

Does habitat restoration increase fish numbers or simply concentrate fish?



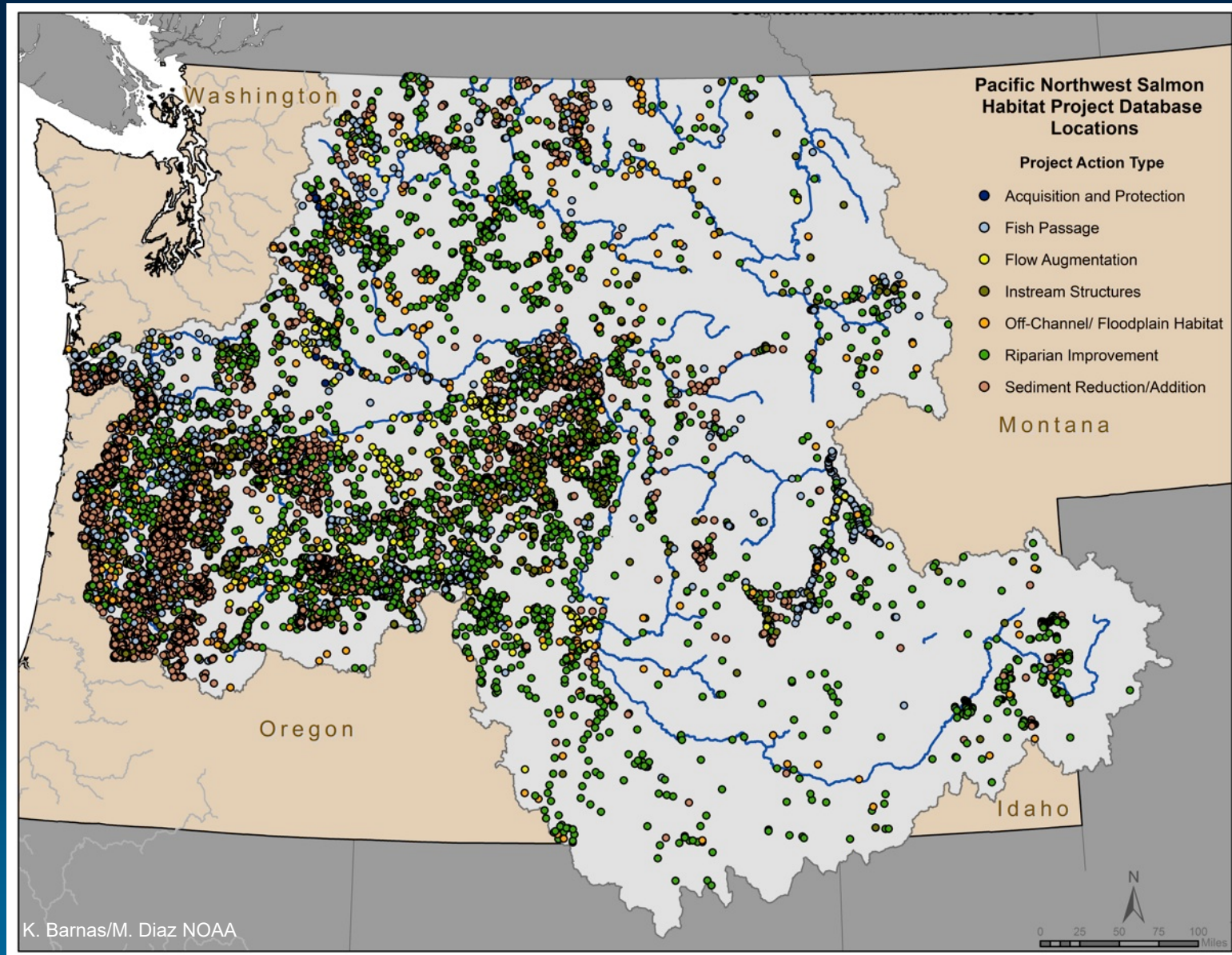
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Watershed Sciences Lab



1,000s of Projects Implemented



Considerable Debate

➤ Physical Response

➤ **Biological Response – More fish or?**

- Concentrate fish?
- Increased fish numbers?
- Increased survival?
- Is project size important?



Review of Restoration Science

600+ papers on effectiveness

North American Journal of Fisheries Management 21: 1-10, 2002
Abstract Fisheries Society 2002

A Review of Stream Restoration Techniques and a Hierarchical Strategy for Prioritizing Restoration in Pacific Northwest Watersheds

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Abstract—Millions of dollars are spent annually on watershed restoration and stream channel improvement in the U.S. Pacific Northwest in an effort to restore degraded streams to a condition that supports a sustainable fishery. The aim of this review is to provide a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. The aim of this review is to provide a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. The aim of this review is to provide a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds.

Watershed restoration is a complex process that involves many land management activities. Many land management activities are required to restore a watershed to a condition that supports a sustainable fishery. The aim of this review is to provide a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds.

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Habitat rehabilitation for inland fisheries

Global review of effectiveness and guidance for restoration of freshwater ecosystems

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484

Fish-Habitat Relationships and the Effectiveness of Habitat Restoration

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U.S. DEPARTMENT OF COMMERCE
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National Marine Fisheries Service
Northwest Fisheries Science Center

Global Review of the Physical and Biological Effectiveness of Stream Habitat Rehabilitation Techniques

PHILIP ROSE, KENNETH HANSON, AND TIM BESCHIE
Abstract—The objective of this review is to provide a global perspective on the effectiveness of stream habitat rehabilitation techniques. The aim of this review is to provide a global perspective on the effectiveness of stream habitat rehabilitation techniques.

Wood placement in river restoration: fact, fiction, and future

Philipp Rose, Tim Beschie, George Pess, and Kaitie Hanson

PERSPECTIVE

Abstract—Despite decades of research, the impact of wood in river restoration remains controversial. We reviewed the literature on wood placement in river restoration and found that the effectiveness of wood placement is highly variable and depends on many factors. The aim of this review is to provide a global perspective on the effectiveness of stream habitat rehabilitation techniques.

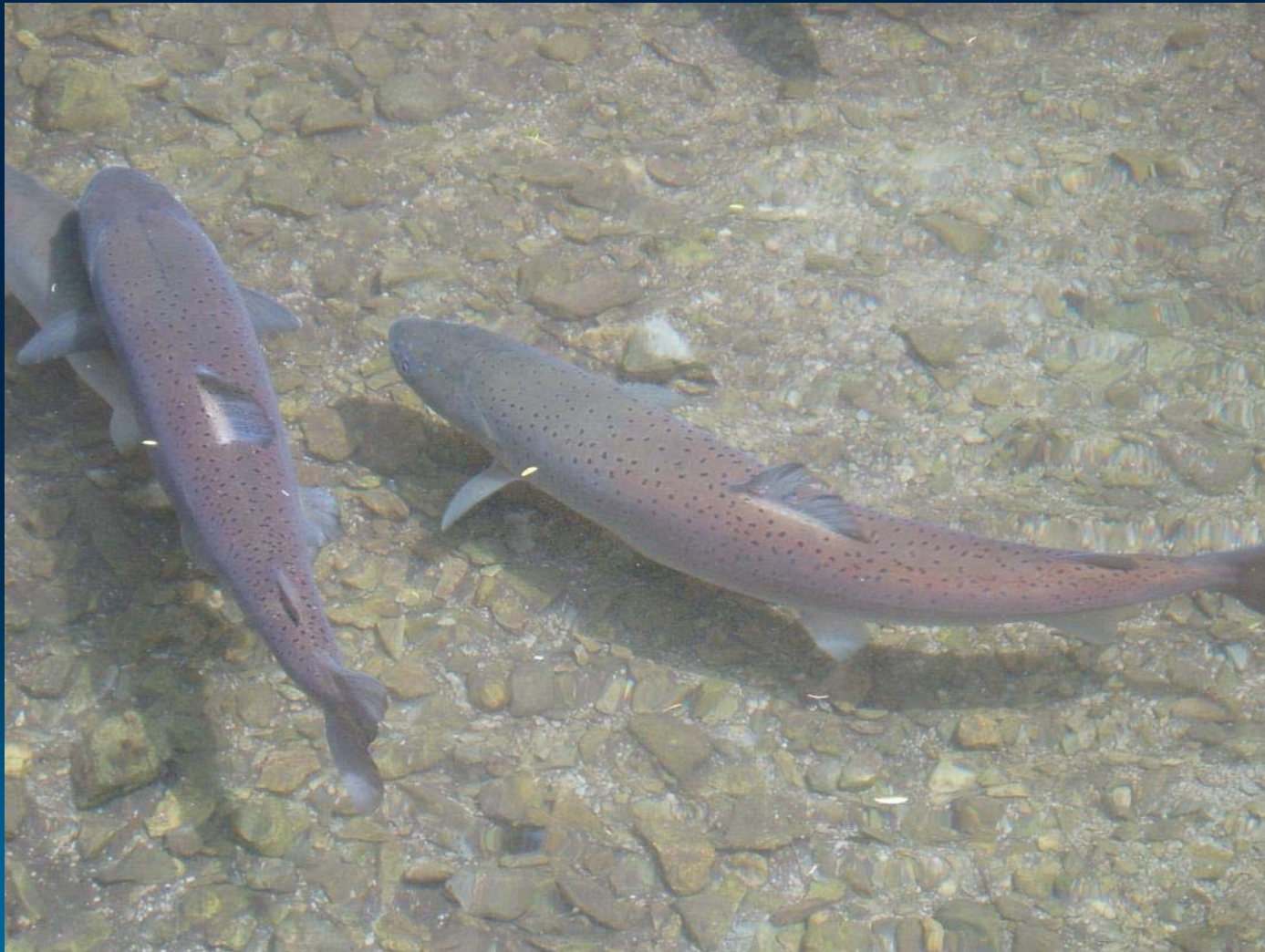
Introduction
The use of wood in river restoration has become a popular practice in many parts of the world. Wood placement is used to improve channel morphology, create habitat, and reduce erosion. However, the effectiveness of wood placement is highly variable and depends on many factors. The aim of this review is to provide a global perspective on the effectiveness of stream habitat rehabilitation techniques.

Goals for Today

- Specifically does river restoration...
 1. increased numbers or simply concentrate fish?
 2. increased fish number or survival?
 3. Is bigger restoration better?



1. Does restoration increase fish numbers or simply concentrate fish?



What does literature say?

- Not a new question
- Movement studies
 - Little movement
- Gowan et al. 1994
 - Increase due to migration (6 streams)

Restricted Movement in Resident Stream Salmonids: A Paradigm Lost?

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Gowan, C., M.K. Young, K.D. Fausch, and S.C. Riley. 1994. Restricted movement in resident stream salmonids: a paradigm lost? *Can. J. Fish. Aquat. Sci.* 51: 2626–2637.

Gerking (1959. *Biol. Rev.* 34: 221–242) proposed a theory about the restricted movement of stream fishes that may be considered a paradigm in salmonid biology. The restricted movement paradigm (our term) hold that resident stream salmonids are sedentary. Numerous studies have supported the restricted movement paradigm, but nearly all have relied on the recapture of marked fish from the same areas in which they were released, an approach we believe is biased against detecting movement. We found substantial movement of trout in streams in Colorado and Wyoming using two-way weirs and radio telemetry. A review of the research on Lawrence Creek, Wisconsin, also showed that movement was important in the response of the trout population to habitat enhancement. Movement of resident stream fish has profound implications for research (e.g., measuring production and habitat models) and management (e.g., habitat enhancement, special regulations, and stocking hatchery fish). Methods capable of detecting fish movement could be incorporated into many studies to assess its importance in systems of interest. New theories and experiments are needed to understand the mechanisms that cause stream salmonids to move.

Gerking (1959. *Biol. Rev.* 34: 221–242) a proposé une théorie sur la limitation du déplacement des poissons dans les cours d'eau que nous croyons être un paradigme en biologie des salmonidés. Selon cette théorie, nommée par nous paradigme de la limitation du déplacement, les salmonidés résidents des cours d'eau seraient sédentaires. De nombreuses études ont appuyé ce paradigme, mais presque toutes étaient fondées sur la recapture de poissons marqués dans les zones mêmes où ils avaient été libérés, une approche que nous croyons biaisée en ce qui concerne la détection du déplacement. Nous avons constaté un déplacement substantiel de truites dans des cours d'eau du Colorado et du Wyoming à l'aide de bordiques à deux voies et de la radiotélémétrie. Une revue de la recherche effectuée dans le Lawrence Creek au Wisconsin a également montré que le déplacement était important dans la réponse de la population de truites à l'enrichissement de l'habitat. Le déplacement des poissons résidents des cours d'eau comporte d'importantes implications en recherche (p. ex., mesure de la production et modèles d'habitats) et en gestion (p. ex., enrichissement de l'habitat, réglementation particulière et stockage des écloséries). Des méthodes permettant de déceler le déplacement du poisson pourraient être intégrées à de nombreuses études afin d'évaluer son importance dans les systèmes en cause. De nouvelles théories et de nouvelles expériences sont nécessaires à la compréhension des mécanismes à l'origine du déplacement des salmonidés dans les cours d'eau.

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But, 20 years later.....

White et al. 2011

2057

Response of trout populations in five Colorado streams two decades after habitat manipulation

Shannon L. White, Charles Gowan, Kurt D. Fausch, Josh G. Harris, and W. Carl Saunders

Abstract: Evaluating the effectiveness of instream structures for increasing trout populations is complicated by a paucity of long-term studies. We report on a study spanning 23 years to assess the effect of installing log weirs on stream habitat and trout abundance. Structures were installed in a randomly selected half of a 500 m study reach in six small Colorado, USA, mountain streams in 1988, and habitat and trout abundance and biomass were measured annually from 1987 to 1994. When five of the streams were resampled in 2009, none of the 53 logs had moved, and all but one were functioning properly. Pool volume remained more than three times higher in treatment sections than in adjacent controls, and mean depth was also greater. Adult trout abundance increased rapidly after structures were installed and remained 53% higher in treatment sections than in controls 21 years later. Effects on juvenile trout abundance were not detected, probably because fry recruitment is strongly influenced by effects of snowmelt runoff, which vary annually among basins. This evaluation shows that instream structures placed in small, stable channels can function for more than two decades when properly installed and can cause long-lasting increases in trout abundance when habitat is limiting.

Résumé: L'évaluation de l'efficacité des structures ajoutées dans un cours d'eau pour augmenter les populations de poissons est compliquée par l'absence d'études à long terme. Nous présentons une recherche sur 23 années qui mesure l'effet de l'addition de digues en billes de bois sur l'habitat du cours d'eau et l'abondance des truites. Les structures ont été installées dans la moitié (choisie au hasard) de sections d'étude de 500 m dans six petits cours d'eau de montagne du Colorado en 1988 et des mesures de l'habitat, de même que de l'abondance et de la biomasse des truites, ont été faites chaque année de 1987 à 1994. Quand cinq des cours d'eau ont été ré-échantillonnés en 2009, aucune des 53 billes de bois ne s'était déplacée et toutes, sauf une, fonctionnaient adéquatement. Le volume des fosses était encore trois fois plus important dans les sections modifiées que dans les sections témoins adjacentes et la profondeur moyenne était aussi plus grande. L'abondance des truites adultes a augmenté rapidement après l'installation des structures et elle était encore 53 % plus élevée que dans les sections témoins 21 ans plus tard. Aucun effet n'a pu être décelé chez les jeunes truites, probablement parce que le recrutement des alevins est fortement influencé par les effets du ruissellement de la fonte des neiges qui varie chaque année d'un bassin à un autre. Notre évaluation montre que les structures placées dans de petits chenaux stables peuvent fonctionner pendant plus de deux décennies lorsqu'elles sont bien installées et qu'elles peuvent produire des augmentations persistantes de l'abondance des truites lorsque l'habitat constitue un facteur limitant

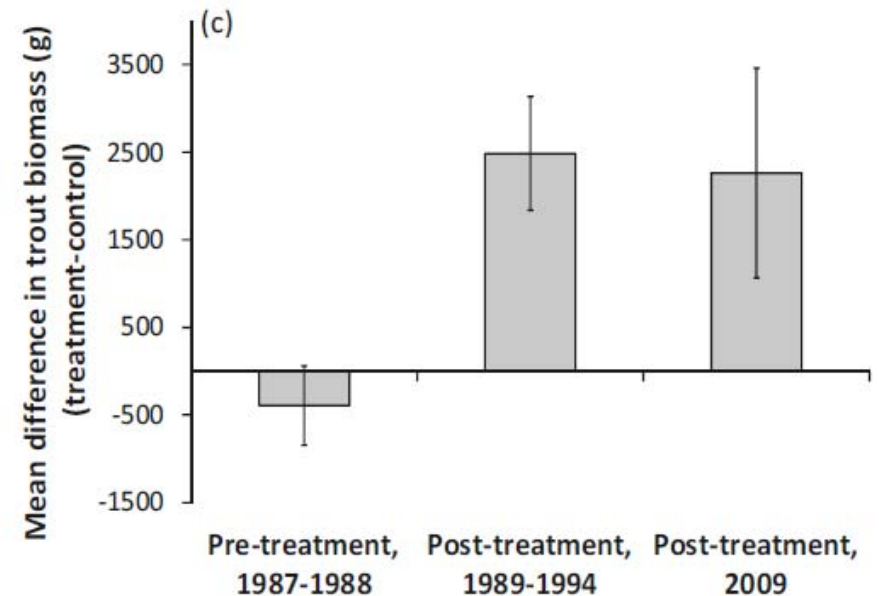
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Introduction

Management of stream salmonids often involves manipulation of habitat, under the assumption that increasing physical habitat will increase fish populations (Hunt 1994; Fausch et al. 1995; White et al. 2010). Addition of instream structures to salmonid streams has been ongoing since the 1930s in North America (White 1996). Numerous studies in various geographic regions have shown that habitat manipulation can increase salmonid abundance and biomass by increasing the

quantity and size of pools, overhead cover, and spawning habitat (e.g., Hunt 1976; Gowan and Fausch 1996a; Solazzi et al. 2000). However, of four recent reviews, including two with quantitative meta-analyses, two concluded that the addition of instream structures resulted in an increase in salmonid populations (Roni et al. 2008; White et al. 2010), whereas the other two concluded that evidence for a positive treatment effect was equivocal or lacking (Thompson 2006; Stewart et al. 2009).

The reason some studies failed to detect effects of instream



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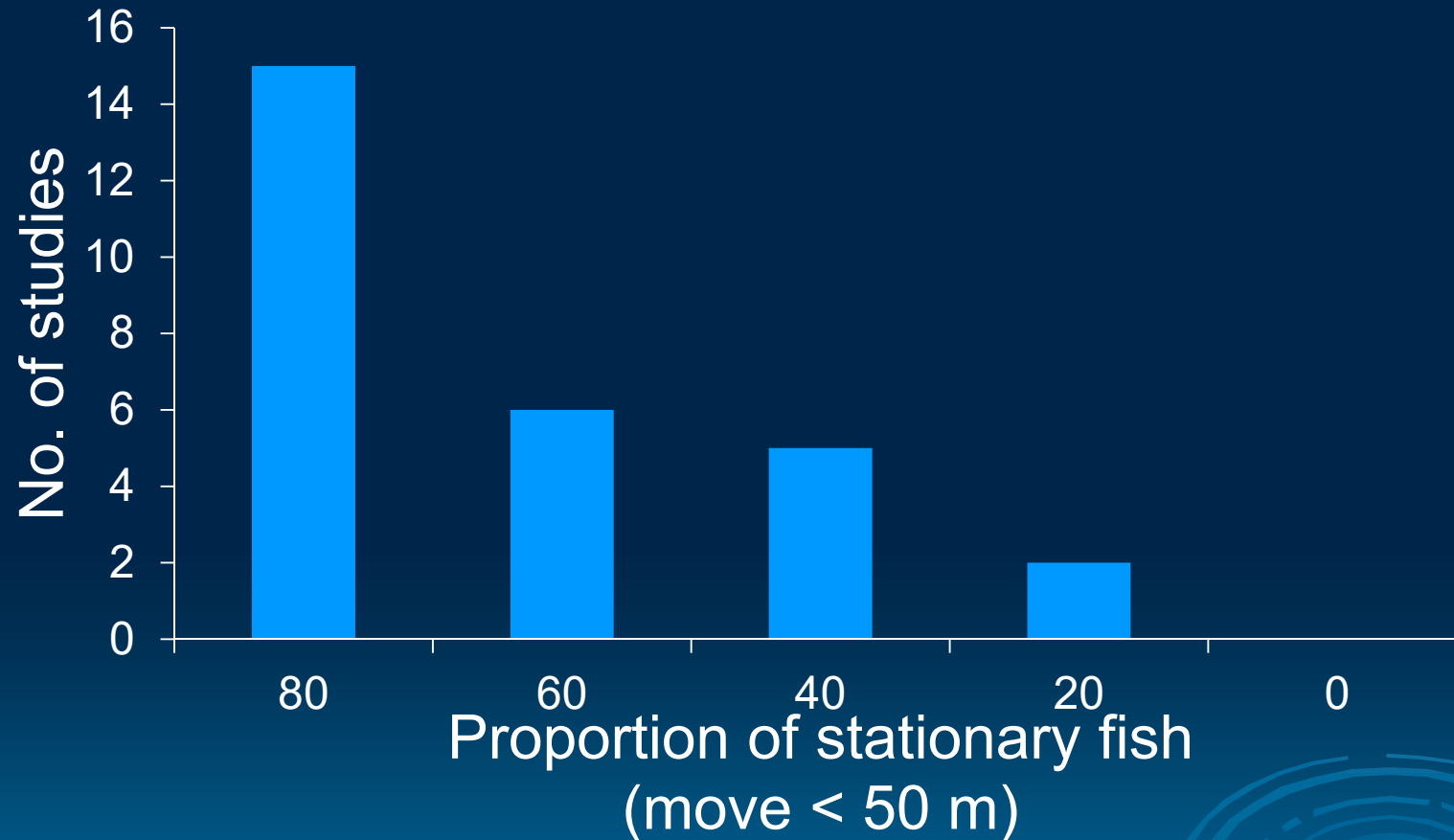
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Movement in stream fishes

Studies on fish movement (n = 27)



Rodriguez. 2002. Restricted movements in stream fishes: paradigm is incomplete, not lost. *Ecology* 83:1-13.

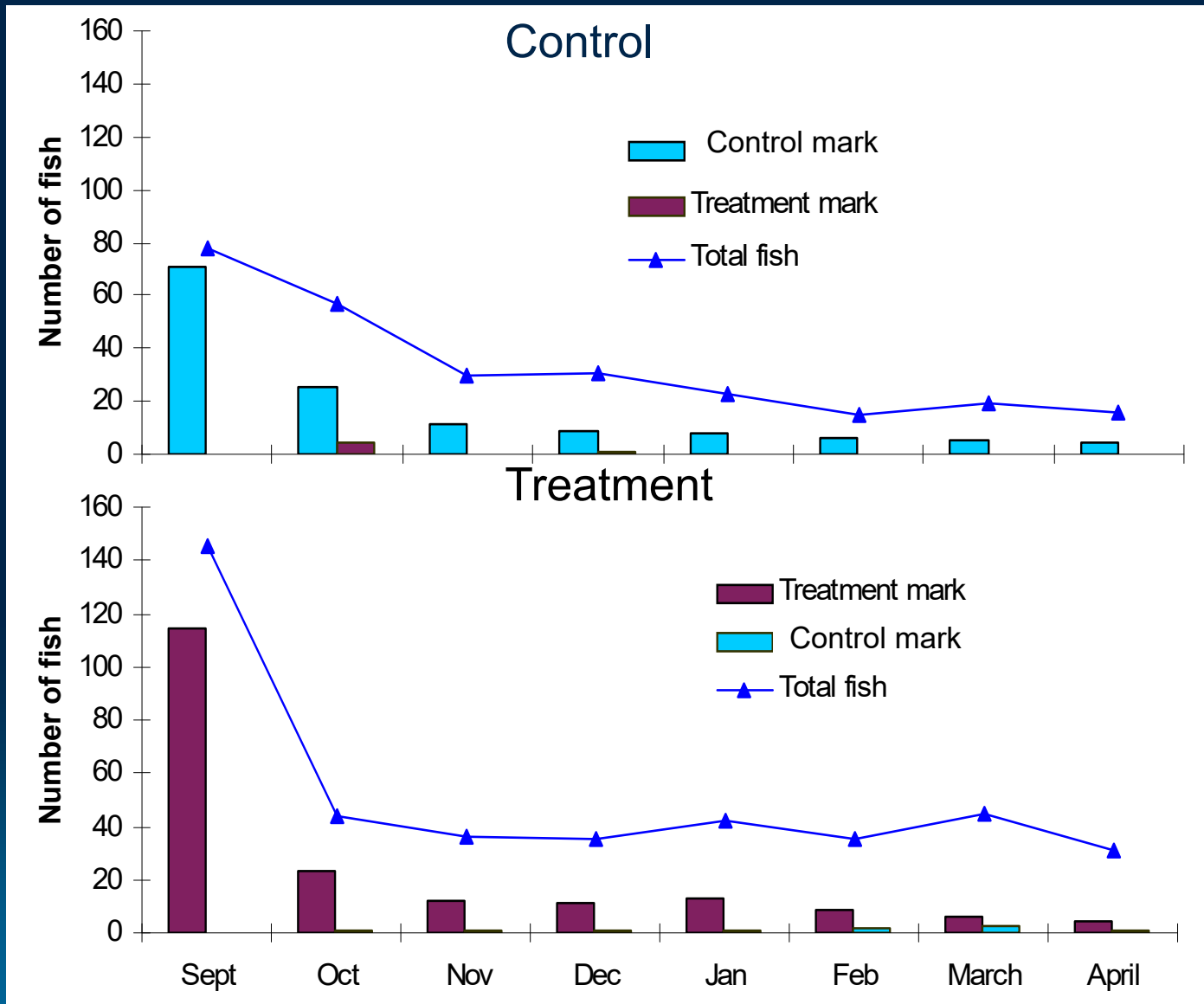
Summary of Literature

(Studies that actually tracked marked fish)

Study	Concentration	More fish
Shetter and Clark 1946		X
Latta 1972	X	
Naslund 1989		X
Slaney et al. 1994	X	
Riley & Fausch 1995; Gowan & Fausch 1996a, b.	X	
Quinn and Kwak 2000	X	
Roni and Quinn 2001b		X
Lehane et al. 2002		X

Fish Move to Restored Habitat?

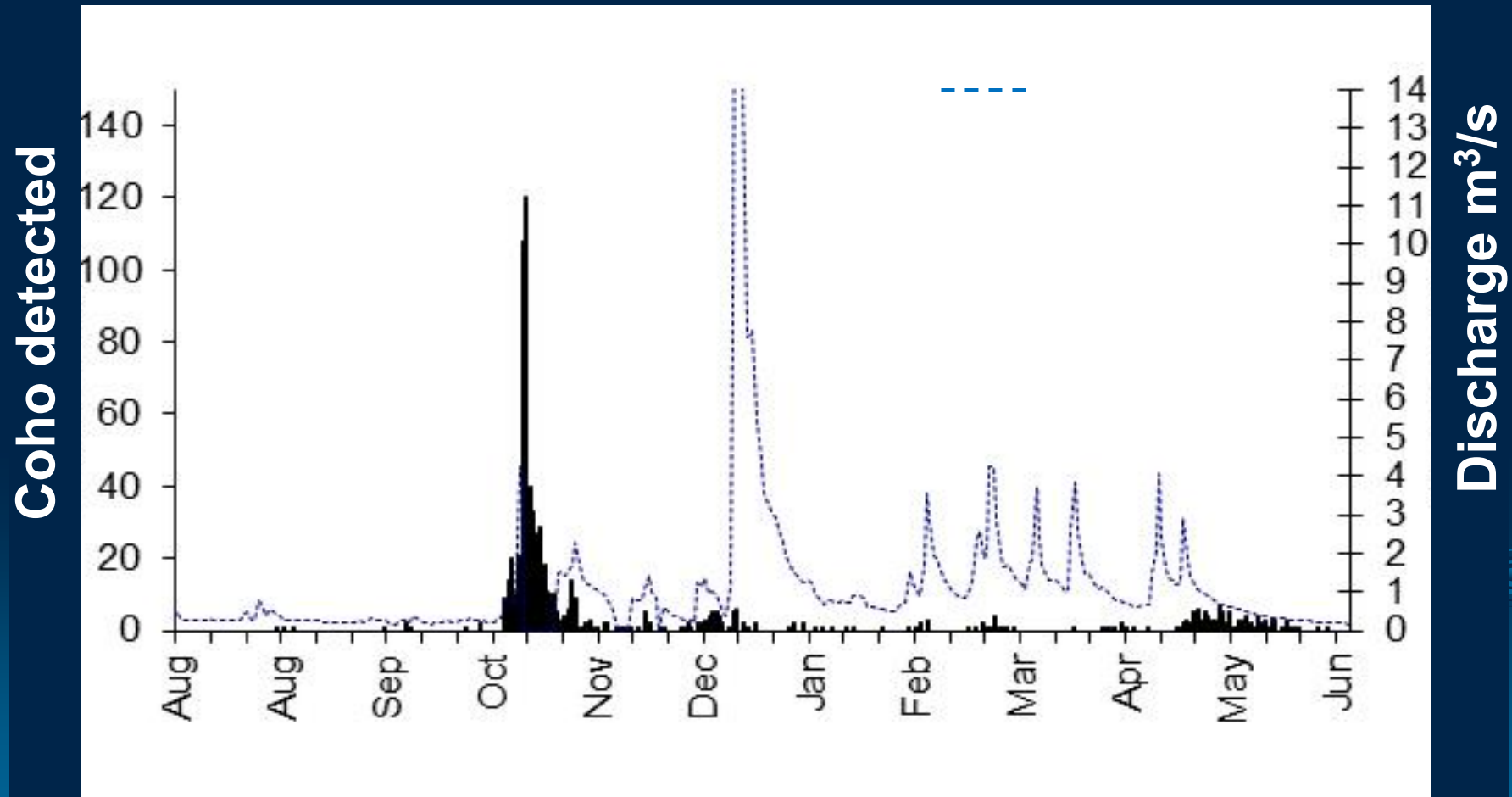
Shuwah Creek Juvenile Coho and Steelhead



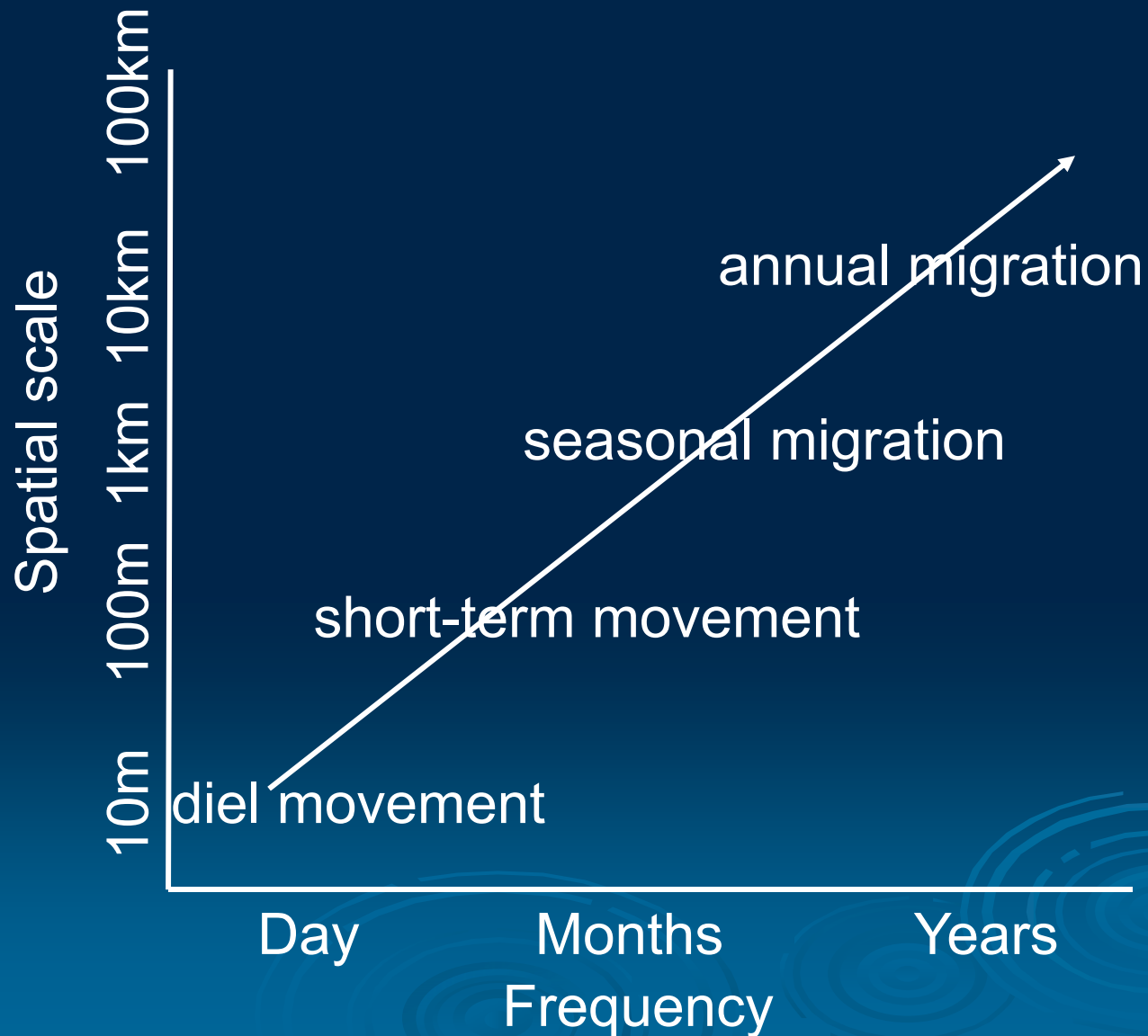
Roni and Quinn 2001 TAFS

Movement vs Migration?

Typical Migration Pattern of Juvenile Coho



Movement vs Migration



Summary of Literature/Studies

- In long term, it is increased abundance not due to immigration/concentration
- Most movement studies indicate most juvenile fish do not move >100m
- But migration is often at scale much larger than restoration (10s of kilometers)

Summary of Literature/Studies

- Some short-term immigration but..
- We're not dealing with marine fish
 - New cohort of salmonids every year
 - Most resident/live 1 to five years
 - Vacated habitat will be colonized



2. Increased number or survival?



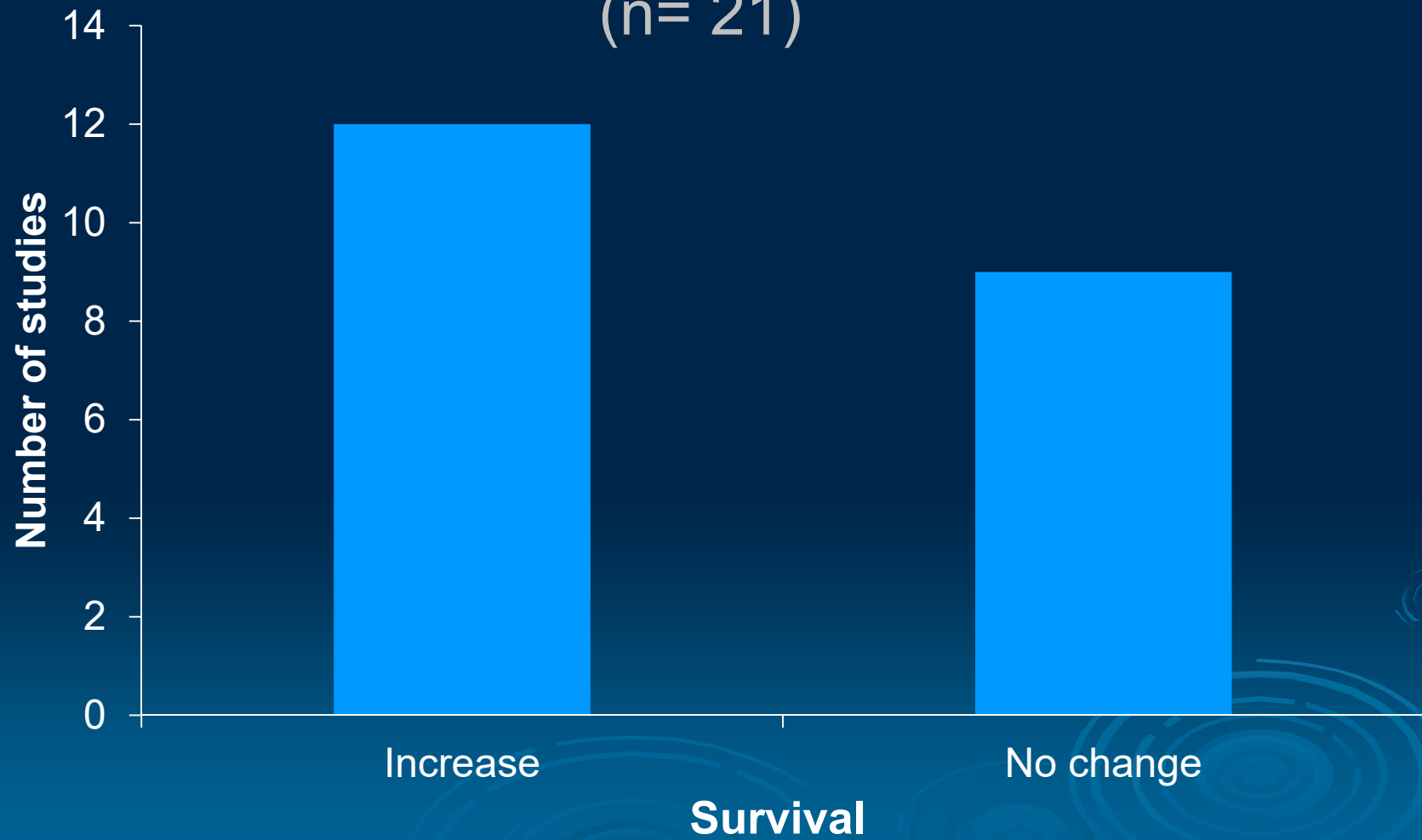
Todd Bennett photo

2. Increased number or survival?


- Increases in fish abundance can be
 - Increase in number (density) or capacity
 - Increase in survival
 - Some combination of two
- 21 published studies looked at survival
 - Results vary widely
- 2 IMWs reporting increased survival

Restoration Effectiveness Studies Examining Survival

(n= 21)



Conclusions

- Literature is mixed
 - Many show improvements in survival but not statistical significant or rigorous
 - Survival is difficult to measure
 - Density or numbers easy to measure
- 

3. Is bigger restoration better?



Few hundred meters

vs

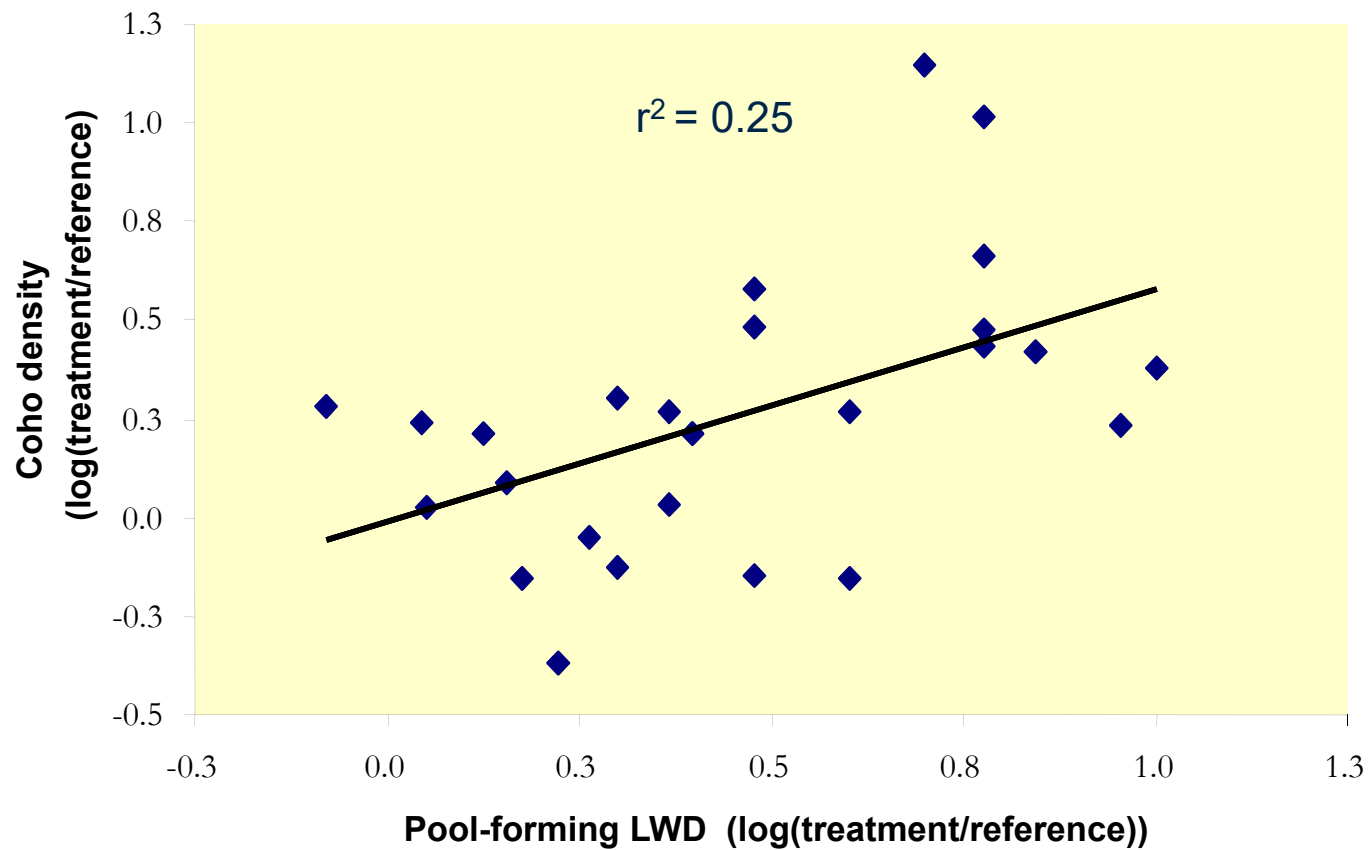
Several thousand Meters

3. Is bigger restoration better?

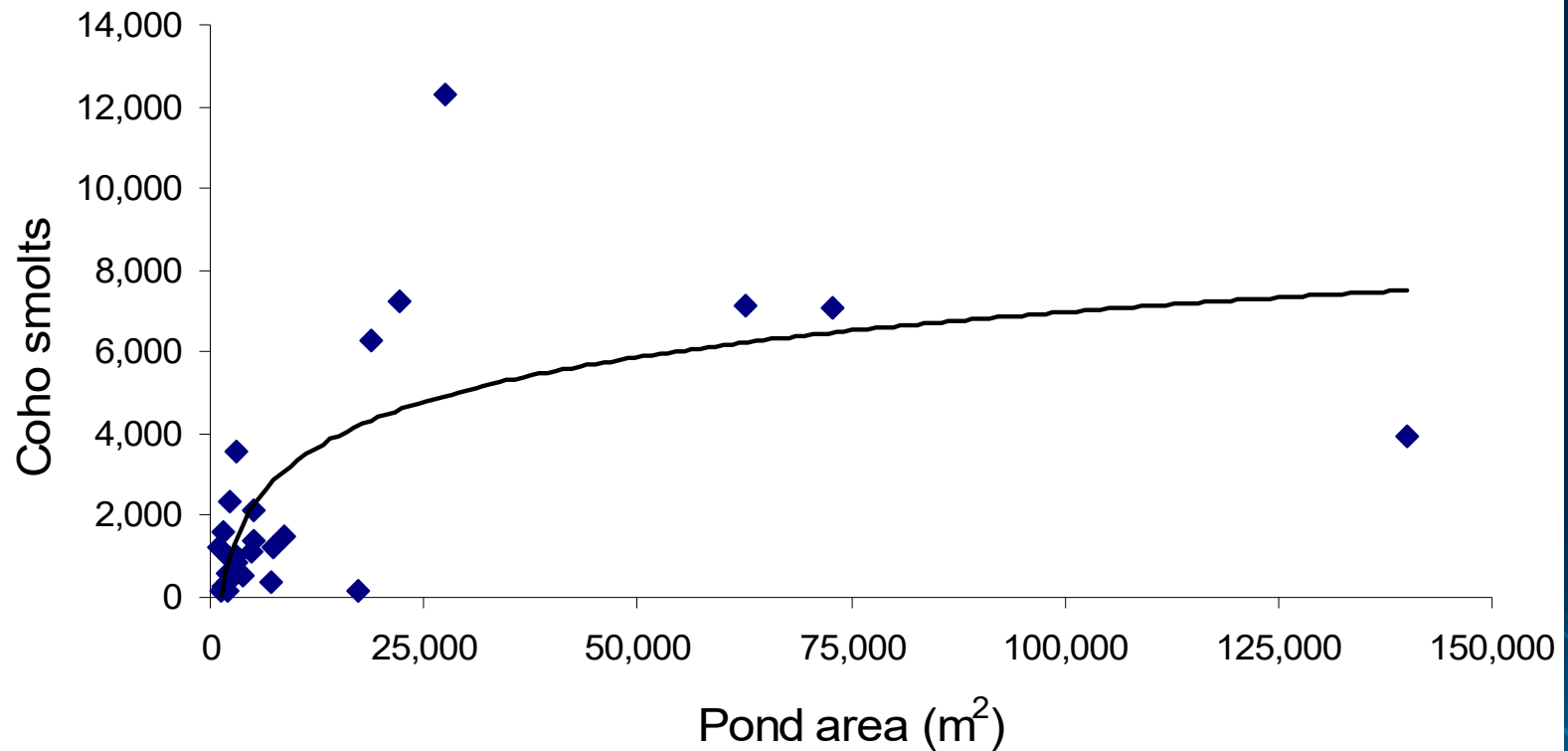
➤ Really three questions

- Intensity of restoration
 - Number of logjams etc.
- Size of project
 - Total stream length or off-channel area
- Total amount in a watershed
 - Cumulative amount of habitat restored

More intensive is better

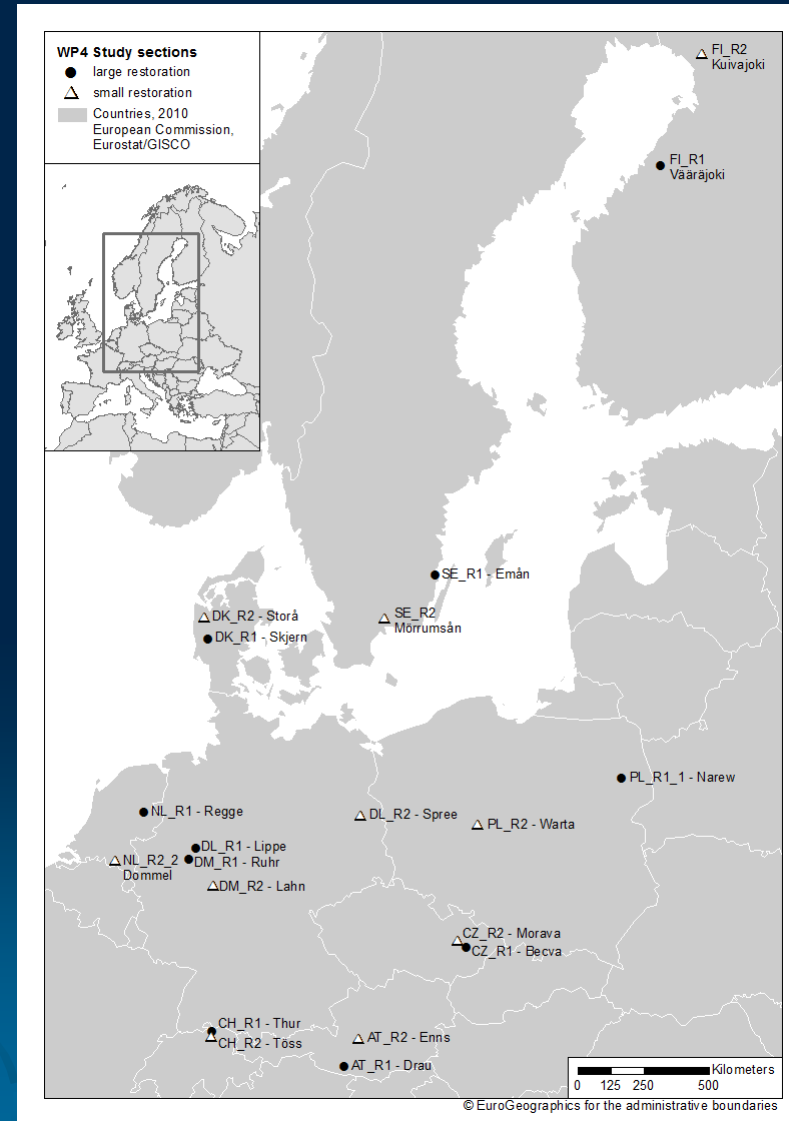


But bigger not better for floodplains or beaver ponds




Recent European Studies Differ

- Schmutz et al. 2015
 - 15 pairs of small and large floodplain projects
- Hering et al. 2015
 - 10 pairs of small and large floodplain & instream
- Zitek and Schmutz 2004
 - Species diversity responds at broader scale



So is Bigger Better?

- Intensity of restoration is important
 - Depends upon project type
 - Clearly for some species bigger
 - Watershed response requires restoring a lot of habitat
- 

Summary

North American Journal of Fisheries Management 21: 1-10, 2002
Analysis Fisheries Society 2002

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²Northeast Fisheries Science Center, National Marine Fisheries Service, 1725 Monticello Boulevard East, Seattle, Washington 98112, USA

Abstract—Millions of dollars are spent annually on watershed restoration and stream habitat improvement in the U.S. Pacific Northwest in an effort to restore degraded stream habitat. However, the effectiveness of these restoration techniques is often uncertain. The aim of this review is to provide a hierarchical strategy for prioritizing stream restoration techniques based on the degree of stream degradation, the degree of habitat loss, and the degree of stream habitat improvement that can be expected. The review is based on a synthesis of the scientific literature on stream restoration techniques and their effectiveness. The review is organized into three sections: (1) a review of stream restoration techniques, (2) a review of stream habitat loss, and (3) a review of stream habitat improvement. The review concludes that stream restoration techniques can be effective in improving stream habitat, but that the effectiveness of these techniques is often uncertain. A hierarchical strategy for prioritizing stream restoration techniques is proposed, based on the degree of stream degradation, the degree of habitat loss, and the degree of stream habitat improvement that can be expected.

Watershed restoration is a complex process that involves many land management activities. The goal of watershed restoration is to improve stream habitat and to restore stream habitat to a condition that is similar to that of a reference stream. The goal of stream habitat improvement is to improve stream habitat and to restore stream habitat to a condition that is similar to that of a reference stream. The goal of stream habitat improvement is to improve stream habitat and to restore stream habitat to a condition that is similar to that of a reference stream.

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Habitat rehabilitation for inland fisheries

Global review of effectiveness and guidance for rehabilitation of freshwater ecosystems



U.S. DEPARTMENT OF COMMERCE
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Fish-Habitat Relationships and the Effectiveness of Habitat Restoration

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Wood placement in river restoration: fact, fiction, and future


Philipp Rose, Tim Beschie, George Pess, and Kaitie Hanson

Abstract—Despite decades of research, the science of wood placement in river restoration remains controversial. We reviewed the literature on wood placement in river restoration and found that the science of wood placement in river restoration is still in its infancy. The science of wood placement in river restoration is still in its infancy. The science of wood placement in river restoration is still in its infancy.

Introduction
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NOAA Technical Memorandum NMFS-NWFSC-127

Summary – 3 Questions

1. Does restoration increase number or concentration fish? – Numbers.
 2. Increased number or survival?
 - Depends upon study – could be both
 3. Bigger restoration better?
 - Depends upon project type
 - Intensity and amount important
- 

Future Research

- Additional research on all three questions!

