scale**, much more **expensive**

# Small scale project

NRSS goal category	Examples of common restoration activites	Median cost (k\$)
Riparian management (RM)	Livestock exclusion	15
Water quality management (WQM)	Riparian buffer creation/maintenance	19
Instream habitats improvement (IHI)	Boulders /woody debris added	20
Fish passage (FP)	Fish ladders installed	30
Bank stabilization (BS)	Revegetation, bank grading	42
Aesthetic/recreation/education (A/R/E)	Cleaning (eg., trash removal)	63
Instream species management (ISM)	Native species reintroduction	77
Land acquisition (LA)		81.2
Dam removal/retrofit (DR/R)	Revegetation	98
Channel reconfiguration (CR)	Bank or channel reshaping	120
Stormwater management (SM)	Wetland construction	180
Flow modification (FM)	Flow regime enhancement	198
Floodplain reconnection (FR)	Bank or channel reshaping	207



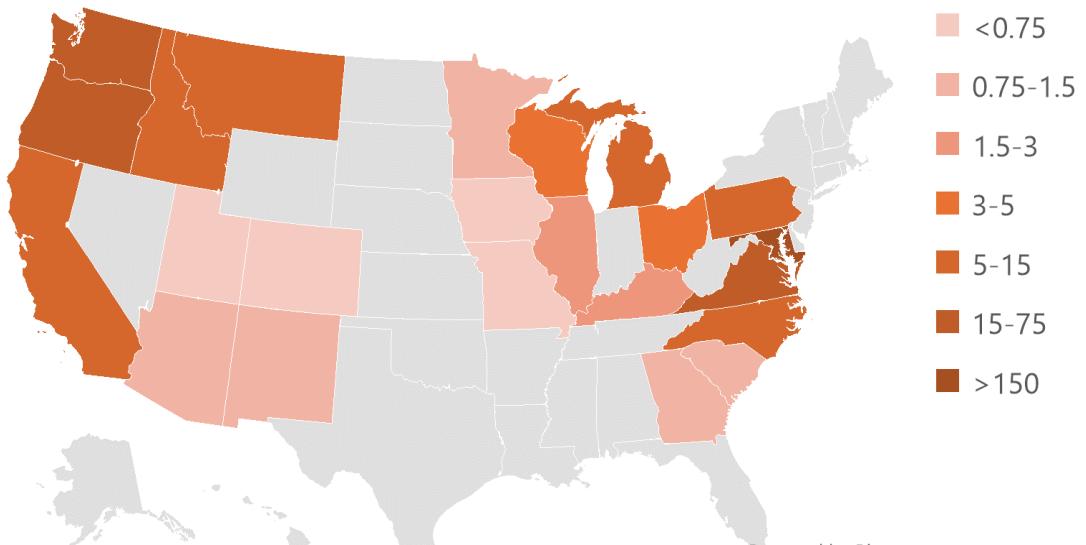
# Large scale project



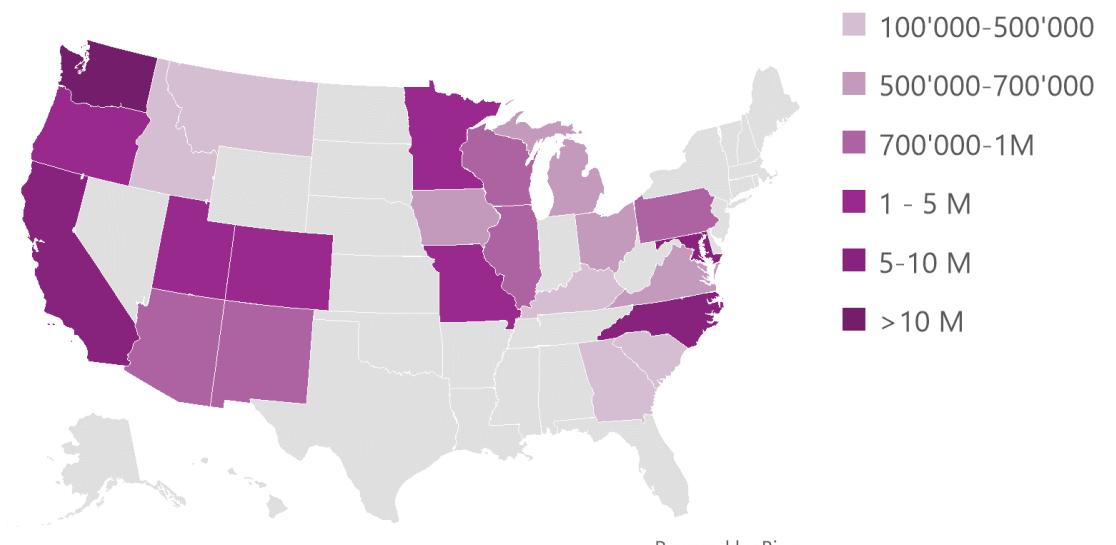
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# Efforts linked to regional project density

No. of Projects / 1000 km

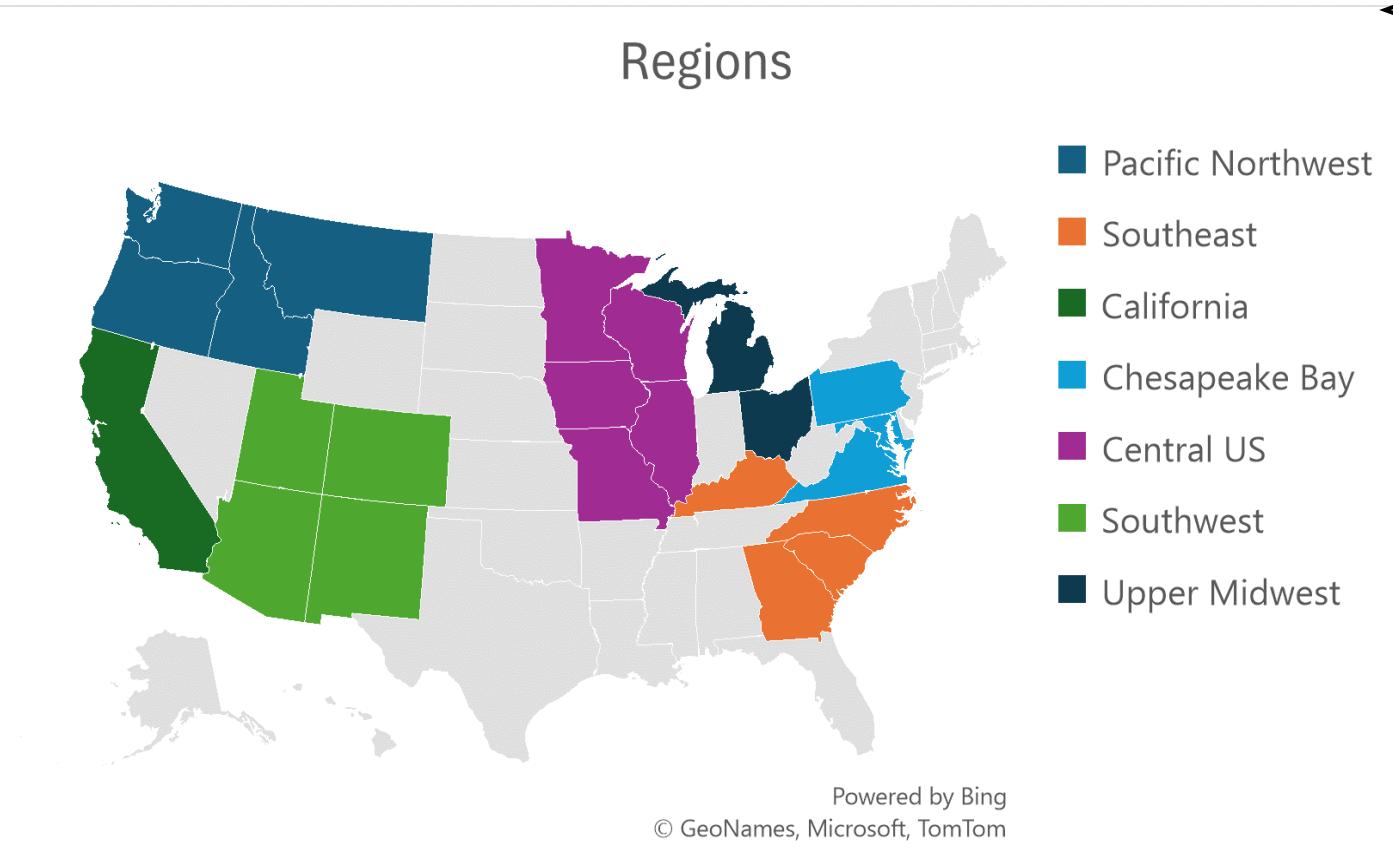


Total Cost (\$) / 1000 km



Regions with **greater project density** tended to have **lower average project costs** (but also linked to other parameters)

# Total costs overview

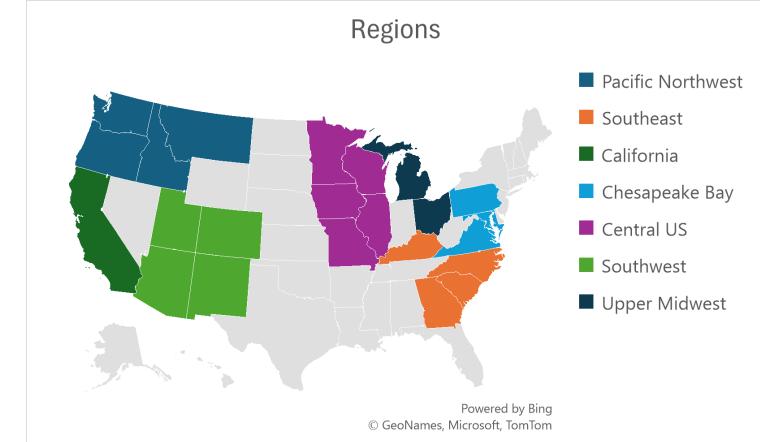


**From 1990 to 2003:**  
**\$7.5 billion** in the regions of interest, at least  
**\$14 to \$15 billion** within the whole US.  
Average: **>\$1 billion a year**

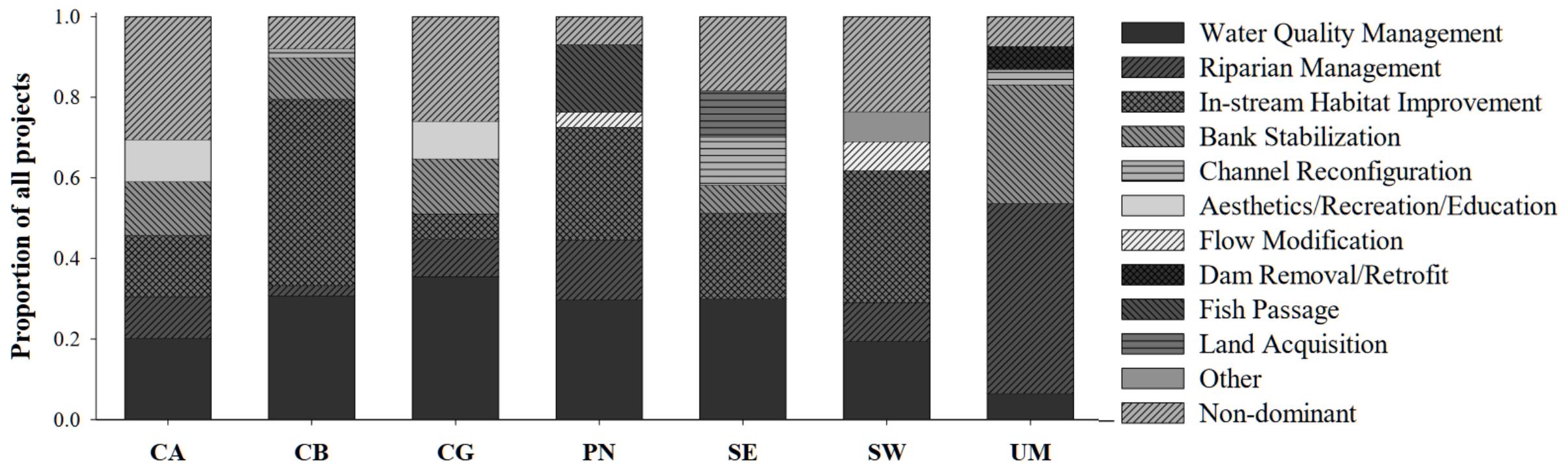
## *Limitations:*

- Only **58% of the project records** had information on project costs
- Underestimation**, due to project records **not including costs for huge restoration project**.

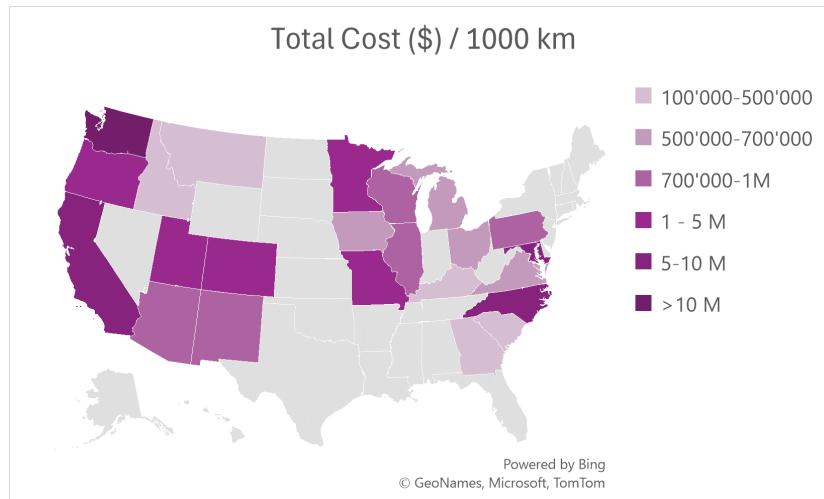
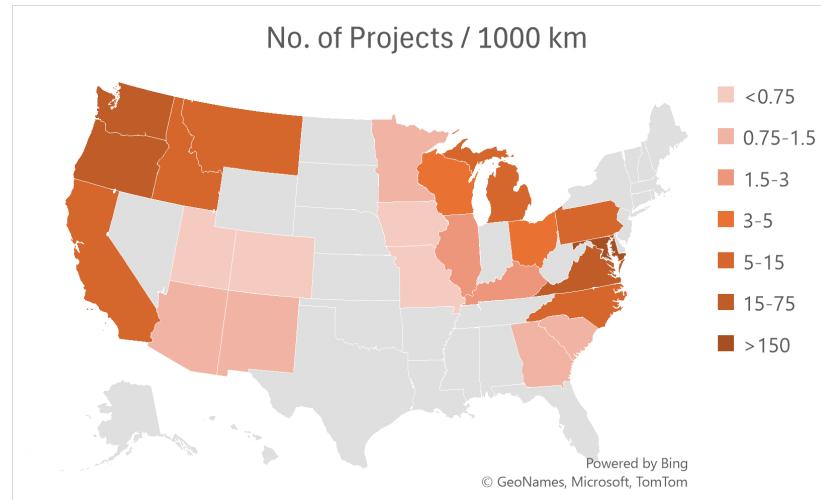
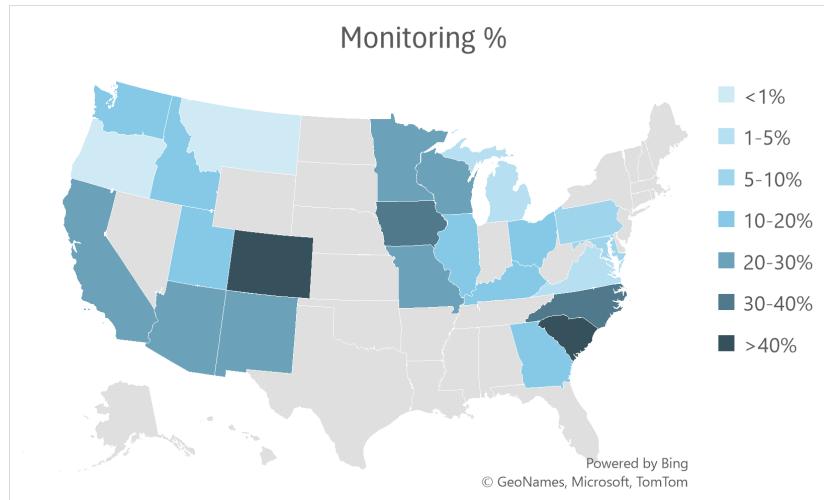
# Efforts linked to the region



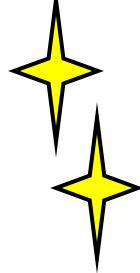
Regional differences in the distribution of types of restoration efforts. To facilitate visual comparison only the top five intent categories for each node are shown in each stacked column. All other "non-dominant" intents are summed as part of the "non-dominant" category.



# Monitoring



- Monitoring varied by region: >20% of projects in the Southwest, Southeast, and Central United States, only 6% of project records in the Chesapeake Bay
- Projects with higher costs were more likely to be monitored
- Regions with greater project density tended to have lower average project costs and thus reported a lower rate of monitoring



# How to improve ?

- Only 10% of project records indicated any form of assessment or monitoring
- Most of the projects were not designed to evaluate the consequences of restoration
- Most small-to-modest size projects are currently not monitored
- Greater efforts needed to gather and disseminate data on methods and outcomes
- Extensive monitoring on every project is unrealistic
- But: Strategic pre- and postassessment with strategized methods
- Data compatibility in tracking and documentation of results → NRRSS database
- This will allow to learn from successes and failures and improve further practice.



Questions ?

# References

- E. S. Bernhardt *et al.*, Synthesizing U.S. River Restoration Efforts. *Science* **308**, 636-637(2005).  
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- Fengzhi He *et al.*, *Impacts of loss of free-flowing rivers on global freshwater megafauna*, *Biological Conservation*.  
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