Wood Placement in River Restoration:

Science Fact & Fiction

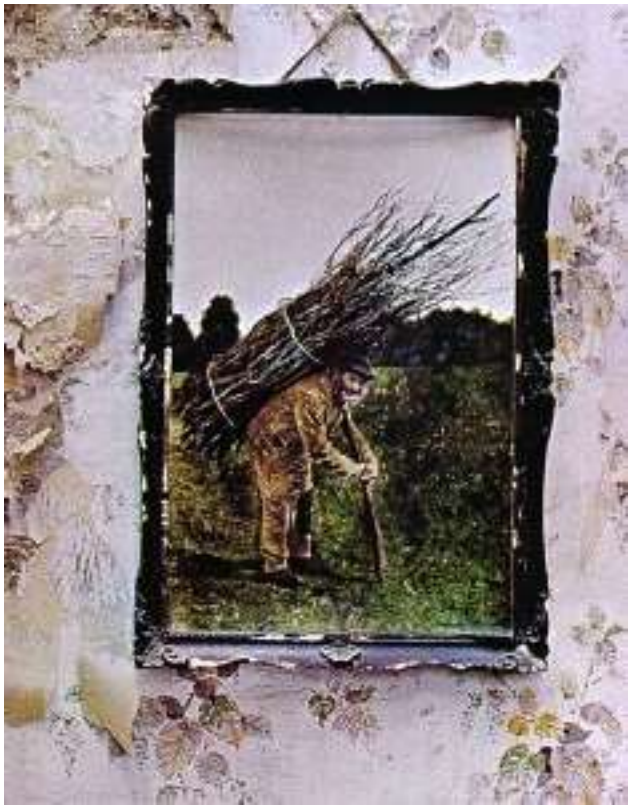
Phil Roni
Cramer Fish Sciences
Phil.roni@fish.sciences.net
&
Tim Beechie, George Pess and Karrie Hanson
Watershed Program
Northwest Fisheries Science Center

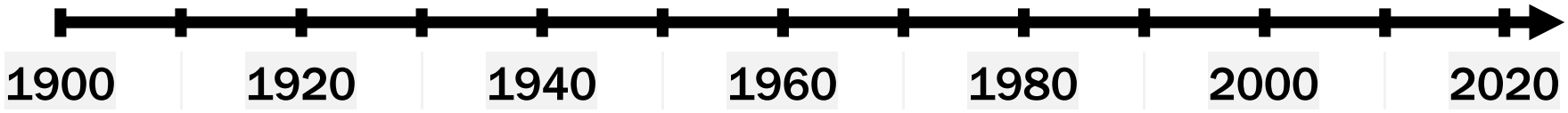
CRAMER FISH SCIENCES®
An Employee Owned Consulting Company

NOAA FISHERIES

Wood Placement Has A Long History

- Initial Efforts in 1890 to 1930
- 1930s to 1950s CCC
- 1960s Midwest US
- 1970s to 1980 Midwest to West
- 1990s to present from structures to natural





Controversy

- Rafting community

- Landowners

- And……Scientific community

Controversy – Literature
Negative results

- High Failure Rates
  - Frissell and Nawa (1992 – WA & OR)
  - Thompson (2002 – Connecticut streams)

- Little Biological Response
  - Thompson (2006 – pre-1980s)
  - Stewart et al. (2009 – stream size a factor)
  - Doyle and Shields (2012 – WQ)

Controversy – Literature

Positive Results

- Midwestern studies –
  - White (1975), Hunt (45 projects), Avery (58 projects)
- Rocky Mountains
  - Binns (71 projects) , White et al. (2011 - 20 yrs. afterward)
- PNW
  - Cederholm et al. (1997) Solazzi et al. (2000) , Roni and Quinn (2001a)
- Reviews and Meta-analysis
  - Roni et al 2002; 2008, 2014 (122 papers wood placement)
  - Whiteway et al. (2011 – 211 projects)
  - Smokerowski & Pratt (2007 – 14 studies)

LWD Placement
Major Areas of Controversy

1. Not natural
2. Failure Rates
3. Physical response
4. Biological response

1. Natural Part of System?

- Wood in World Rivers
- Extensive Literature on topic
- GLO notes in US
  - *Surveys back to 1810*

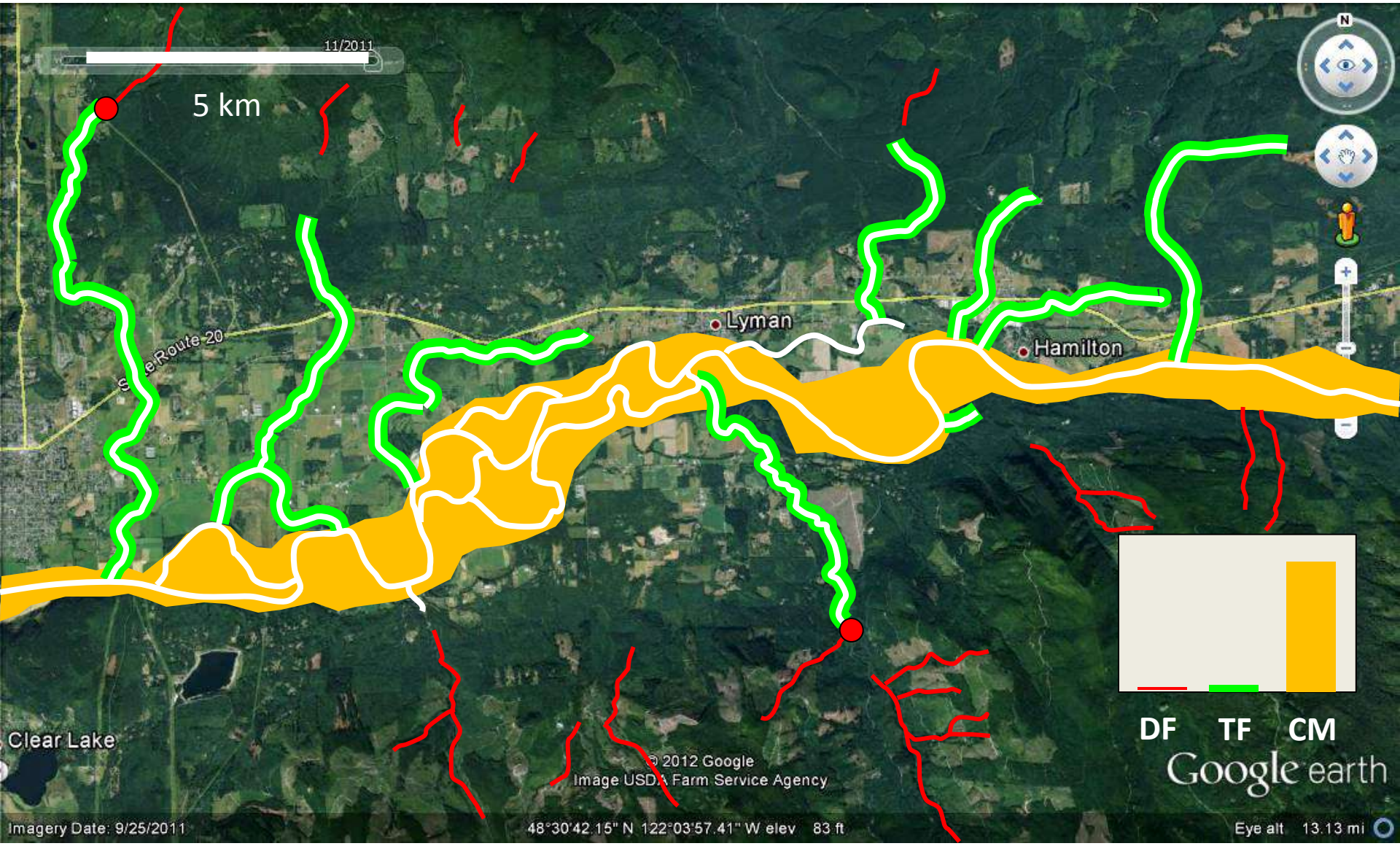
The Great Raft on the Texas-Oklahoma Border
100 to 150 miles long – took 5 years for US Govt.
To remove in 1830s

Deforestation

- Eastern US
  - Since 1800s
- Western US
  - Since early 1900s
- Europe & Mediterranean
  - 100s to 1,000s of years ago

www.globalchange.umich.edu

Source of LWD in Rivers



But….

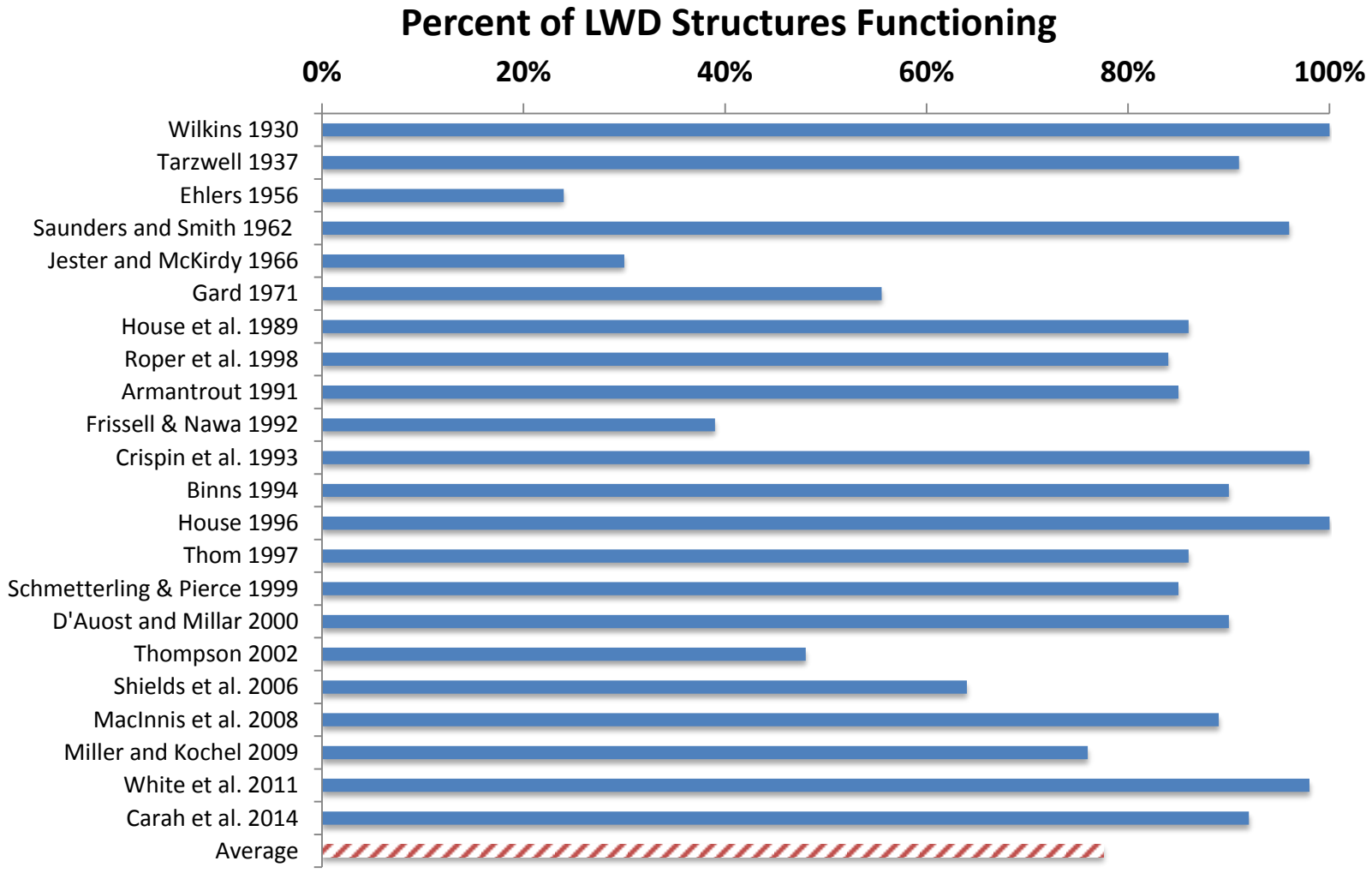
- Not all channels retain wood
  - Canyons and constrained reaches
  - Meadow streams
  - Extreme desert streams

Question is Not was LWD present but…

- What was/is source of LWD?
- How much was delivered to stream?
- How much was retained in reach?



2. Failure Rates



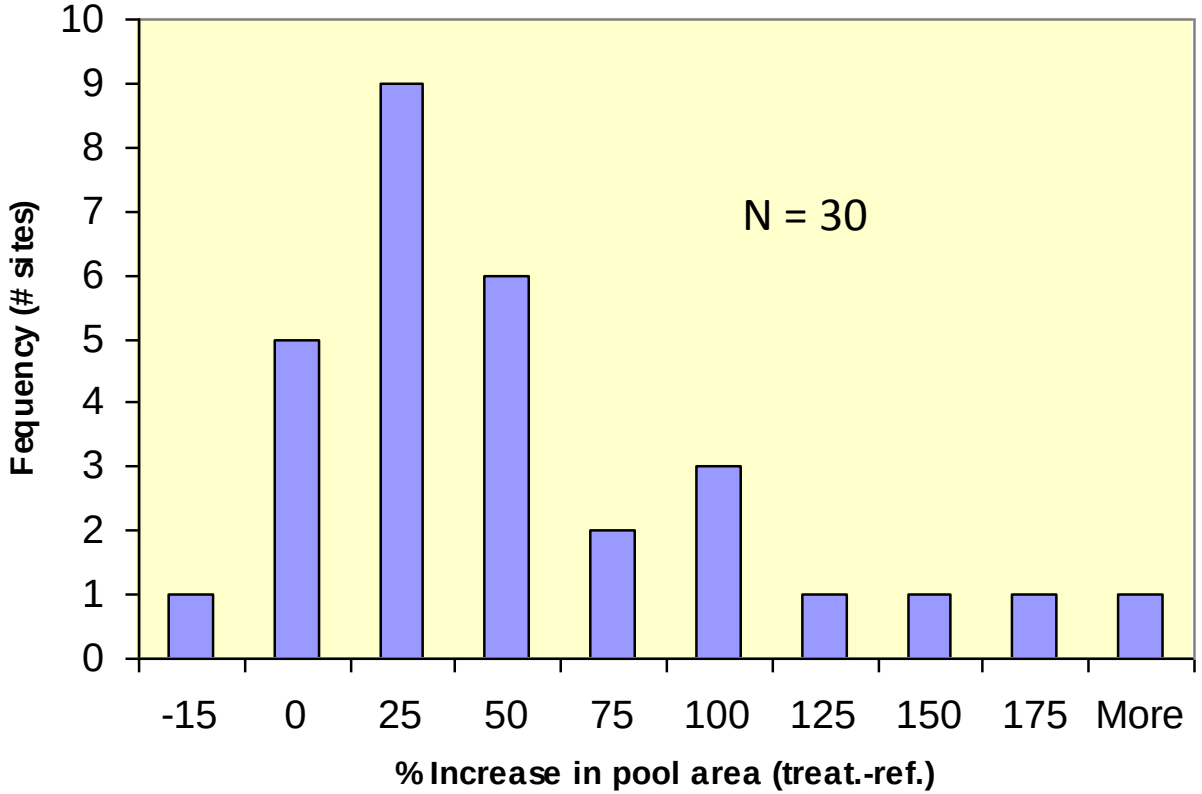
Evolving Techniques

Structure Failure or Success?

But…..Do we really expect them to stay static?

3. Physical Response

- Extensive literature documenting improvements
  - Pool area
  - Habitat complexity
  - LWD levels



Roni and Quinn 2001a

Effect on Physical Habitat

- But little change if..
  - Other processes not addressed
  - Existing LWD were already high
  - Little LWD was placed
  - LWD was small or undersized for channel

Effect on physical habitat

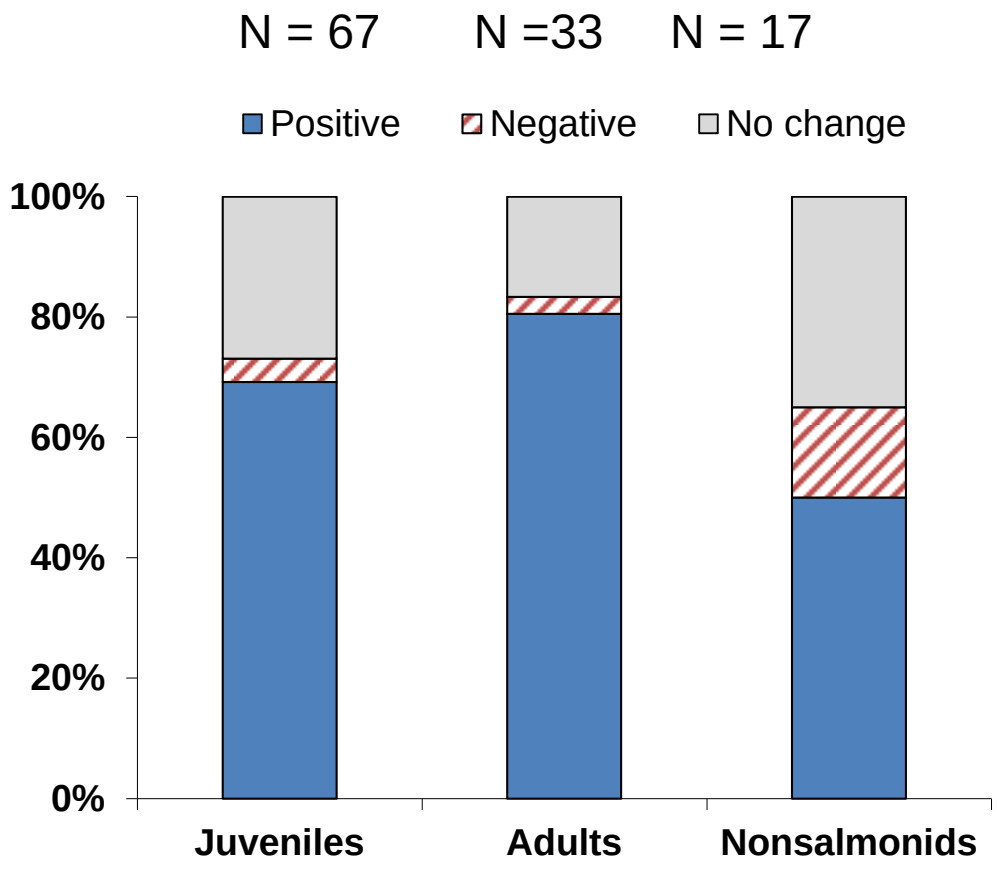
- More appropriate questions are
  - Have underlying processes been addressed?
  - How intensive does treatment need to be?
  - How long will it take to achieve a physical response?
  - How long will it last?

Scott Pozarycki photo

4. Biological Response

- Does placing LWD increase fish numbers?

Fish Response to Instream

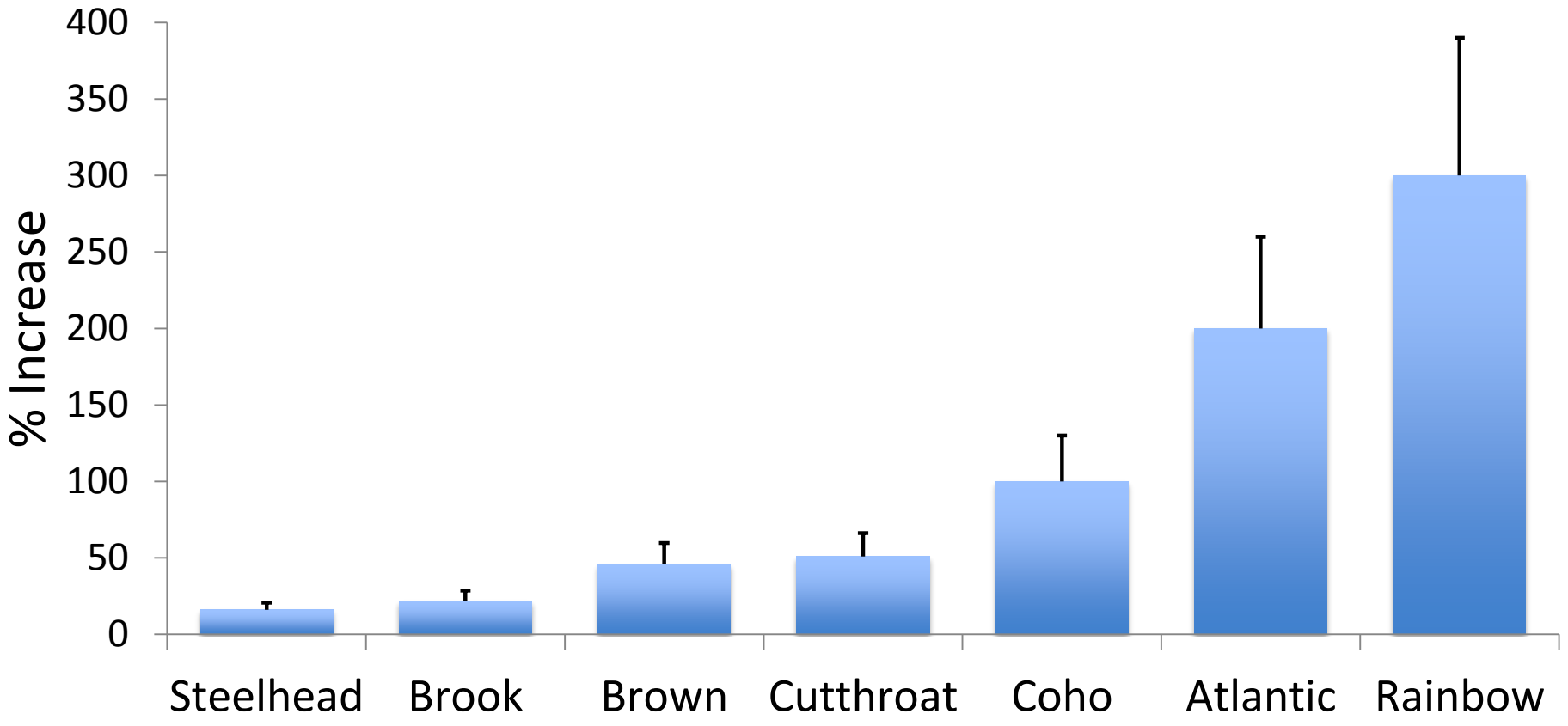


- Positive results for juvenile salmonids species
- Few studies on adults & non salmonids

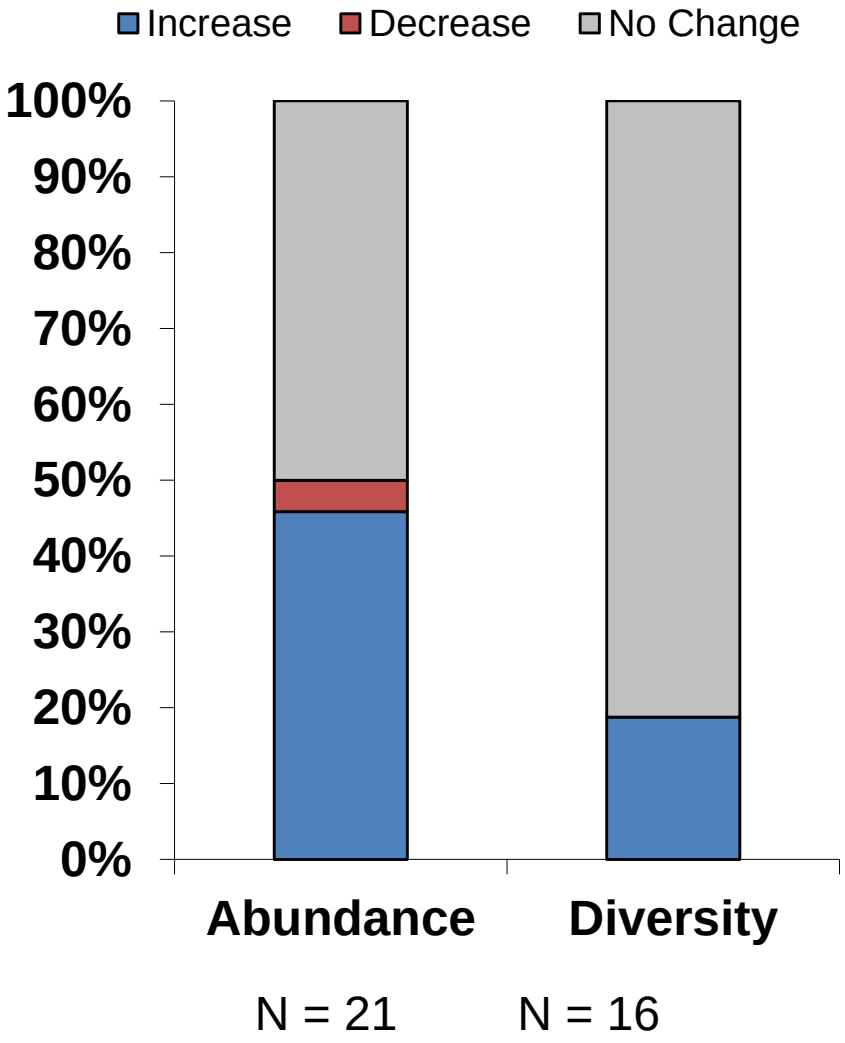
Data from Roni et al. 2014 CJFAS

Meta-Analysis – Whiteway et al. 2010

Examined 211 Projects



Instream – Macroinvertebrates



- No consistent response to LWD placement
- Other factors influence productivity

Data from Roni et al 2008, 2014

More Appropriate Biological Questions

- What is scale and longevity of increases?
- How much LWD is needed to elicit a response?
- What is response for less studies species and life-stage?
- What is response to LWD placement in larger streams?
- What is effect on survival?

Summary

Major Areas of LWD Controversy

1. Not natural
2. Failure Rates
3. Physical response
4. Biological response

Summary

Major Areas of Controversy

1. Not natural – Not accurate
2. Failure Rates – Low for newer techniques
3. Physical response – Well documented
4. Biological response – Well documented for trout & coho (FW)

Conclusions - Rivers

Four More Appropriate Questions

1. How much LWD was there, what was it source and where did it accumulate?

2. What type of LWD and how should it be placed?

3. How much LWD is needed to affect a physical response and how long will response last?

4. What is response of Chinook and other less wells studied species in larger streams?

What about LWD in Estuaries?

Papers Located on Estuarine LWD

- Gonor 1988. What we know about large trees in estuaries, in the sea and on coastal beaches. (Chapter in Maser et al. 1988 Tech. Rep. PNW-GTR-229)
- Everett and Ruiz 1993. Coarse woody debris as a refuge from predation in aquatic communities—an experimental test. Oecologia 93:475–486 (Chesapeake Bay)
- Wick 2002. Ecological function and spatial dynamics of large woody debris in Oligohaline-Brackish Estuarine Sloughs for Juvenile Pacific salmon (MS Thesis)
- Hindell 2007 Determining patterns of use by black bream *Acanthopagrus butcheri* (Munro, 1949) of re-established habitat in a south-eastern Australian estuary. J Fish Biol 71:1331–1346
- Hood 2007 Large woody debris influences vegetation zonation in an Oligohaline tidal marsh. Estuaries and Coasts 30:441-450.
- Cornu 2008 Effectiveness Monitoring for LWD Placement in South Slough Tidal Wetlands (Tech report)
- Tonnes 2008 Ecological functions of marine riparian areas and driftwood along North Puget Sound Shorelines (MS Thesis)

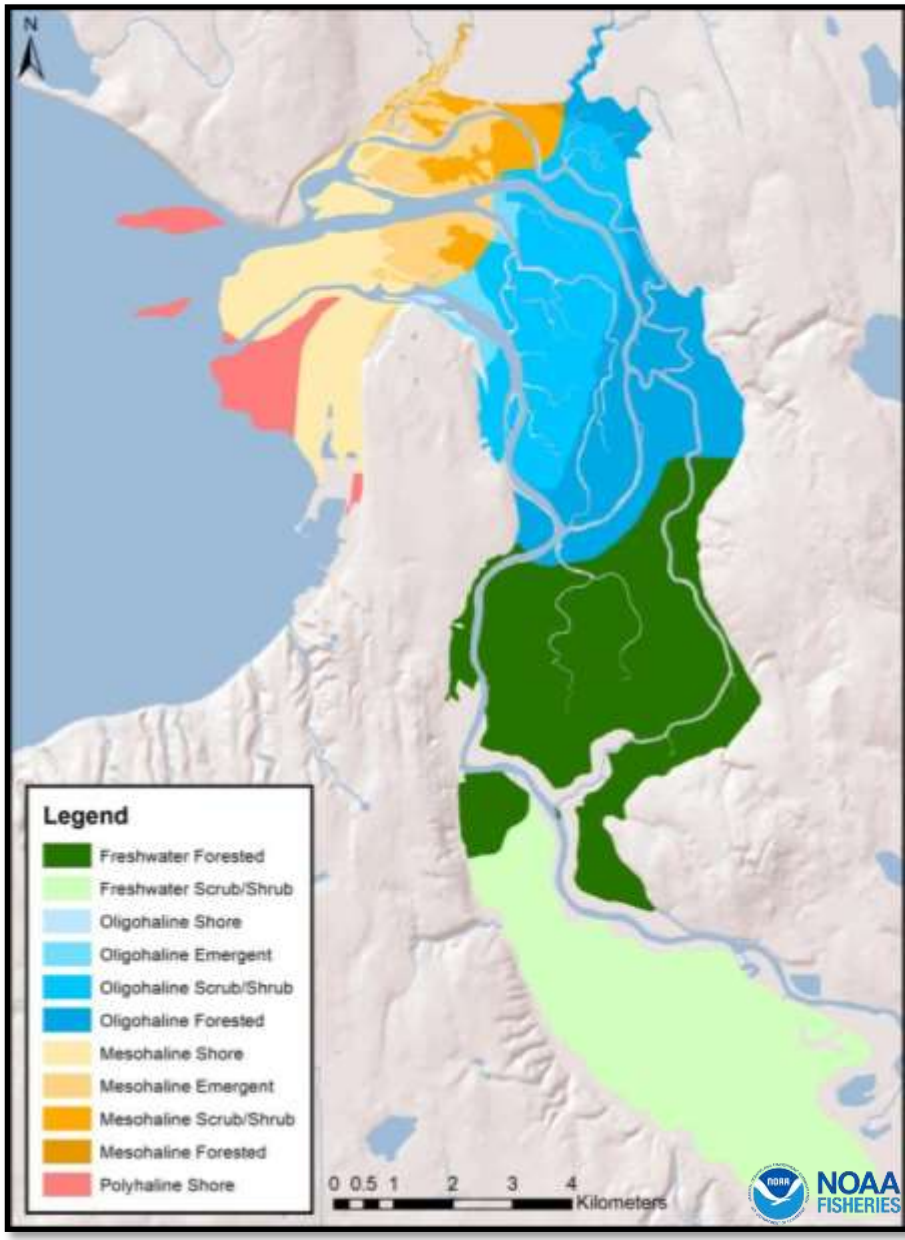
Number of Papers

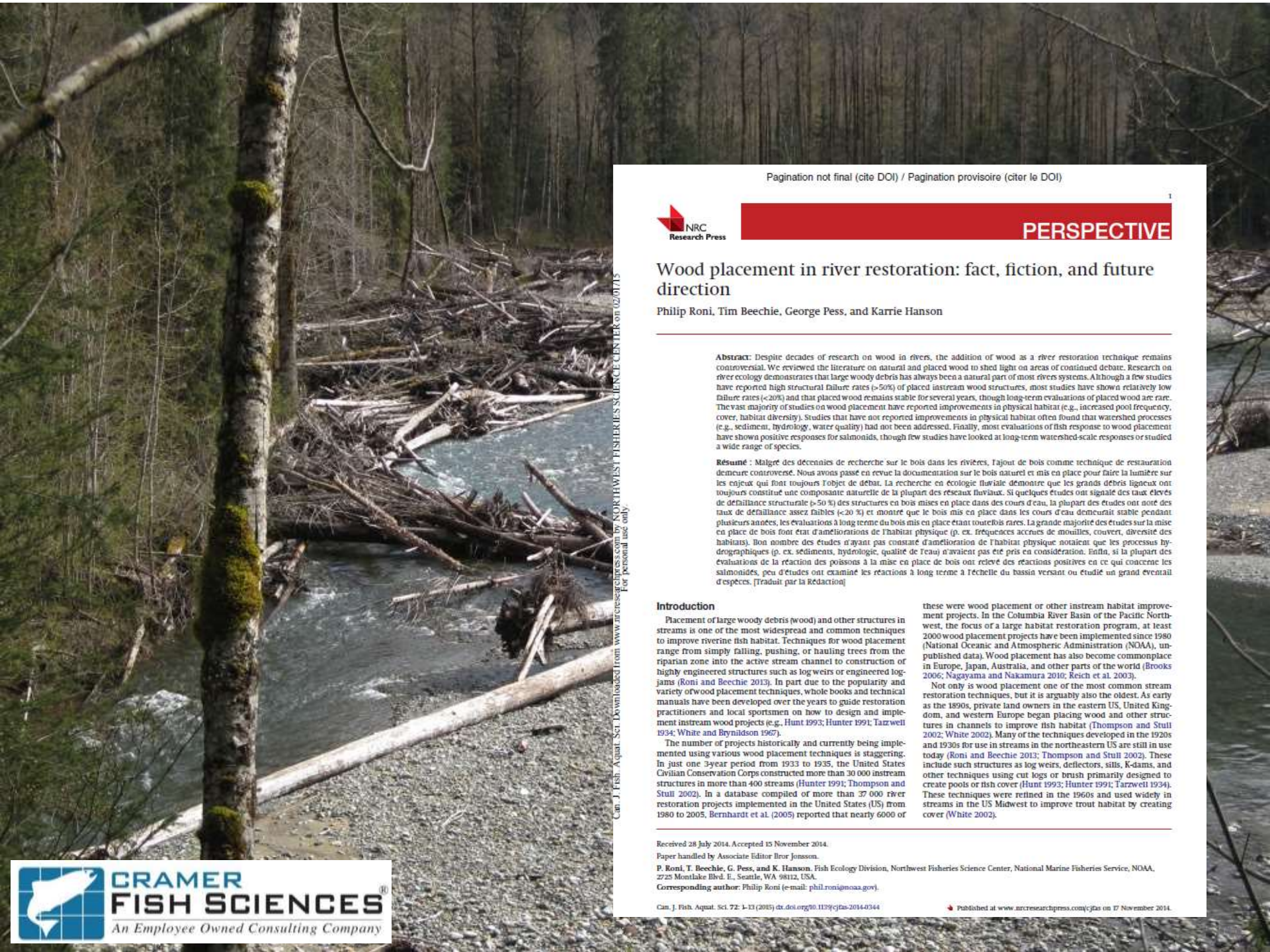
Category	Rivers	Estuaries
Sources and natural functions	>500	few on temperature estuaries
Historical levels	>50	Handful
Where does it accumulate and how	>100s	?
Effectiveness of wood placement	122	3*

* Note there is some gray literature web sites etc. about recent projects

Conclusions - Estuaries

1. How much LWD was there, what was it source and where did it accumulate?
2. How does #1 differ in different zones of estuary?
3. Fish and other biota use of natural LWD?
4. What type of LWD, where and how should it be placed?
5. Physical and biological response to placed wood?





NRC Research Press

PERSPECTIVE

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

Philip Roni, Tim Beechie, George Pess, and Karrie Hanson

Abstract: Despite decades of research on wood in rivers, the addition of wood as a river restoration technique remains controversial. We reviewed the literature on natural and placed wood to shed light on areas of continued debate. Research on river ecology demonstrates that large woody debris has always been a natural part of most rivers systems. Although a few studies have reported high structural failure rates (>50%) of placed instream wood structures, most studies have shown relatively low failure rates (<20%) and that placed wood remains stable for several years, though long-term evaluations of placed wood are rare. The vast majority of studies on wood placement have reported improvements in physical habitat (e.g., increased pool frequency, cover, habitat diversity). Studies that have not reported improvements in physical habitat often found that watershed processes (e.g., sediment, hydrology, water quality) had not been addressed. Finally, most evaluations of fish response to wood placement have shown positive responses for salmonids, though few studies have looked at long-term watershed-scale responses or studied a wide range of species.

Résumé : Malgré des décennies de recherche sur le bois dans les rivières, l'ajout de bois comme technique de restauration demeure controversé. Nous avons passé en revue la documentation sur le bois naturel et mis en place pour faire la lumière sur les enjeux qui font toujours l'objet de débat. La recherche en écologie fluviale démontre que les grands débris ligneux ont toujours constitué une composante naturelle de la plupart des réseaux fluviaux. Si quelques études ont signalé des taux élevés de défaillance structurale (>50 %) des structures en bois mises en place dans des cours d'eau, la plupart des études ont noté des taux de défaillance assez faibles (<20 %) et montré que le bois mis en place dans les cours d'eau demeurait stable pendant plusieurs années, les évaluations à long terme du bois mis en place étant toutefois rares. La grande majorité des études sur la mise en place de bois font état d'améliorations de l'habitat physique (p. ex. fréquences accrues de mouilles, couvert, diversité des habitats). Bon nombre des études n'ayant pas constaté d'amélioration de l'habitat physique notaient que les processus hydrographiques (p. ex. sédiments, hydrologie, qualité de l'eau) n'avaient pas été pris en considération. Enfin, si la plupart des évaluations de la réaction des poissons à la mise en place de bois ont relevé des réactions positives en ce qui concerne les salmonidés, peu d'études ont examiné les réactions à long terme à l'échelle du bassin versant ou étudié un grand éventail d'espèces. [Traduit par la Rédaction]

Introduction

Placement of large woody debris (wood) and other structures in streams is one of the most widespread and common techniques to improve riverine fish habitat. Techniques for wood placement range from simply falling, pushing, or hauling trees from the riparian zone into the active stream channel to construction of highly engineered structures such as log weirs or engineered log-jams (Roni and Beechie 2013). In part due to the popularity and variety of wood placement techniques, whole books and technical manuals have been developed over the years to guide restoration practitioners and local sportsmen on how to design and implement instream wood projects (e.g., Hunt 1993; Hunter 1991; Tarzwell 1934; White and Brynildson 1967).

The number of projects historically and currently being implemented using various wood placement techniques is staggering. In just one 3-year period from 1933 to 1935, the United States Civilian Conservation Corps constructed more than 30 000 instream structures in more than 400 streams (Hunter 1991; Thompson and Stull 2002). In a database compiled of more than 37 000 river restoration projects implemented in the United States (US) from 1980 to 2005, Bernhardt et al. (2005) reported that nearly 6000 of these were wood placement or other instream habitat improvement projects. In the Columbia River Basin of the Pacific Northwest, the focus of a large habitat restoration program, at least 2000 wood placement projects have been implemented since 1980 (National Oceanic and Atmospheric Administration (NOAA), unpublished data). Wood placement has also become commonplace in Europe, Japan, Australia, and other parts of the world (Brooks 2006; Nagayama and Nakamura 2010; Reich et al. 2003).

Not only is wood placement one of the most common stream restoration techniques, but it is arguably also the oldest. As early as the 1890s, private land owners in the eastern US, United Kingdom, and western Europe began placing wood and other structures in channels to improve fish habitat (Thompson and Stull 2002; White 2002). Many of the techniques developed in the 1920s and 1930s for use in streams in the northeastern US are still in use today (Roni and Beechie 2013; Thompson and Stull 2002). These include such structures as log weirs, deflectors, sills, K-dams, and other techniques using cut logs or brush primarily designed to create pools or fish cover (Hunt 1993; Hunter 1991; Tarzwell 1934). These techniques were refined in the 1960s and used widely in streams in the US Midwest to improve trout habitat by creating cover (White 2002).

Received 28 July 2014. Accepted 15 November 2014.

Paper handled by Associate Editor Ivor Jonsson.

P. Roni, T. Beechie, G. Pess, and K. Hanson. Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112, USA.

Corresponding author: Philip Roni (e-mail: phil.roni@noaa.gov).