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Approaches to nonsalmonid small fish passage in arid areas of the American Intermountain West and Great Plains

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Approaches to non-salmonid small fish passage in arid areas of the American Intermountain West and Great Plains

William Rice

United States Fish and Wildlife Service



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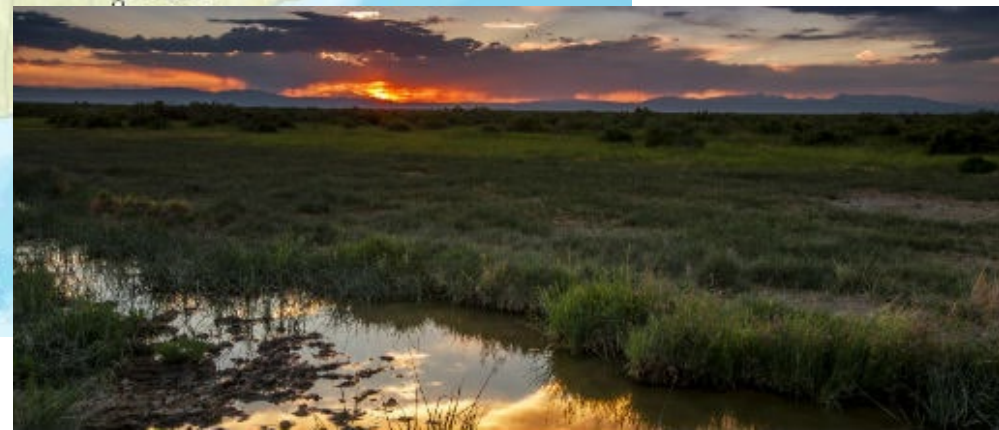


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Topic 2 Landscape Design



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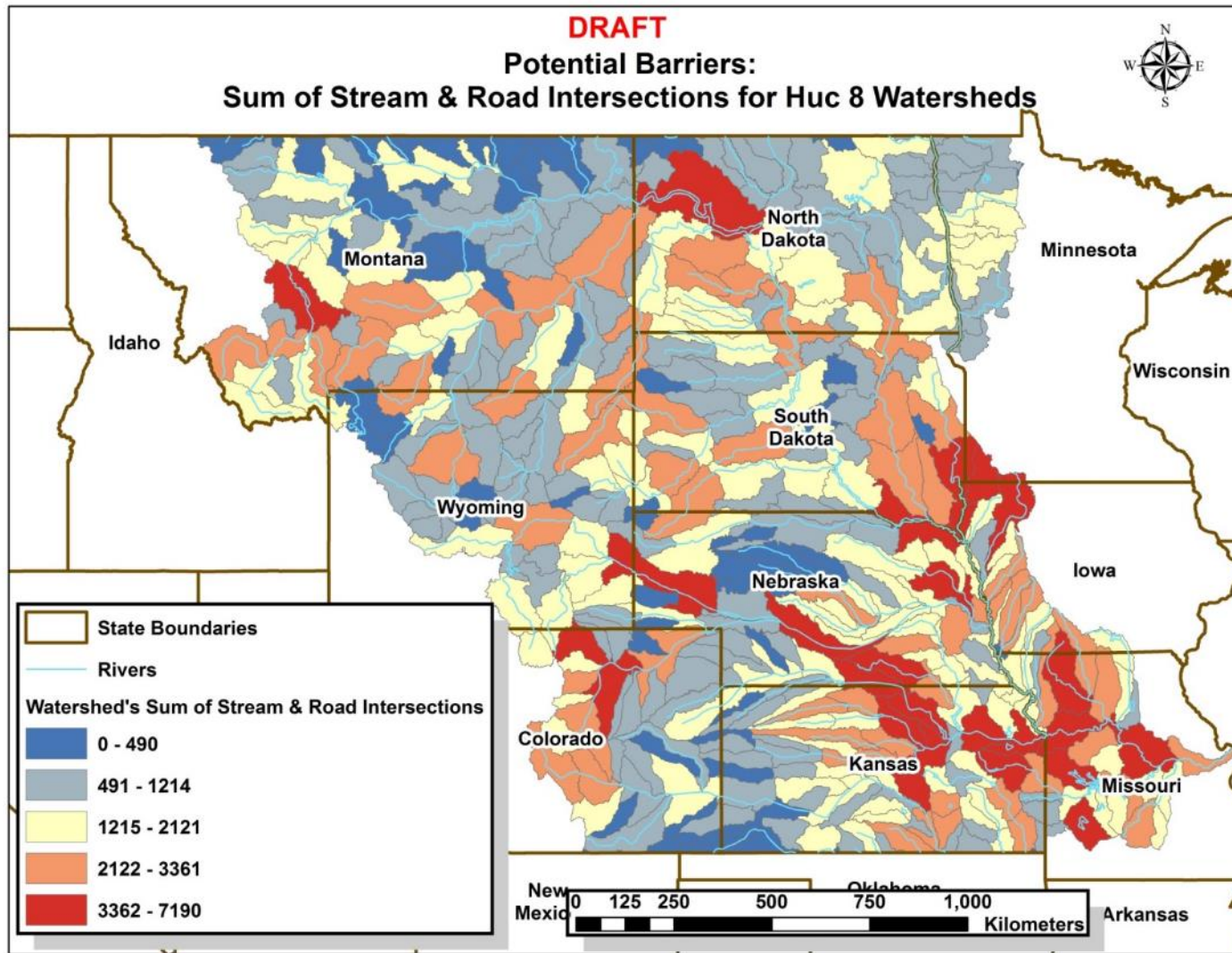


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Just the Plains:
Over 500,000
Crossings



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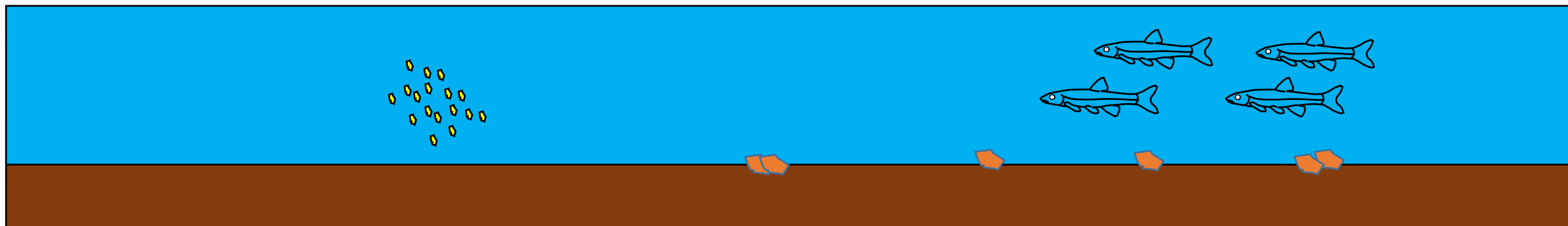
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Plains/Intermountain Fish Biology

Over 90 species of non-salmonids

Great Plains species –

- <100 mm
- 1-2 year life



Loss of eggs by thousands of diversions is unstudied....



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Plains/Intermountain Fish Biology

Little Studied but there is some....

- Longnose Dace (~64 cm/sec burst)_{Docker, et al, 2016}
- Silvery Minnow (80-100 cm/sec burst)
Bestgen, et al, 2013
- Ficke (2015) created predictive swimming models for 15 species



Rio Grande Sucker

Rio Grande Chub



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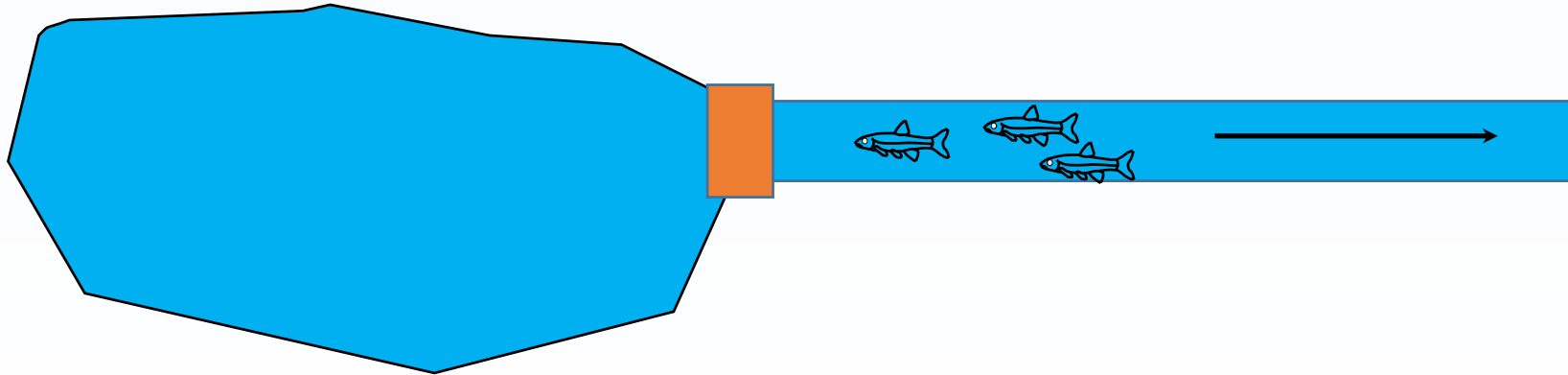
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Biology and Fish Passage

Lots of fish passage projects move fish into reservoirs..... questionable for riverine species



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Denil Weirs



Ineffective....

Denil Weirs – more for salmonids but attempted to be used for non-salmonids.



More Technical Fishways - Pool and Orifice Weir



Lincoln Street Fishway,
Wichita, Kansas



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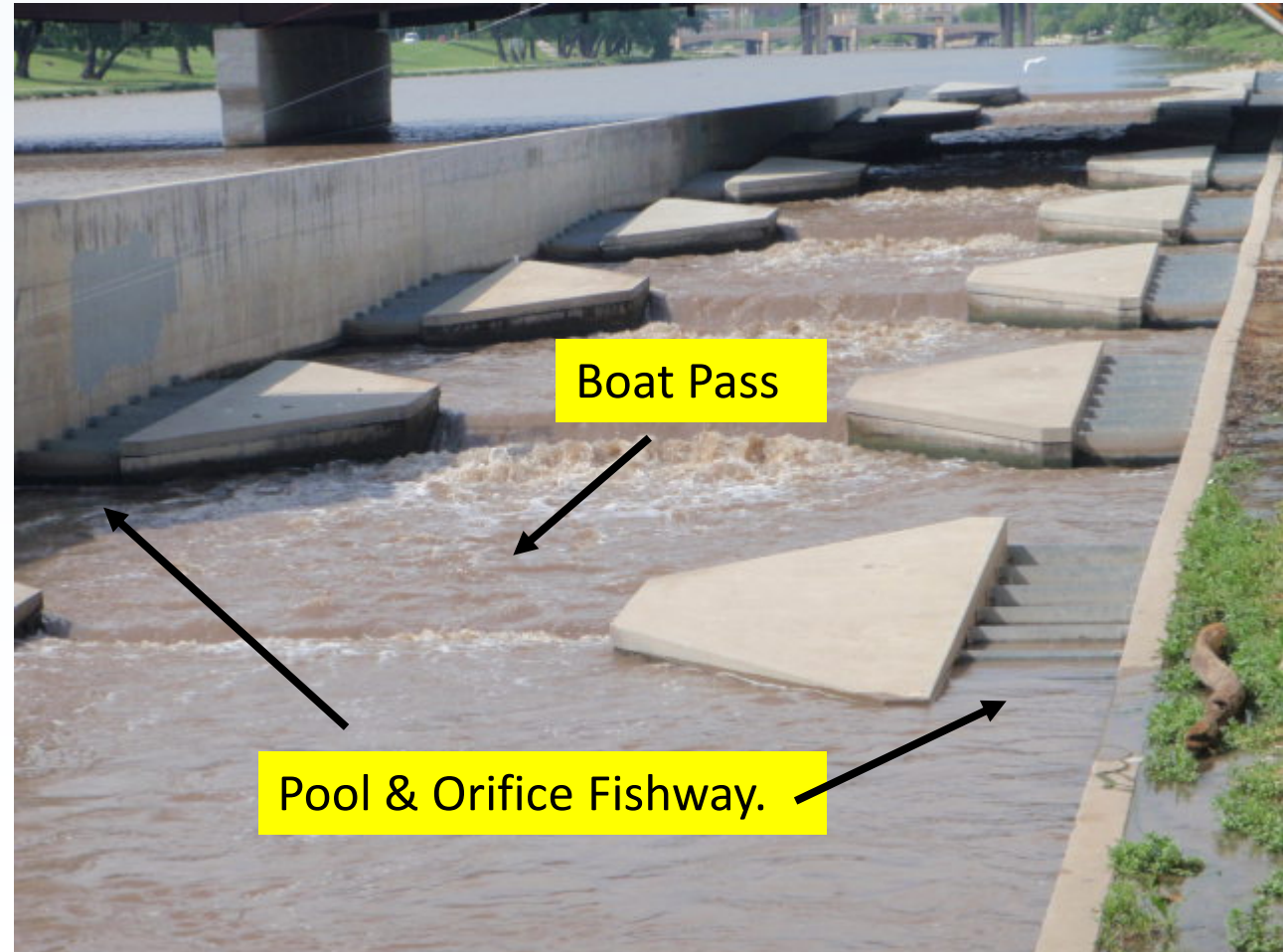
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More Technical Fishways - Pool and Orifice Weir

- 2.5% to 4.1% slope, 140 meters long with 77 pools
- 11 weirs each with an orifice (0.2 m W x 0.3 M H) 0.2 m up from bottom of each 88 baffles
- 2016 study for small-bodied minnows (Cyprinidae).
- Showed 74% of total species captured were using the fishway (29 species).



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Grouted Rocky Ramps



Colorado Front Range, Photos from CPW

Grouted Rocky Ramps – selective fish passage. Not preferred for non-salmonids.



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More Engineered Rocky Ramps



Fossil Creek Reservoir, Cache le Poudre River, Colorado

Photo from CPW

Nature-Like Rocky Ramps



Advantages

- Variation of velocity paths
- Nature-like

Cons

- Attraction issues for certain species
- Rock not available everywhere



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Rocky Ramp Criteria

Design Criteria for Fish Passage Structures Colorado

Species Assemblage	Velocity (ft/s)	Minimum Depth (ft)	Vertical Drop (ft)	Turbulence (EDF)	Froude Number
Native minnows and darters	1-2	0.50	0.00	<7	<1
Native dace and suckers	2-3	0.50	0.00	<7	<1
Trout	3-6	0.5-1.0	0.5-1.0	<7	<1

Note: EDF = Energy Dissipation Factor (v^3QS/A)

CPW, 2015.

- Ficke, 2015 – 5% slope or less on rocky ramps
- Bureau of Reclamation – 1% slope maximum for silvery minnow (recommendation)



Nature-Like Rocky Ramps



Baca NWR, Colorado, 2017 – 3.0% slope – Rio Grande Chub and Sucker, Longnose Dace



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Rocky Ramps

2017/18 Baca Fish Movement Study (preliminary)

Movement	Rio Grande Sucker		Rio Grande Chub	
Upstream	5	38%	14	67%
Downstream	5	38%	5	24%
Both	3	23%	2	10%
Unknown*	9		3	

* Fish only detected once



Movement utilizing 60 cm/sec design burst speed between rocks



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Culverts and Bridges – Kansas Clear Creek



Species	2004-2015	2015
Topeka Shiner	28	112
Orange-throat darter	57	109
Central stone roller	91	242

36 redbelly dace collected in 2015 compare to 31 collected in prev. 11 years.

1st confirmed golden red horse juveniles since 2004.



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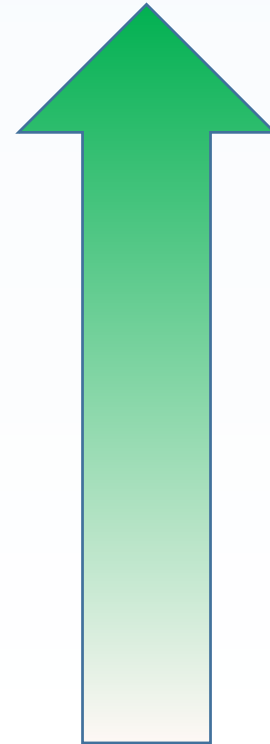
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Summary

- Bridges
- Embedded Culverts
- Nature-Like Rocky Ramps
- Engineered Rocky Ramps
- Grouted Rocky Ramps
- Technical Fishways



Better Fish
Passage



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Areas for Further Research

Retrofits - Culvert Baffles



Figure 3.5: Box culverts fitted with single-sided baffles.

From: O'Connor, Stuart, Campbell-Beschorner, 2017



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Areas for Further Research

Culvert Streambanks

- Need
- Stability



Rocky Ramps

- Attraction
- Types of substrate



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