

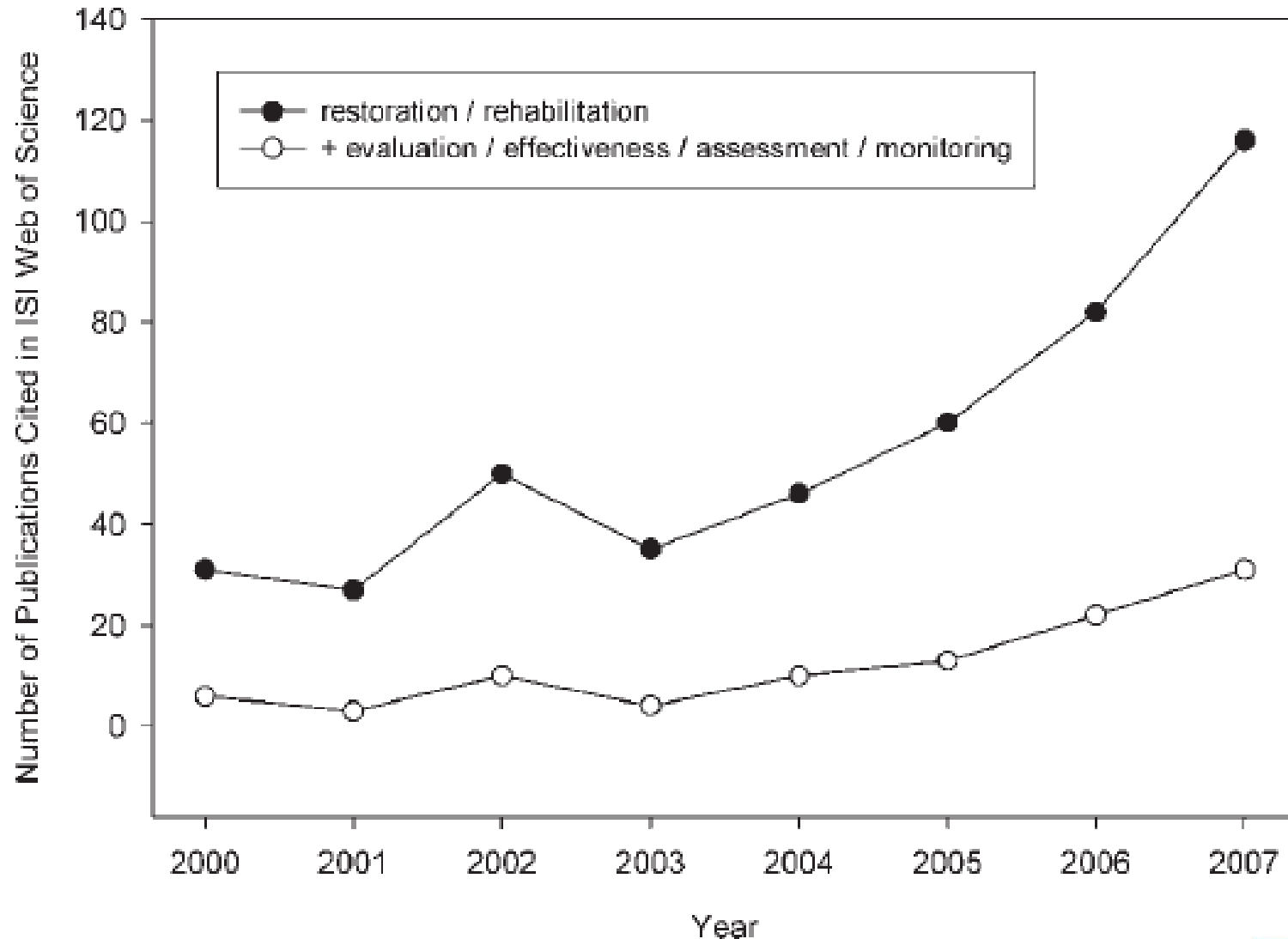


# **Most Bang for your Buck**

**Optimisation of catchment  
restoration strategies.**

**Tommy McDermott and David C. Bradley**

# Growth in restoration literature



From: Schiff *et al.*, 2011

# Talk Justification

- Large body of literature dealing with restoration.
- Lack of demonstrable success is well documented
- Often the lack of monitoring is cited and failure to consider ecological benefits (e.g. Selvakumar *et al.*, 2010).
  - But what of publications that do consider ecology, is there sufficient information?
- Only a fraction of restoration projects published.(Schiff *et al.*, 2011).
- How useful is non-published data?
- Funding shortages: can we provide guidance on value for money?

# Method

1. Web of Science search: [restoration OR rehabilitation] AND [stream OR river].
2. Google Scholar.
3. Paper screening:
  - Only surveys with ecological surveys retained.
  - Meta-analyses and reviews not retained for scoring.
3. Online search for restoration reports.

**Approximately 300  
reports/papers on river  
restoration**

**Total of 26  
suitable studies**

4. Scoring criteria identified and categorisations defined by percentiles.

# Scoresheet.

## PROJECT

- Continent
- Country
- Source
- Length (m)
- Cost

## MONITORING

- Pre-  
Post-  
Control
- No. of stations
- Temporal extent
- Replicates

## NEGATIVE ECOLOGICAL INDICATORS

- Invasive Flora
- Invasive Fauna

## RESTORED FEATURES

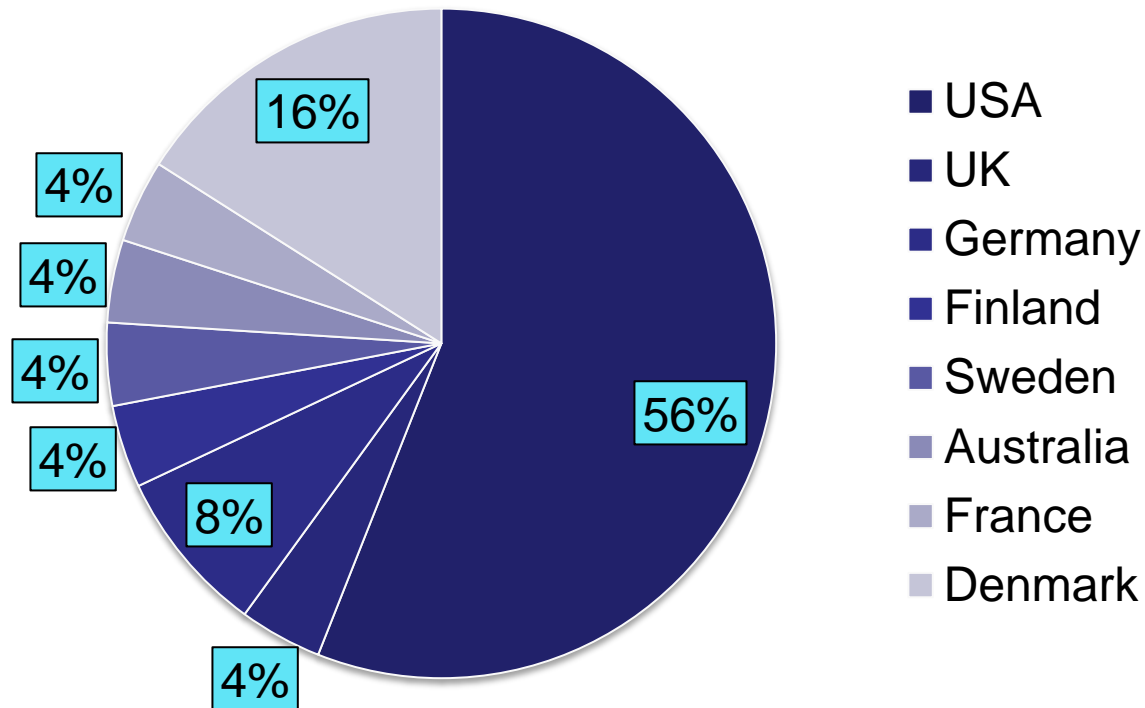
- Channel Geometry
- Channel Debris
- Erosion/deposition
- Flow
- Longitudinal connectivity
- Banks
- Riparian zone
- Land use
- Lateral connection

## POSITIVE ECOLOGICAL INDICATORS

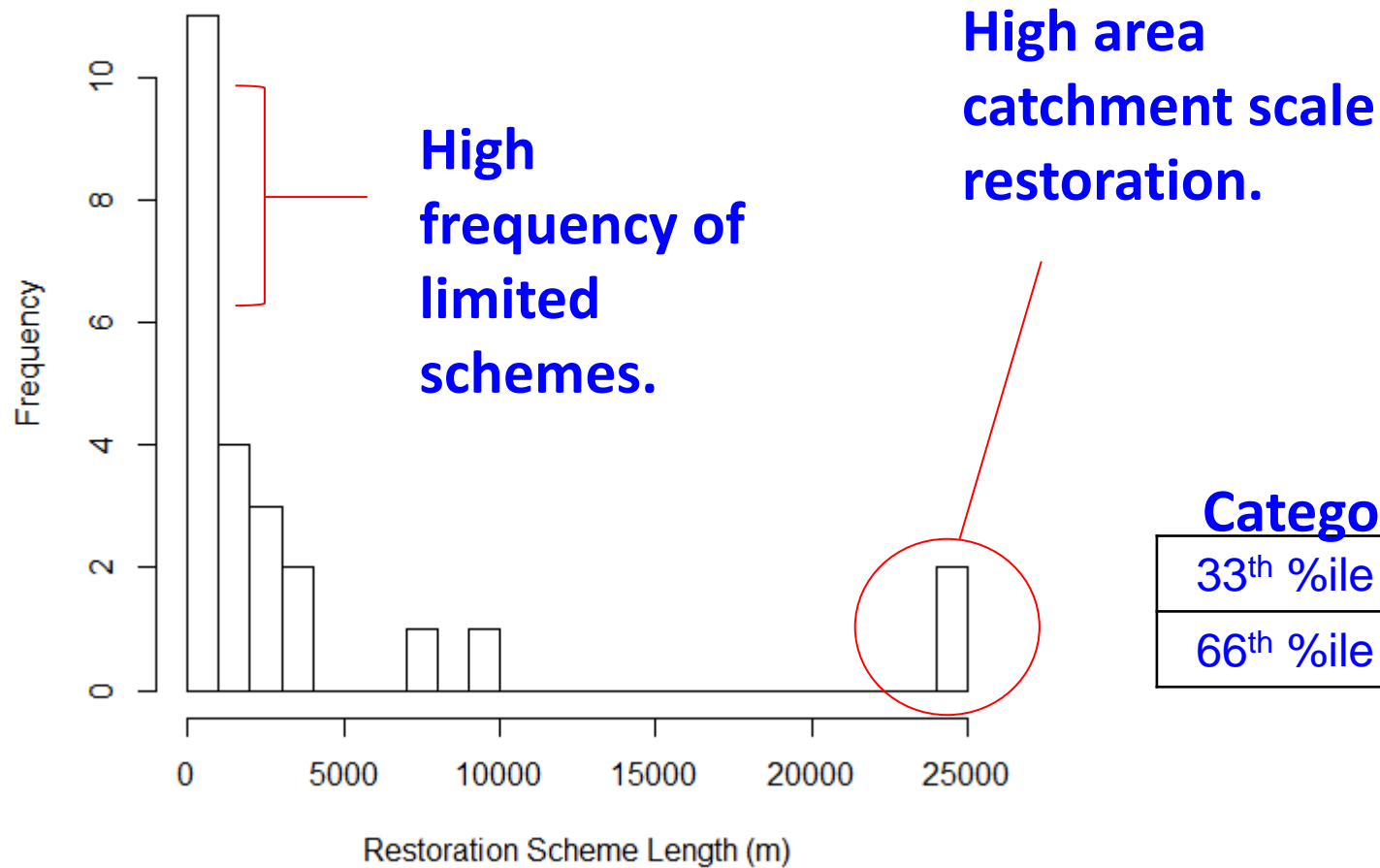
Receptors considered  
Receptor improvement  
Receptor decrease

- Benthic macroinverts
- Fish
- Macrophytes
- Other (diatoms etc.)

# Distribution of projects by country.



# Length of restoration schemes.



## Category Limits

33 <sup>th</sup> %ile	718
66 <sup>th</sup> %ile	2489

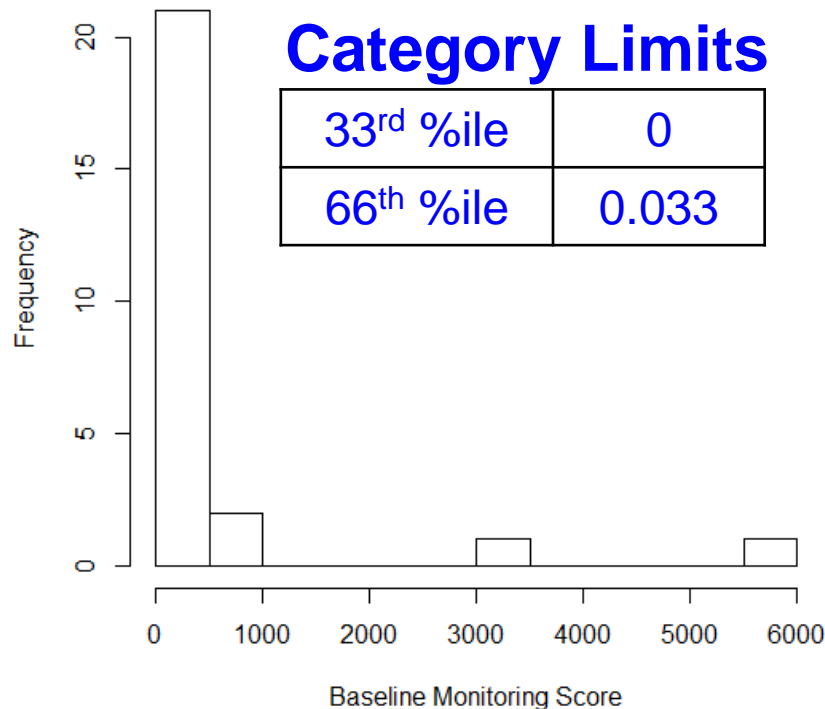
# Baseline monitoring.

**Baseline  
Monitoring  
score**

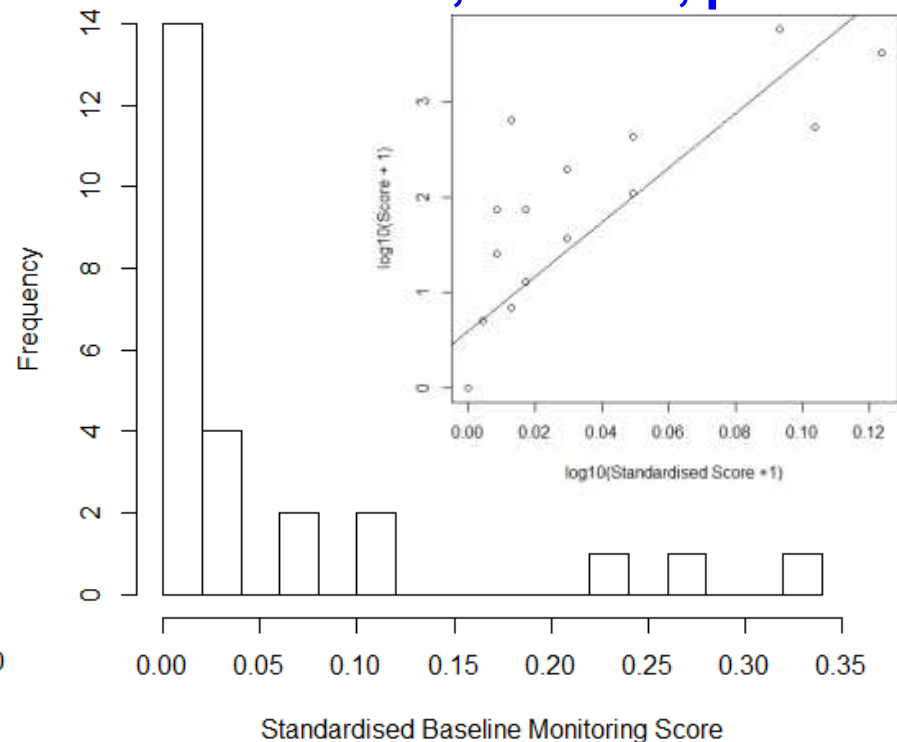
**= Stations x yearly replicates x survey  
timescale (months)**

## Category Limits

33 <sup>rd</sup> %ile	0
66 <sup>th</sup> %ile	0.033



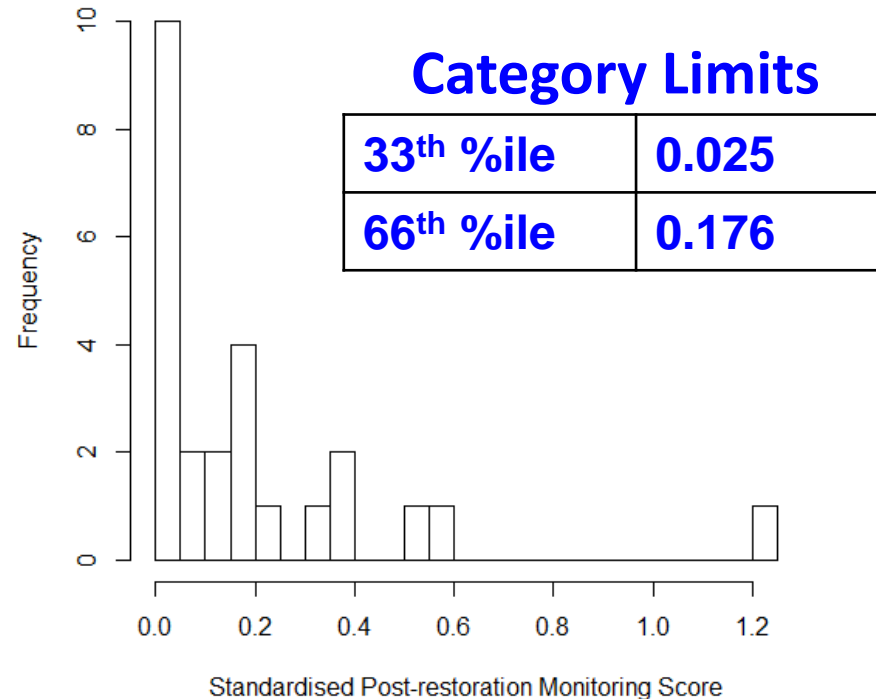
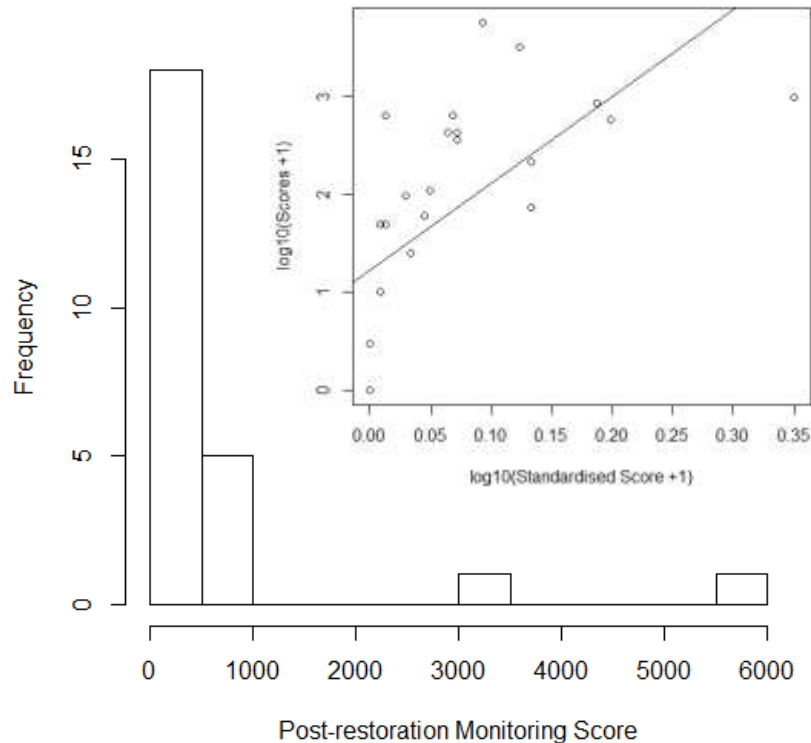
**d.f.= 23,  $t = 6.98$ ,  $p. < 0.001$**



# Post-restoration monitoring.

**Monitoring score** = stations x seasonal replicates x survey timescale (months)

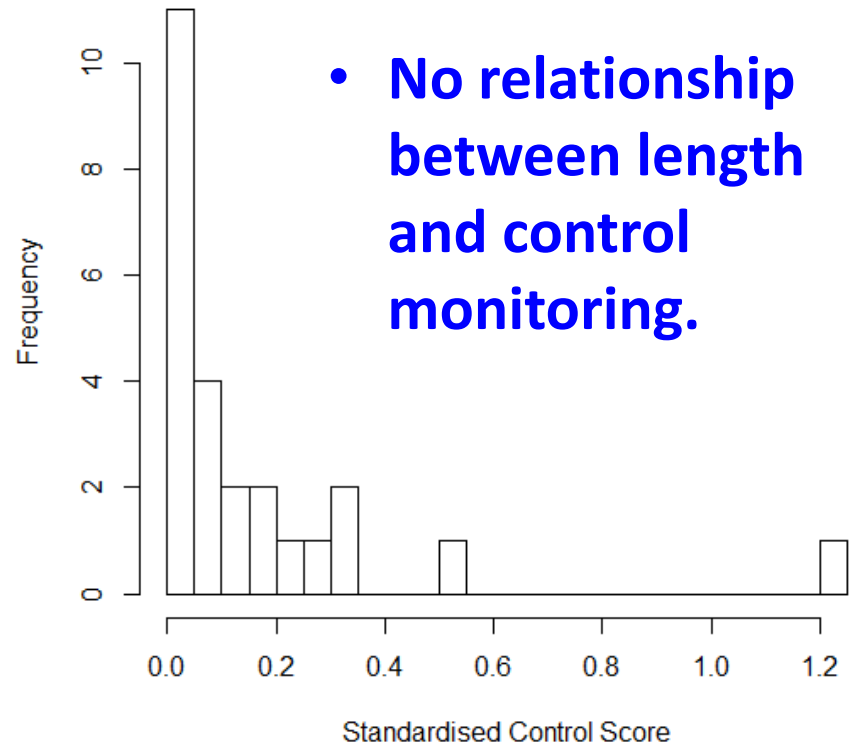
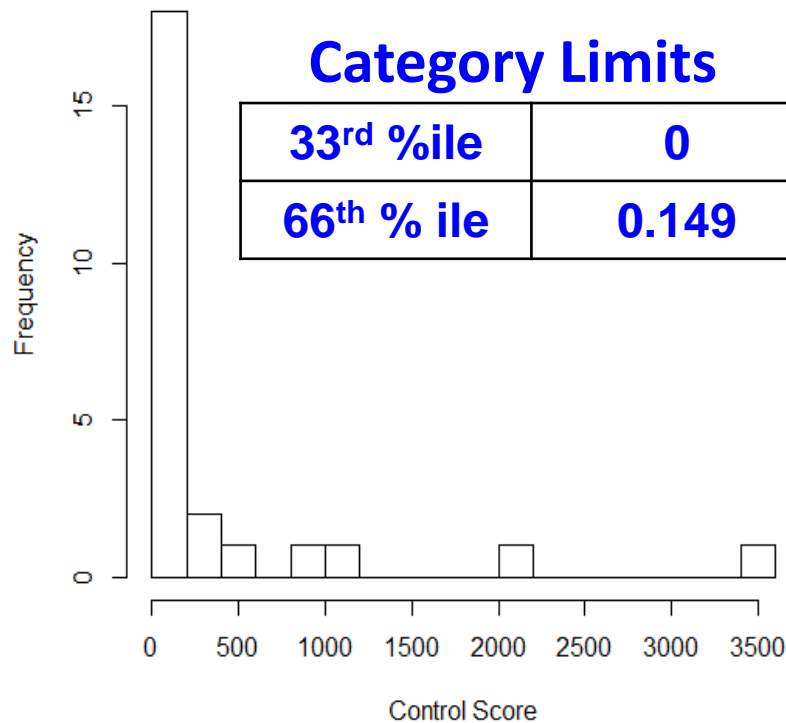
**d.f. = 23, t = 3.89, p. = 0.007**



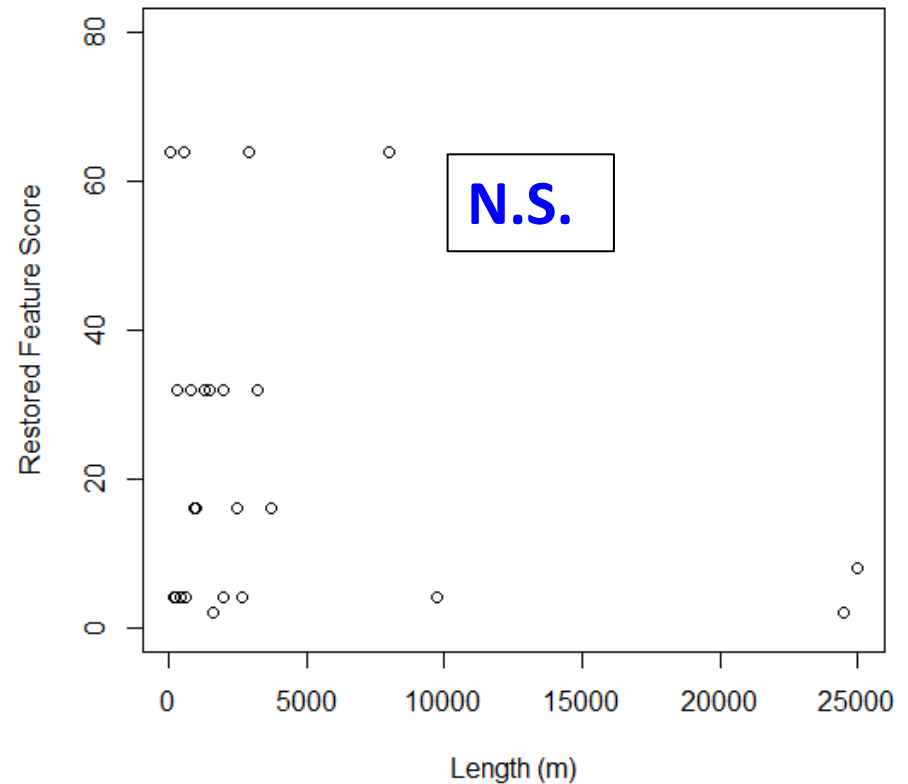
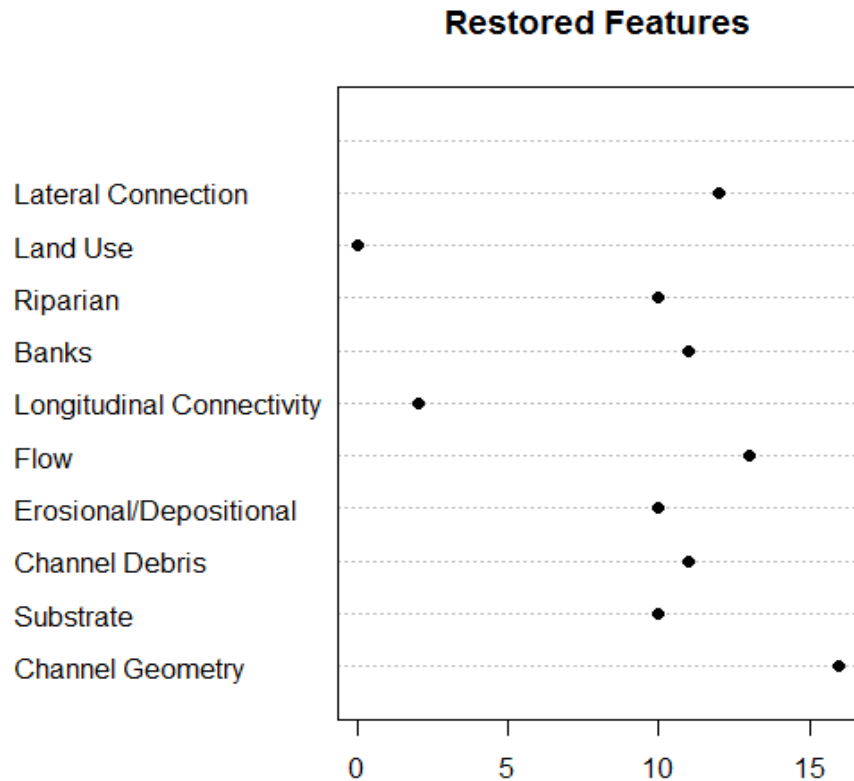
# Control monitoring.

**Control  
monitoring  
score**

**= Stations x seasonal replicates x survey  
timescale (months)**



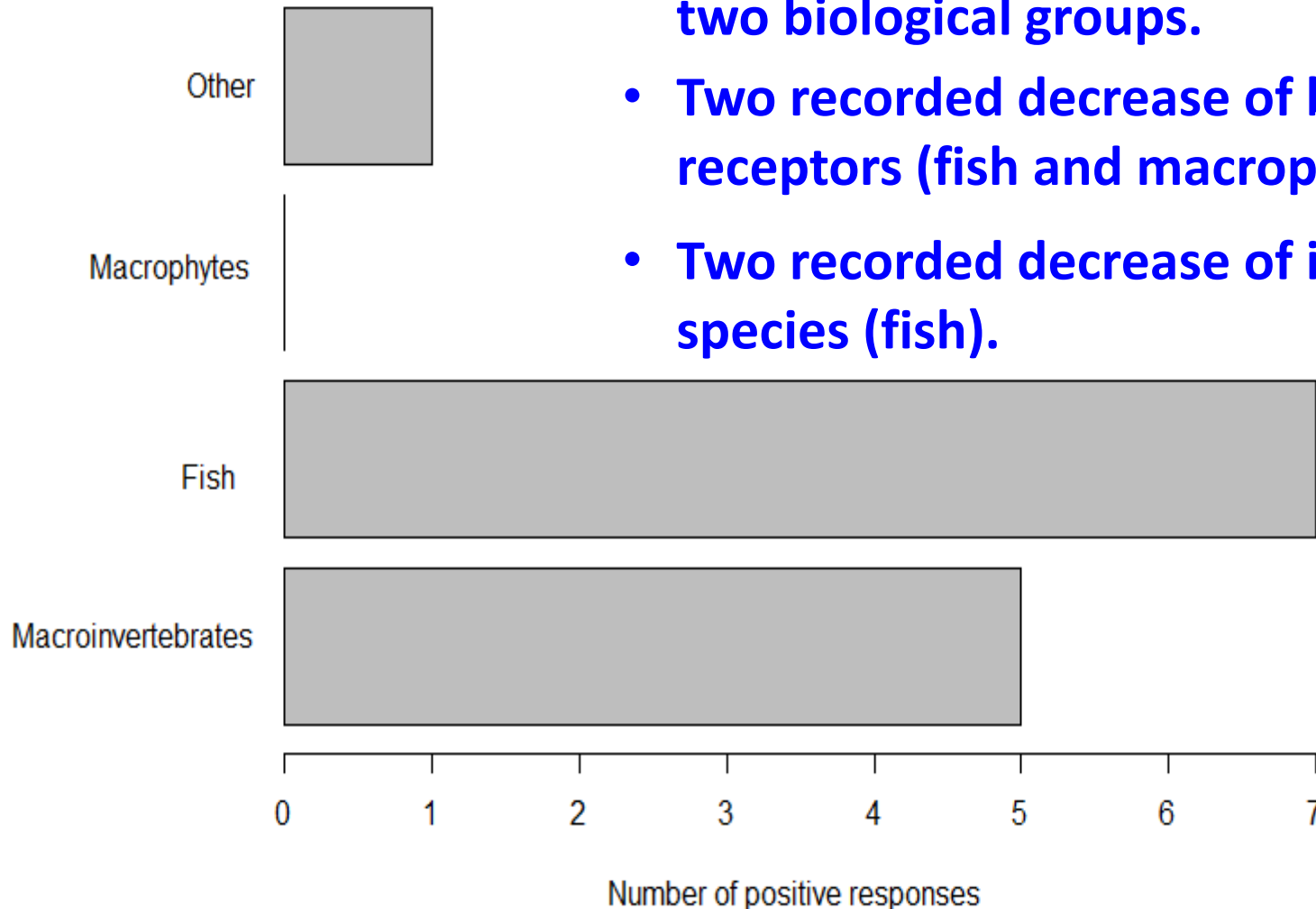
## Restoration effort.



- **No relationship between restoration effort and length.**

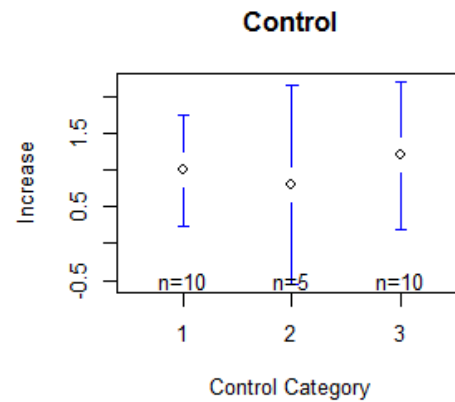
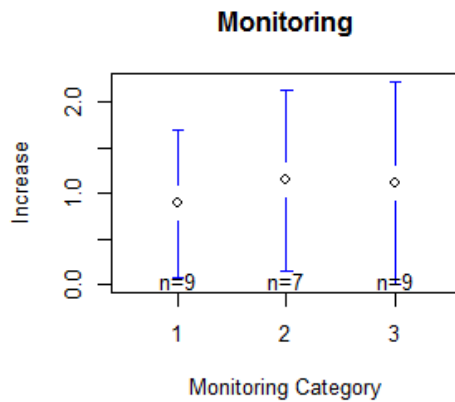
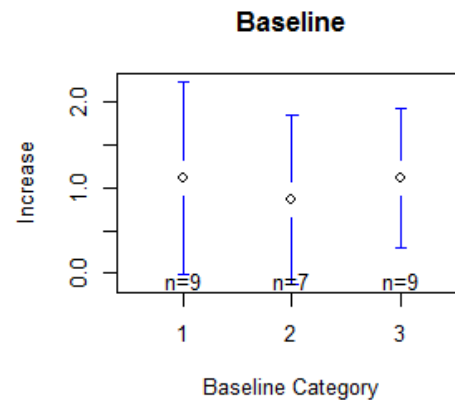
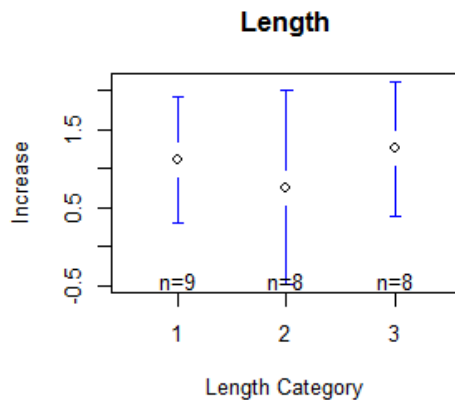
# Ecological effects of restoration.

- One study recorded increases for two biological groups.
- Two recorded decrease of biological receptors (fish and macrophytes).
- Two recorded decrease of invasive species (fish).



# Ecological benefit V Projects categorisations.

- Analysis carried out on receptor increase scores and project length, baseline, monitoring and control score groups.



Category	Quality
1	Low
2	Medium
3	High

- No relationship between project categories and ecological benefit.

# Summary of results.

- Restoration literature dominated by US studies.
- Non peer reviewed sources often not suitable.
- Small scale programs still dominate.
- Longer surveys = better baseline and post-monitoring.
- Use of control sites not related to length.
- > 50% studies recorded no positive response.
- Detection of response not related to project scale.
- Low sample size = less confidence.
- Suitable studies do not have information on costs.

# Key points from studies.

- Are our questions too simple?
  - No net increase in redd numbers but increased survivability (Merz *et al.* 2004).
  - Increased selection of higher quality habitats (Elkin *et al.*, 2007).
  - Invasive community shifts (Baldigo *et al.*, 2008).
  - Life history strategy changes (Solazzi *et al.*, 2000).
- Failure in methods.
  - BACI design not always suitable (Johnson *et al.*, 2005).
  - Measuring *recovery from* or *response to* restoration?
  - Control selection.
- Are we throwing the dice and hoping to roll a 12? Does restoration force systems into periods of instability and unpredictability? (Paillex *et al.*, 2009).

# Conclusions and recommendations.

- Recording and dissemination of information is still inadequate.
- Leads to low confidence in results from studies such as this.
- Perpetrates broken link between the theory and practice.
- PRJ studies fail to consider cost, while non-published sources do not provide the necessary level of information.
- A cross-institutional framework is required to record details of restoration projects and publishing of results should be encouraged.
- Funding bodies need to give equal consideration to monitoring.
- The dominance of patchwork projects is still very evident, potentially representing poor value for money (Schiff et al., 2008).

But remember...we are improving!

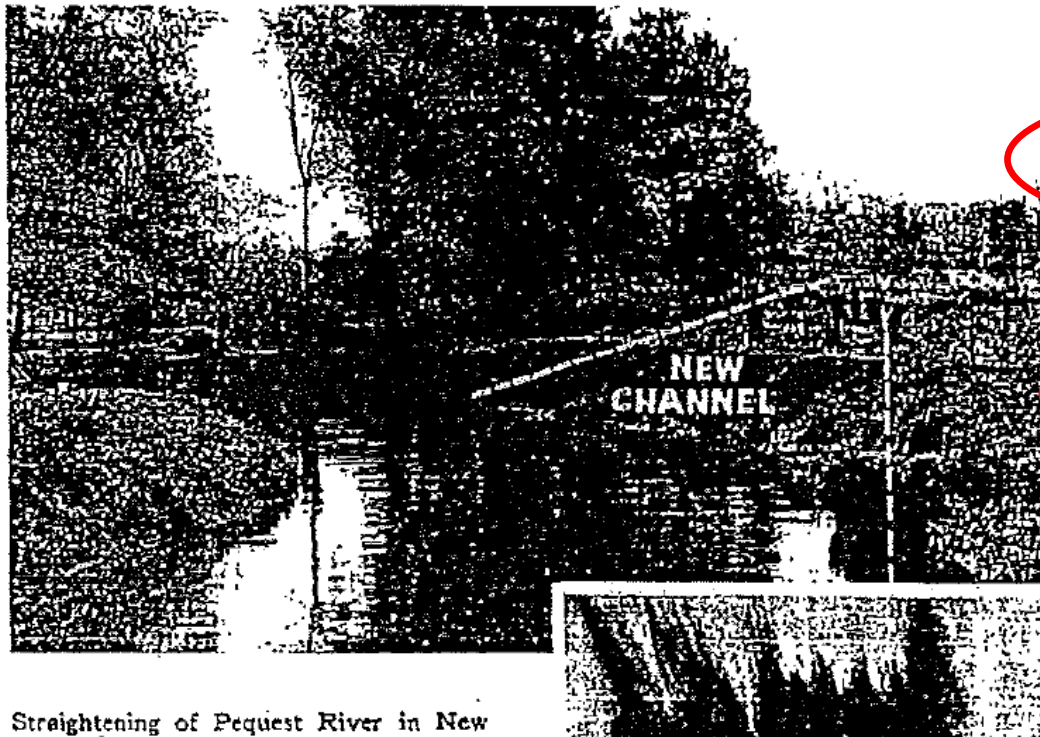
August, 1935

AMERICAN FORESTS

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# How DYNAMITE

## *streamlines streams*



Straightening of Pequest River in New

**C**ROOKED STREAMS are a menace to life and crops in the areas bordering on their banks. The twisting and turning of the channel retards the flow and reduces the capacity of the stream to handle large volumes of water. Floods result. Crops are ruined. Lives are lost. Banks are undermined, causing cave-ins that steal valuable acreage.

In many instances straightening out a stream has doubled its capacity for disposing of run-off water.

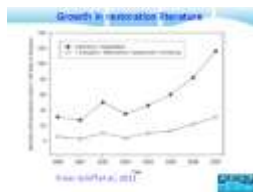
DYNAMITE may be used most efficiently and economically in taking the kinks out of a crooked stream. The dynamite is loaded along the length of "cut-off" channel. When fired,

# Acknowledgments and Thanks.

- Nigel Milner and Rachel Whatmore for assistance with references.
- David Fraser and Kirsten Wright for comments on presentation.



# Presentation – Tommy McDermott & David C. Bradley



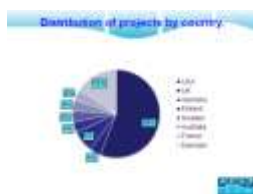
- Large increase in the number of publications
- Rate of growth of talking about restoration is much greater than the rate at which actual projects are assessed in the literature.
- The latter also probably does not reflect a growth in the relative number of projects published, but simply reflects the increasing number of restoration projects.



- Selvakumar... <10% of restoration projects 2000-2010 in US had monitoring
- But do non-published sources provide adequate resolution to be compared along more rigorous published studies?
- There is a very large body of work out there that is not included in the literature, and it is necessary that we establish the usefulness of it.
- We want to bring together the published and unpublished sources and manipulate the information contained within them so we can begin to understand the relationship between cost/effort and ecological benefit.

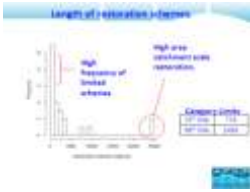


- Project: information including its location, the source of the information (literature, website etc), the length in metres of the restored river and cost. However, cost was only available for 1 study
- Monitoring. Three classes, baseline, post monitoring and controls. Scoring criteria were the number of stations, the length of monitoring in months and the number of replicates (in year)
- Restored features, this is based on the CEN hydromorphology classification, which can also be justified with a restoration focus.
- Positive ecological indicators. Scores were developed for the indicators assessed, and any increase or decrease. However information was not common on decreases.
- Negative ecological indicators. Although there is some information that restoration can reverse the spread of invasives, only two studies reported this.

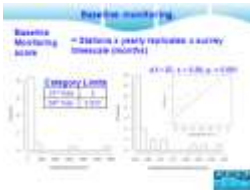


- The dominance of US restoration projects is clear, and it was estimated in one paper that recent restoration work has ran into the billions in the USA
- I have a perception that European projects claim a much greater success rate for restoration than is seen in the

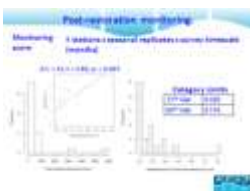
American theatre, and it was a secondary aim to explore this. However it was not possible given the level of data available.



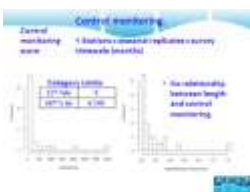
- The extent of restoration projects are very heavily weighted towards the lower end of the spatial scale. Very few catchment restoration schemes were found in the resources.
- The percentile table demonstrates the breakpoints in the categories, > 718 were the low distance, 718-2489 for mid-range studies, and greater than this for large scale restoration works.



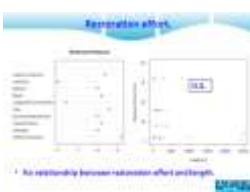
- Graph one shows the unstandardized scores for baseline monitoring.
- However if the scores are standardised by length we see a much more diverse distribution.
- If we compare standardised scores with actual scores, we find a strong indication that there is a relationship between baseline monitoring effort and project length (this was tested directly).
- However, whether this relates to an a priori selection of rivers based on previous research/monitoring effort is unclear.
- The fact that the lower percentile limit was 0 indicates that baseline monitoring was not ubiquitous.



- Similar situation to the baseline monitoring. Standardising the scores by length diversifies the distribution, while positive relationship between length and score.
- The greater occurrence of monitoring is demonstrated by the >0 percentile lower limit
- However, certain studies conducted monitoring during the restoration work and they weren't included.
- Non-linear doubled  $r^2$  but data is not sufficiently high quality to use non linears confidently. Interesting possibility of using relationship to maximise length v monitoring with applications for cost management.



- 'No relationship between length and control
- High occurrence of no scores for controls (43% of survey had no controls)
- Controls also varied between control from references, control from impacted or a mixture of both.
- A word on the scoring system. I believe that the information categories are a useful way of summarizing the relevant data. While the scoring system was adequate in this case and reflected the true state of the monitoring programs, I do believe that given a more complex set of data with greater sample size it is possibly too simplistic to the point that it may not work successfully. Therefore, I don't recommend that it is replicated in its current form for future work.



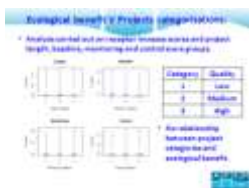
- The restored features are based on the CEN standard. Multiple features were restored in single projects, although often not the primary focus of the effort (e.g. emplacement of LWD to increase cover also serves to disrupt homogenous flow patterns or increase scouring).
- However, the features restored were independent of the length of

survey, indicating that even short scale surveys can have quite complex restoration efforts.

- The effect of this short scale project dominance is probably seen in the very low level of projects which attempt to restore longitudinal connections or to encourage more natural land uses adjacent to river riparian corridors.



- Although numerous studies recorded an ecological benefit from restoration, over half the surveys still recorded no benefit from restoration.
- The number of projects considering restoration benefit on fish and inverts were roughly the same, therefore the increased positive response from fish may indicate a greater response potential from fish to restoration.
- Alternatively it may reflect the increased complexity of macro invert communities resulting in a less clear pattern of response



- 174 papers were identified as potentially useful and 1 non published source, from the EA.
- Of the papers used all bar the EA report were PR Journals
- Scoring criteria was kept simple, and was multiplicative, to give higher scores to more in-depth studies
- Categories for length and monitoring efforts were based on third percentiles, which means they are only relevant to this study.



