Functional Flows:
A practical strategy for riparian restoration

Stewart Rood
Canada

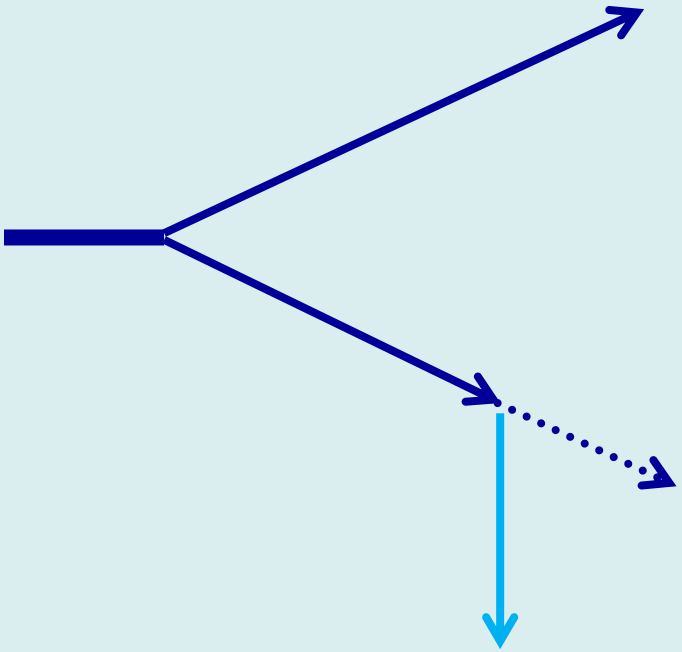
RIPA-1: First International Conference on
Riparian Ecosystems Science and Management

Bratislava, April 2022

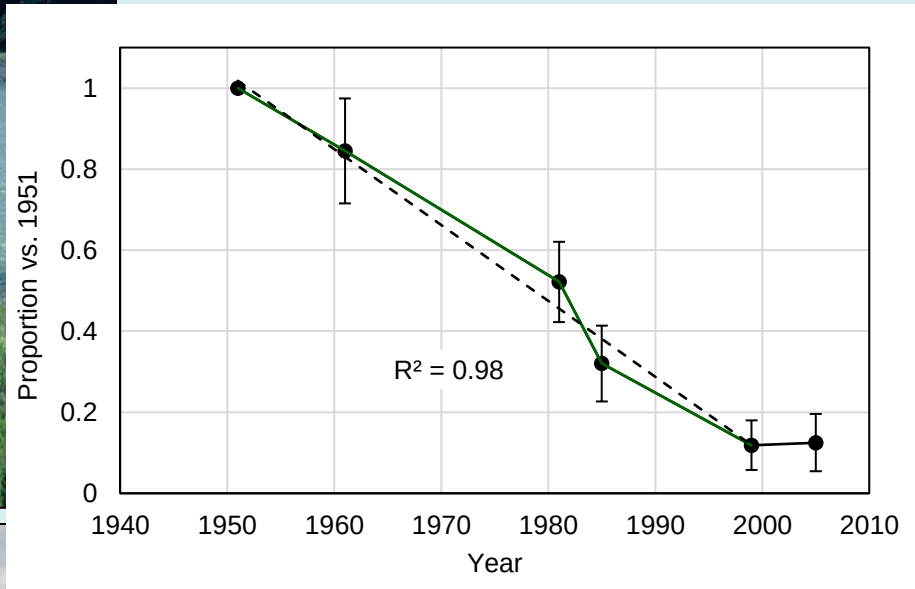
University of Lethbridge
FIAT LUX

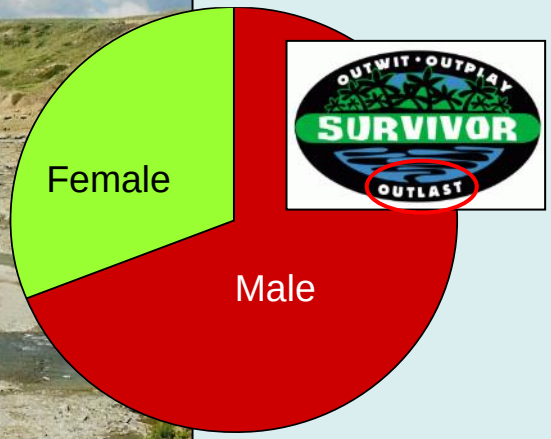
Fundamental principle

River ecosystems
require instream flow



Rood et al. (2003) Tree Physiology





Rood et al. (1995) Botany
Rood & Gill (in preparation, RRA)

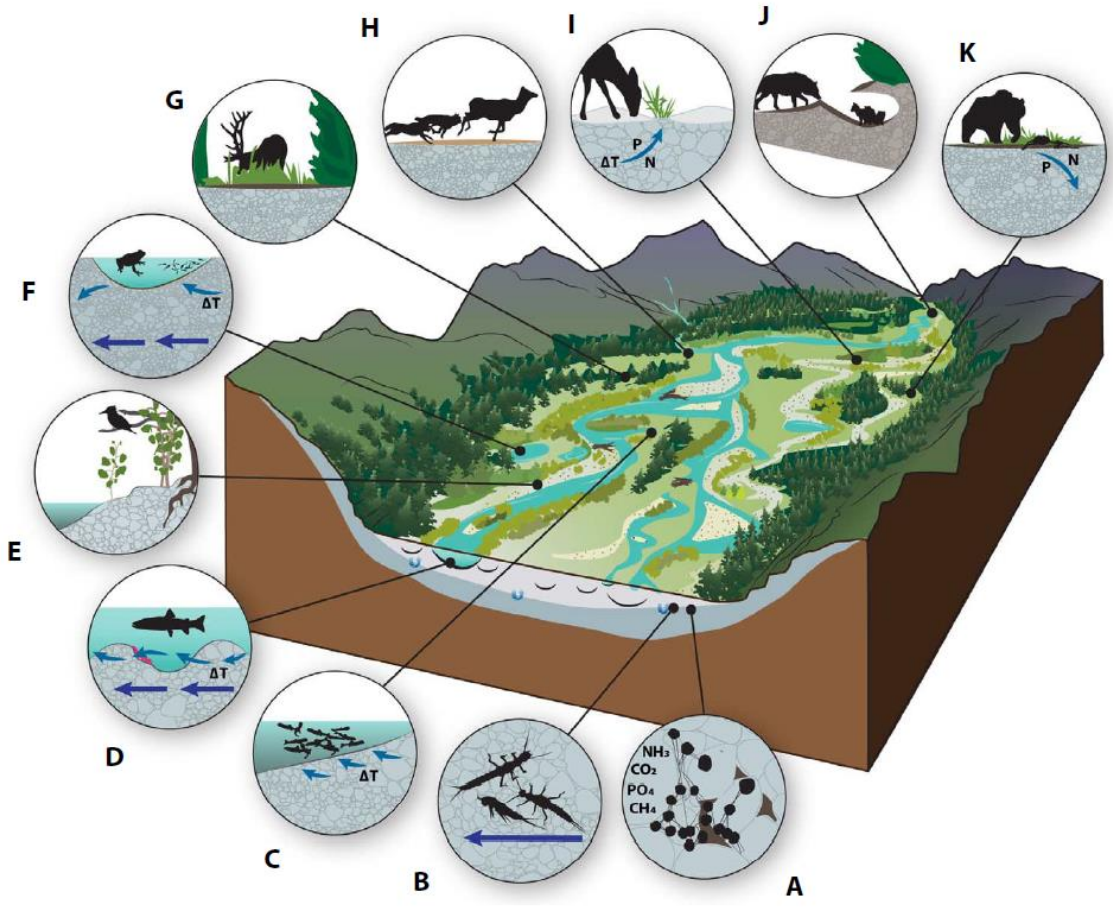
REVIEW

APPLIED ECOLOGY

Gravel-bed river floodplains are the ecological nexus of glaciated mountain landscapes

Science Advances (2016)

F. Richard Hauer,[1,2]* Harvey Locke,[3] Victoria J. Dreitz,[4] Mark Hebblewhite,[4,5] Winsor H. Lowe,[5,6] Clint C. Muhlfeld,[2,7] Cara R. Nelson,[5] Michael F. Proctor,[8] Stewart B. Rood[9]



Instream Flow Needs – Flow amount and pattern
to sustain an organism (or process)

Environmental Flows – Flows to sustain
the aquatic and riparian ecosystems

BioScience 1997

The Natural Flow Regime

A paradigm for river conservation and restoration

N. LeRoy Poff, J. David Allan, Mark B. Bain, James R. Karr, Karen L. Prestegaard,
Brian D. Richter, Richard E. Sparks, and Julie C. Stromberg

However, it is generally not feasible
to restore natural flow regimes

An alternative:

Functional Flows

1. *River regulation for ecosystem enhancement. Flow normalization & compensation.*
2. *Support physical processes, life history traits of aquatic animals & riparian plants.*
3. *Environmental benefit during wet years, to compensate for stress during dry years.*

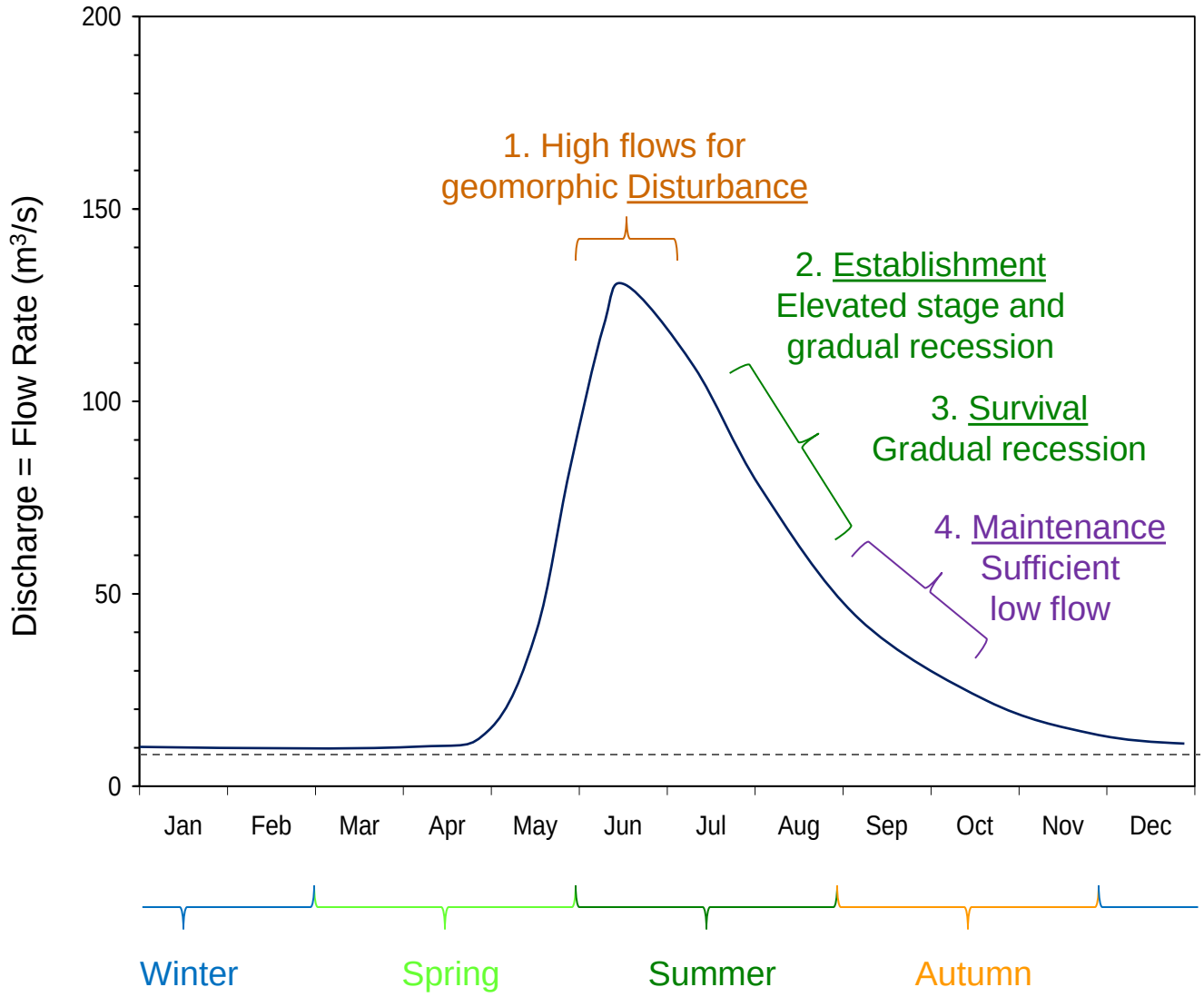
Hughes & Rood (2003) Environmental Management

Rood et al. (2005) Frontiers in Ecology and Environment

Yarnell et al. (2015) BioScience

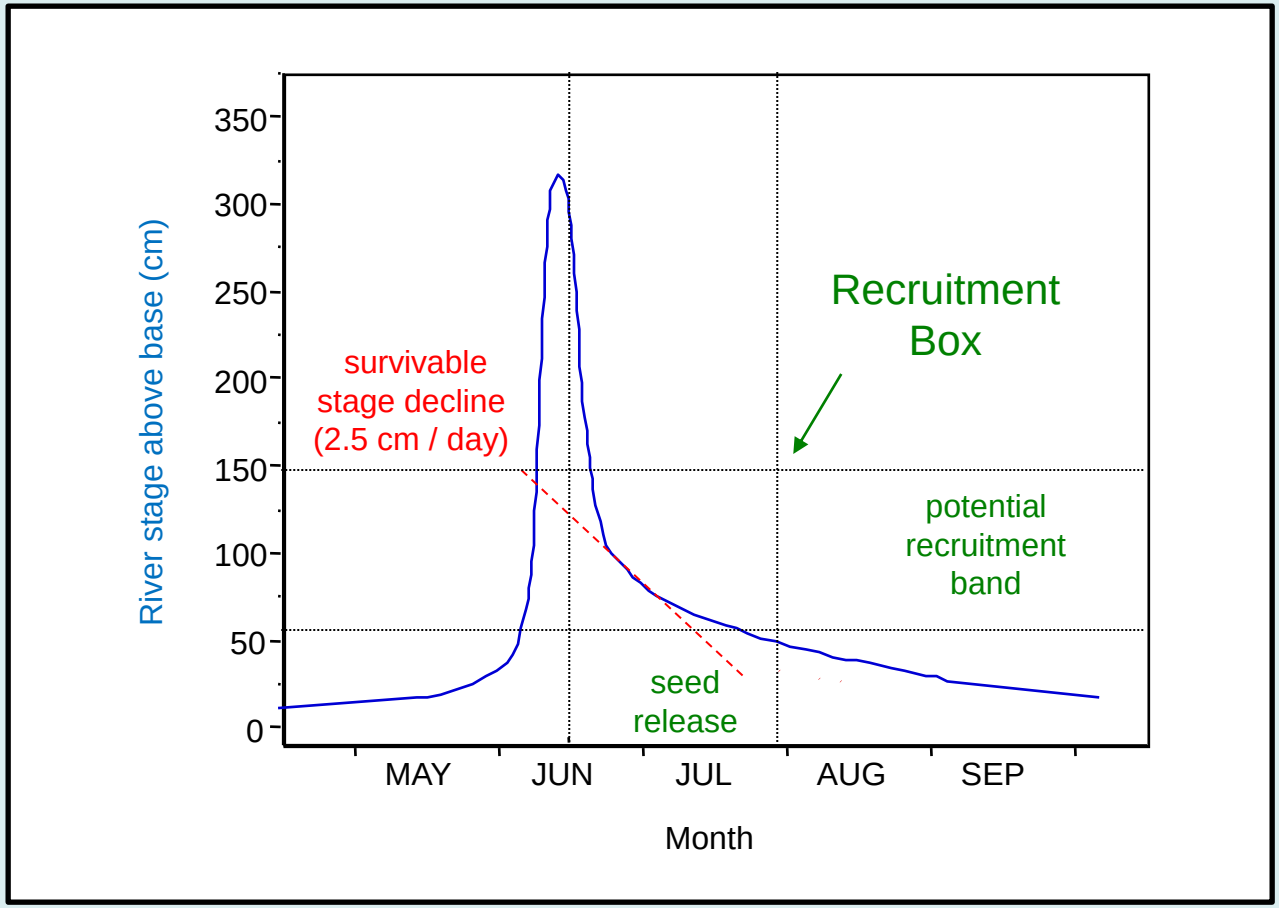
Bow R., Banff

Riparian requirements



Different management objectives:

Condition	Flow	Objective	Strategy	Quantity
Wet	1/4 year High flow	Rejuvenation	High spring flow and gradual recession	85%
Normal	2/4 years Normal flow	Growth	Moderate summer flow	60%
Dry	1/4 year Low flow	Survival	Sufficient summer flow	45%

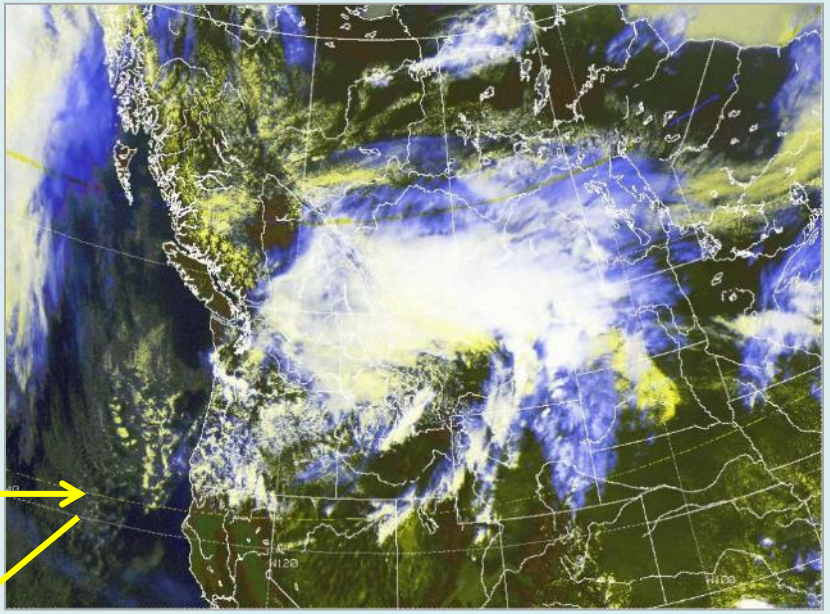


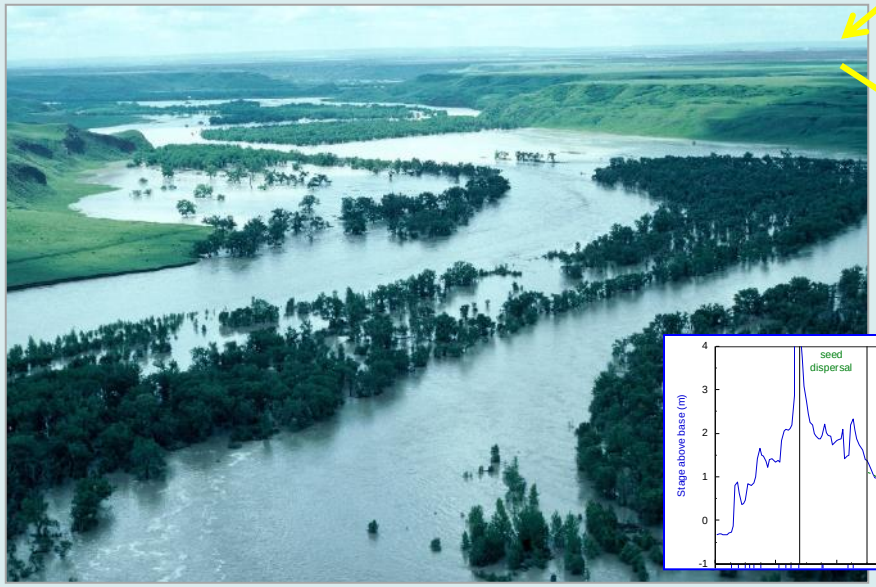
Mahoney & Rood (1998) Wetlands

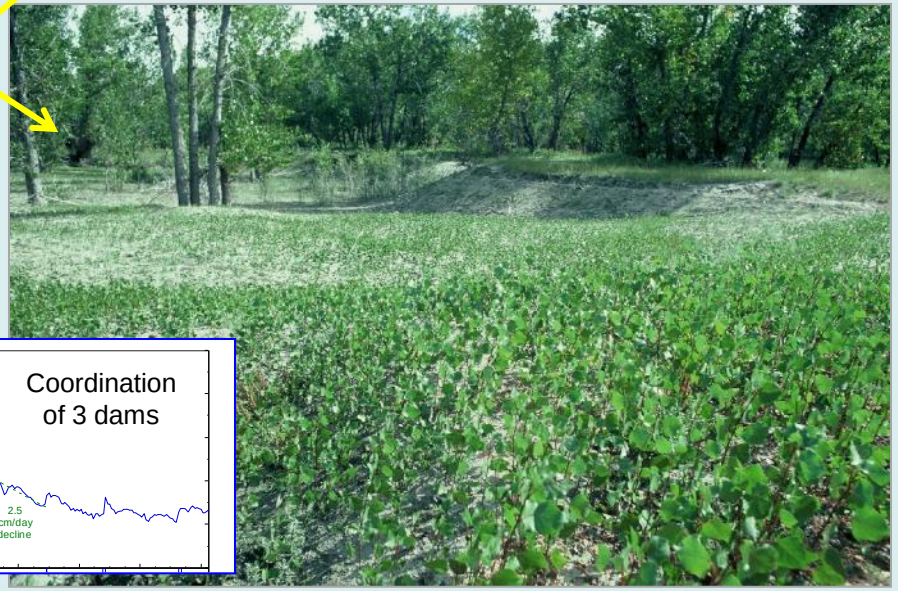
Validating the model

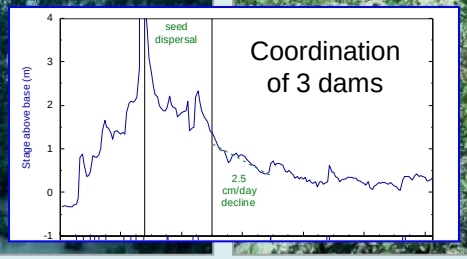
Oldman River system, Canada

Rood et al. (1998) Wetlands
Kalischuk et al. (2001) For. Ecol. Manag.

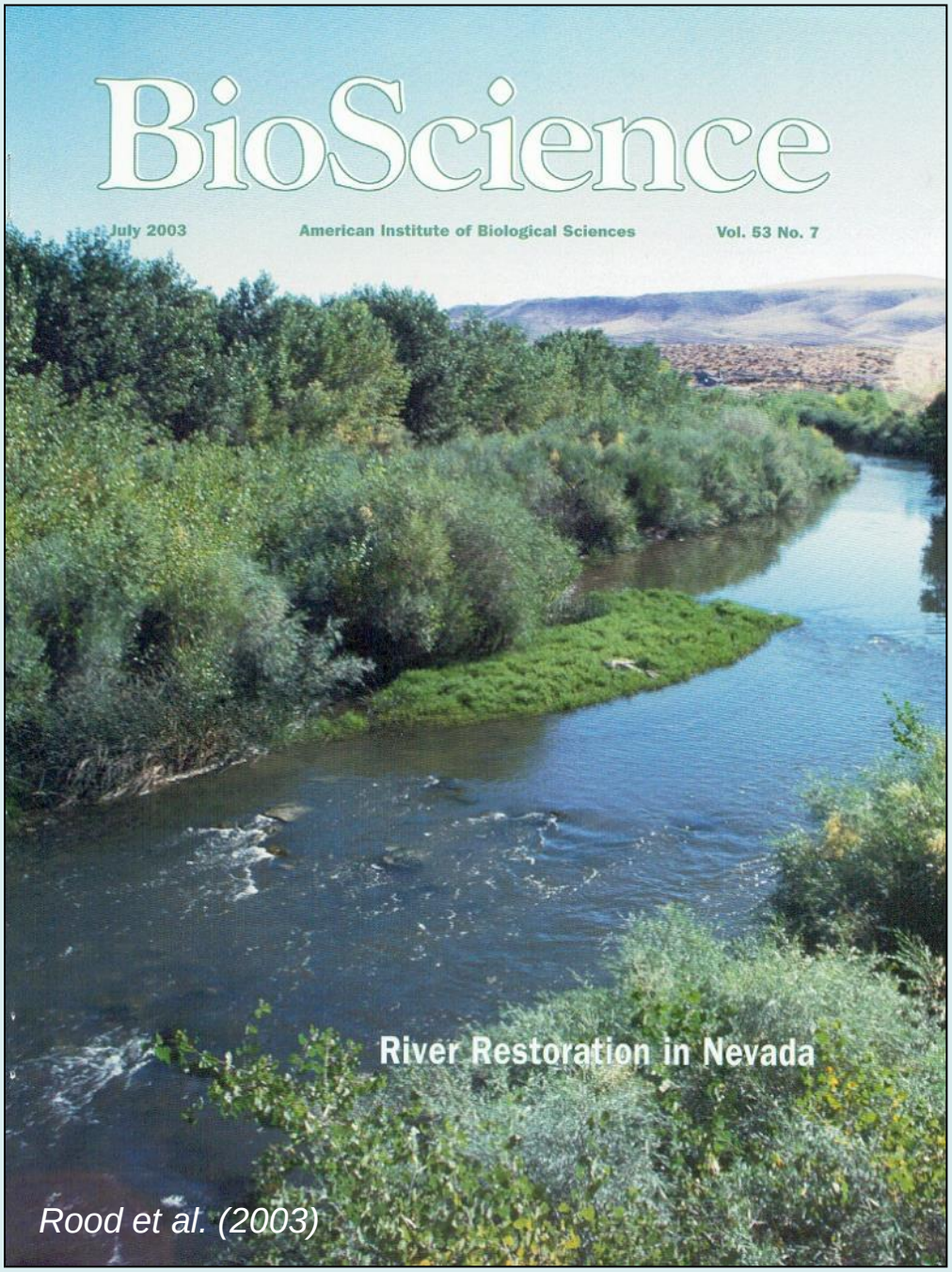








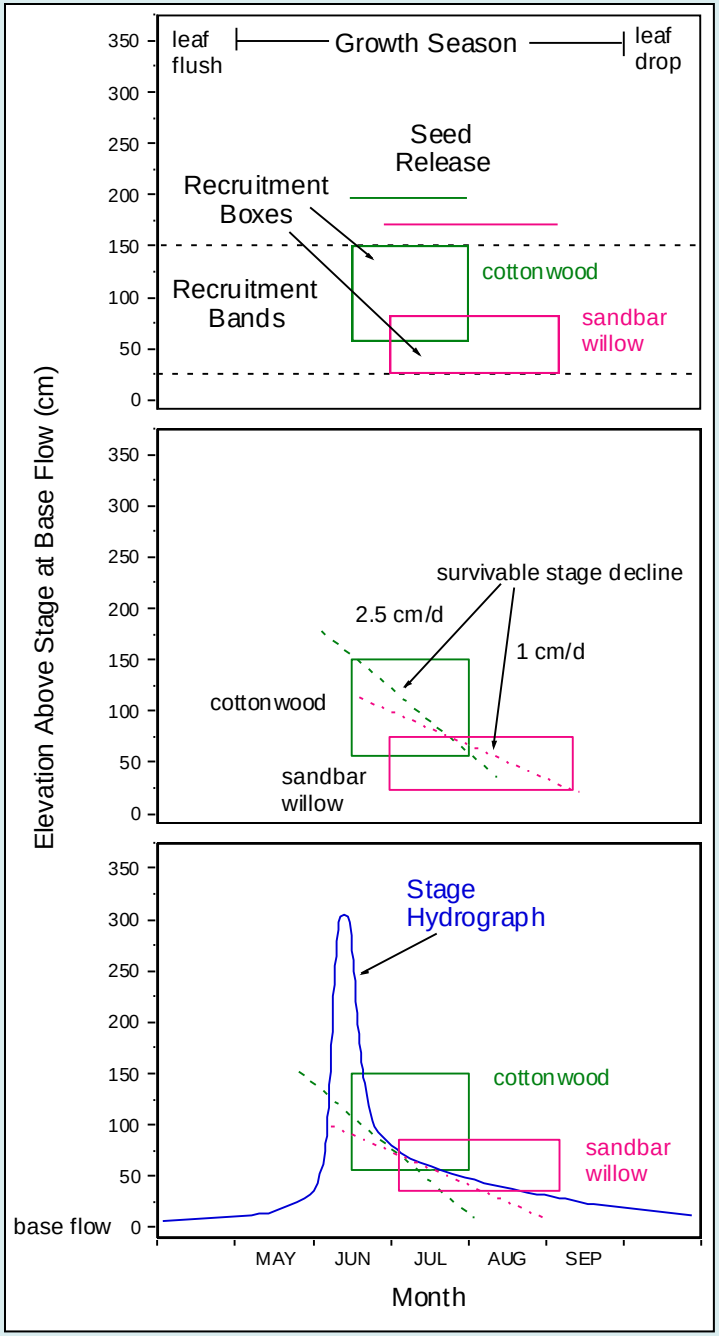
Coordination of 3 dams



Rood et al. (2003)

Ecosystem restoration

- Cottonwoods & willows
- Channel form
- Water temperature
- Cui-ui suckers
- Cutthroat trout
- Riparian birds
- Interception of contaminants



Amlin & Rood (2002) Wetlands

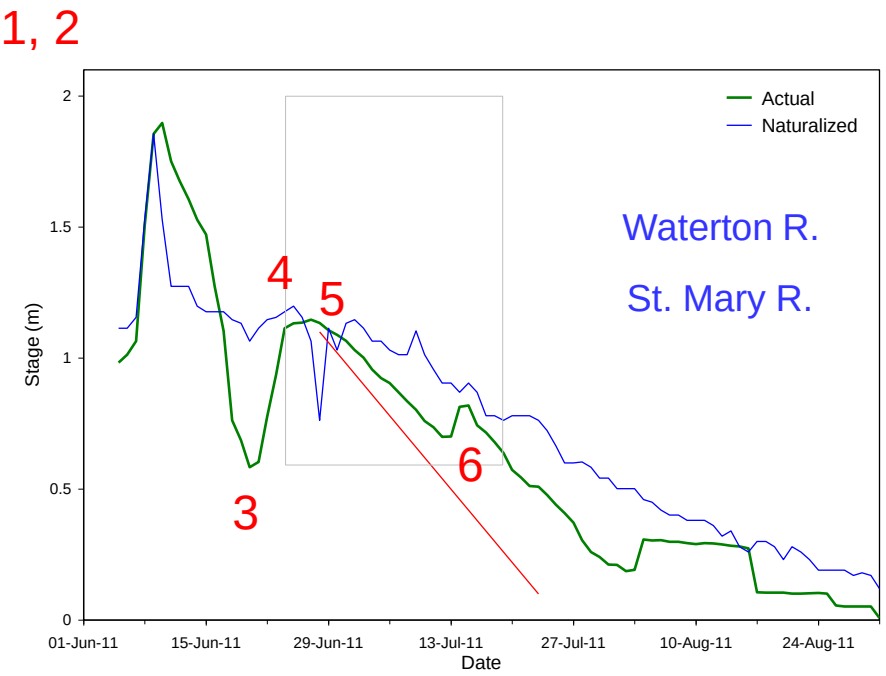

Truckee R. - 25 years of functional flows
Systemic Restoration

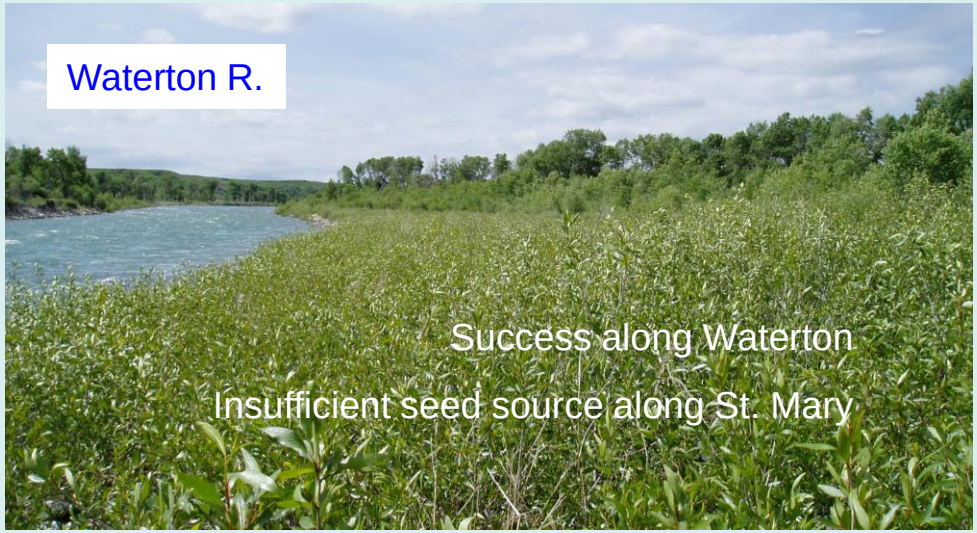
Functional Flow Prescriptions

1. Disturbance - As possible, allow bankfull & even flood flows
2. Establishment – Provide higher stages during seed dispersal
3. Survival – Ramping, gradual recession
4. Maintenance – Sufficient flows through the growing season
5. Removal – Avoid scouring after colonization

Opportunistic implementation

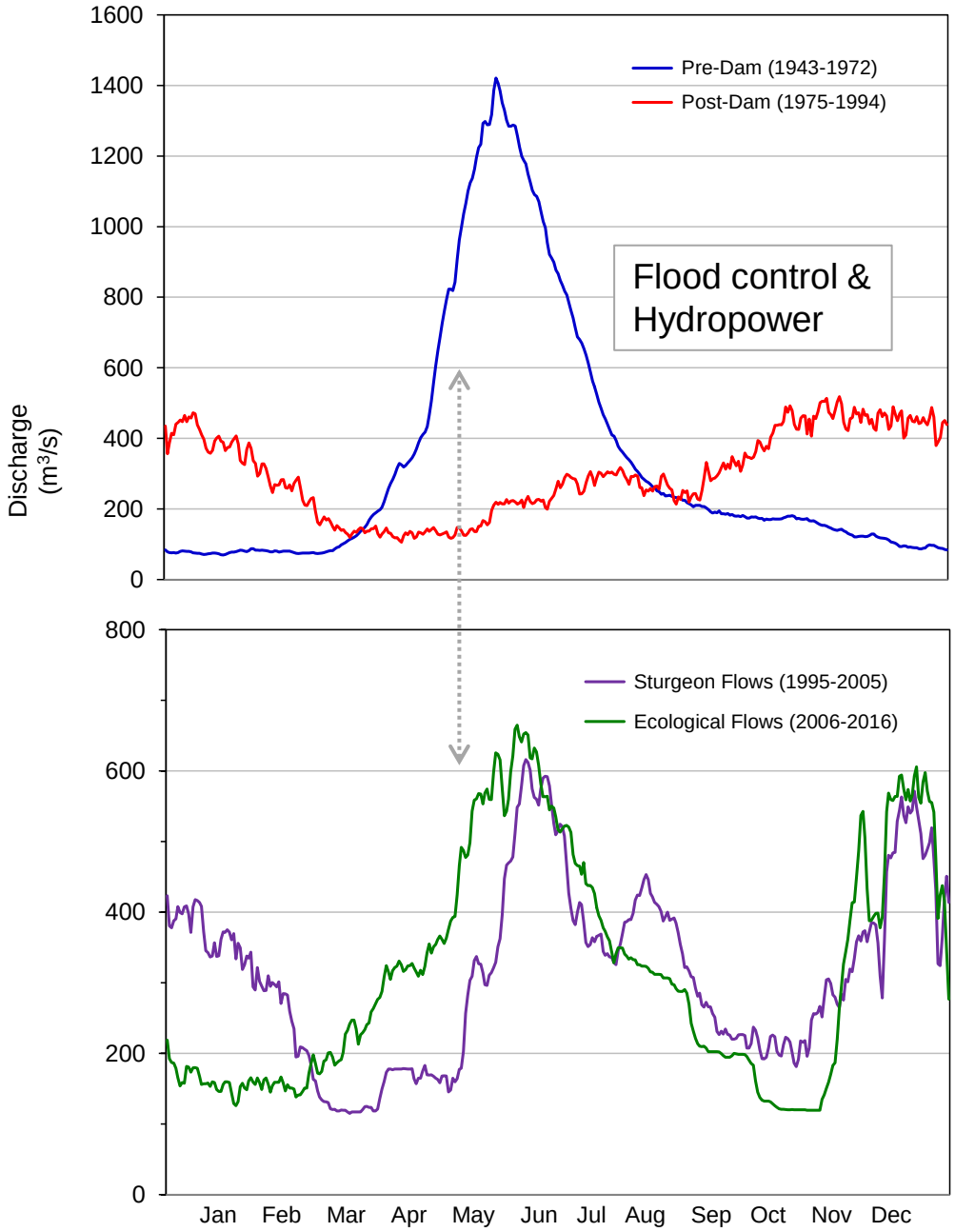
1. 2010 – High flows, wet year
2. Spring, 2011 - Agency agreements
3. Increase storage
4. Raise stage to recruitment band
5. Commence ramping with seed release
6. Storage correction



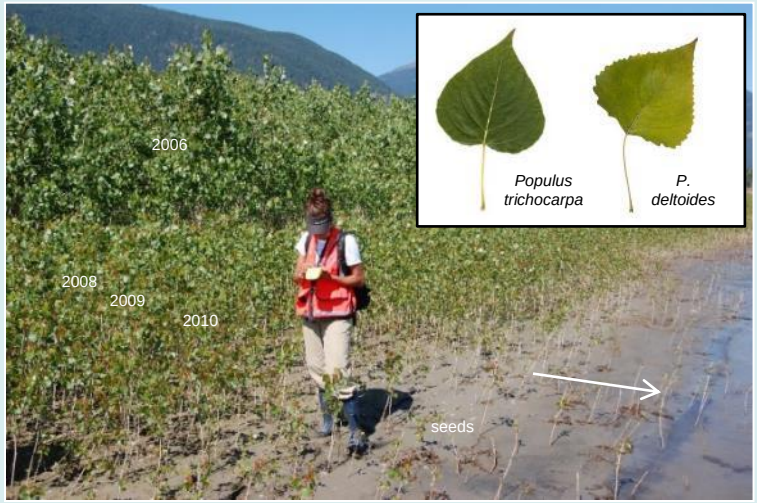


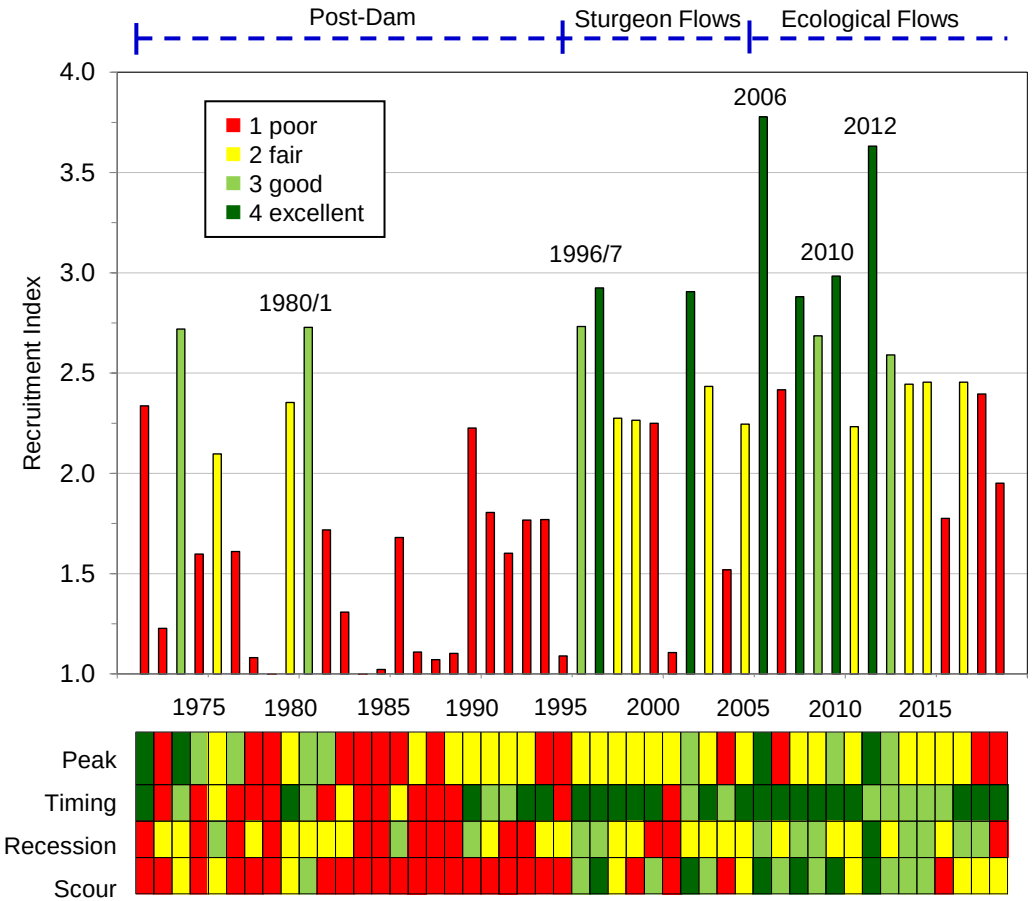
Rood et al. (2015) RRA; Foster et al. (2018) Restoration Ecology

Kootenai R.
USA & Canada



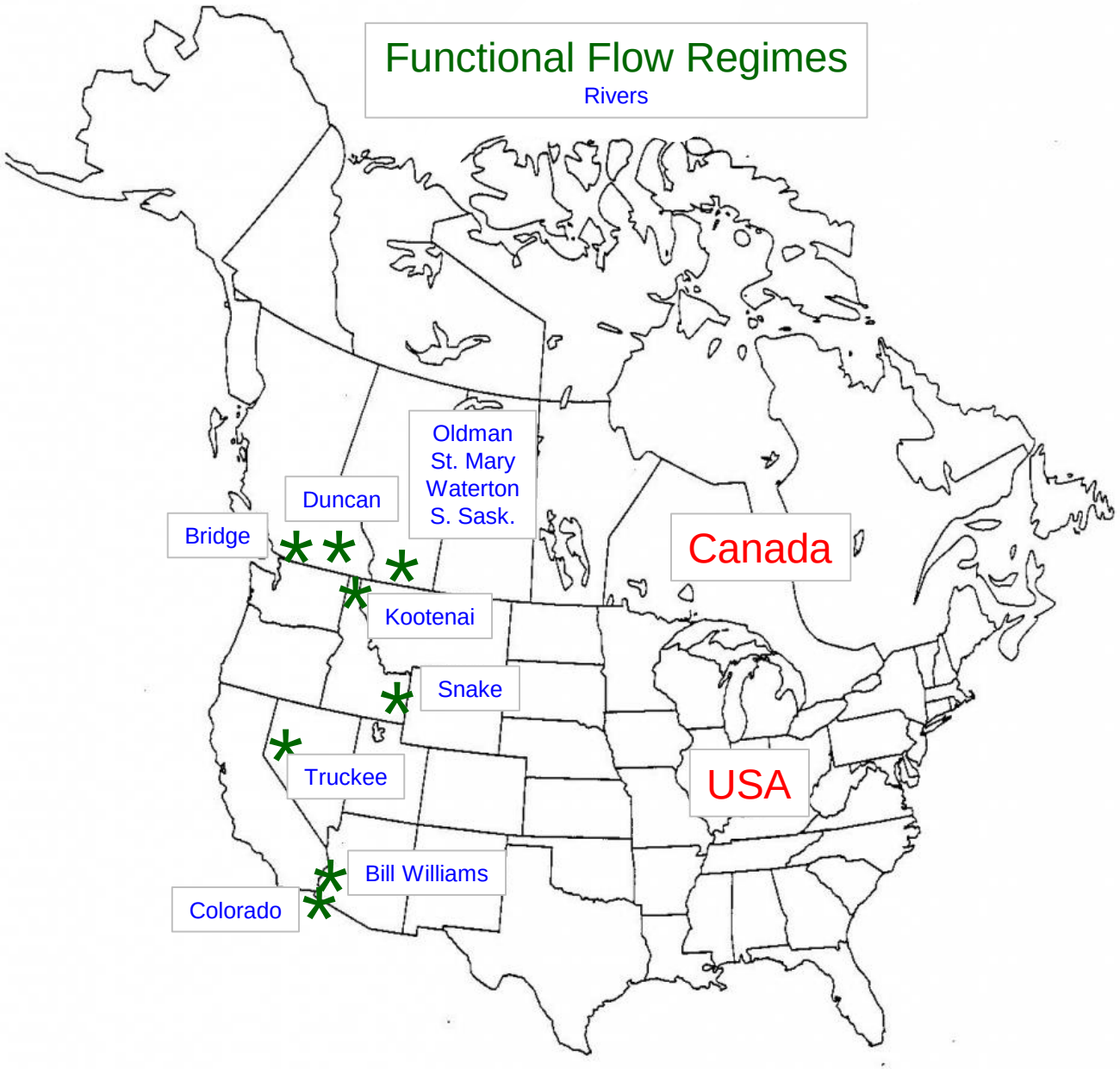

reed canarygrass
cottonwood
Stage (m)
6
5
4
3
2
1
0
-1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


2006
2008
2009
2010
seeds
Populus trichocarpa
P. deltoides


Post-Dam
Sturgeon Flows
Ecological Flows
1 poor
2 fair
3 good
4 excellent
Recruitment Index
4.0
3.5
3.0
2.5
2.0
1.5
1.0
1980/1
1996/7
2006
2010
2012
1975
1980
1985
1990
1995
2000
2005
2010
2015
Peak
Timing
Recession
Scour

Implementing Functional Flows

River	Fish	Indigenous nations	Social - Management
Oldman, S. Sask., AB	Trout	Piikani	New dam project
Waterton, St. Mary, AB		Kainai	
Truckee, NV	Cui-ui sucker	Paiute	Endangered species & new dam
Kootenai, MT, ID, BC	White sturgeon	Kootenai	Endangered species
Snake, ID	multiple		Dam relicensing
Bridge, BC	Salmon	Xwisten	Lawsuit
Duncan, BC	Trout		


Functional Flow Regimes
Rivers
Oldman
St. Mary
Waterton
S. Sask.
Duncan
Bridge
Canada
Kootenai
Snake
Truckee
USA
Bill Williams
Colorado

Flowing to the Future

- Further applications to refine functional flow regimes

- Across ecoregions & riparian vegetation communities

- Across river channel types - braided

- Irreversible thresholds

- River ice

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Review

Regeneration of *Salicaceae* riparian forests in the Northern Hemisphere: A new framework and management tool

Eduardo González [a, b, *], Vanesa Martínez-Fernández [c], Patrick B. Shafroth [d], Anna A. Sher [b], Annie L. Henry [b], Virginia Garófano-Gómez [e, f], Dov Corenblit [f]

(2018)

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A practical strategy for riparian restoration

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ALBERTA INNOVATES
Alberta Environment and Parks
NSERC CRSNG

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