

Fish Passage at River Structures



RESEARCH AND DESIGN GUIDELINES

Introduction

Instream structures, such as culverts, water diversions and dams, can negatively affect fish by fragmenting populations, reducing migratory ranges, and limiting access to habitat for spawning, feeding and refugia. Many rivers in Colorado contain man-made structures that create partial (obstacles) or complete barriers depending on the fish species and life stage. Habitat fragmentation associated with instream barriers is a serious threat to Colorado's Species of Greatest Conservation Need (SGCN) and sport fisheries. Therefore, it is important that fisheries managers identify and evaluate the influence of instream structures on fish populations.

Fish Passage Research Objectives

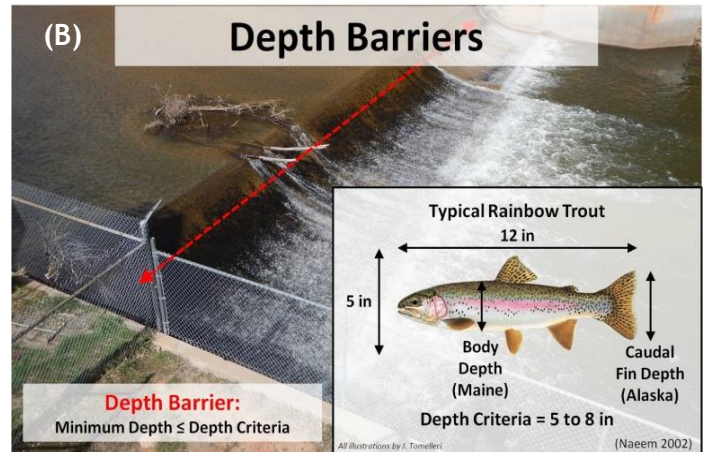
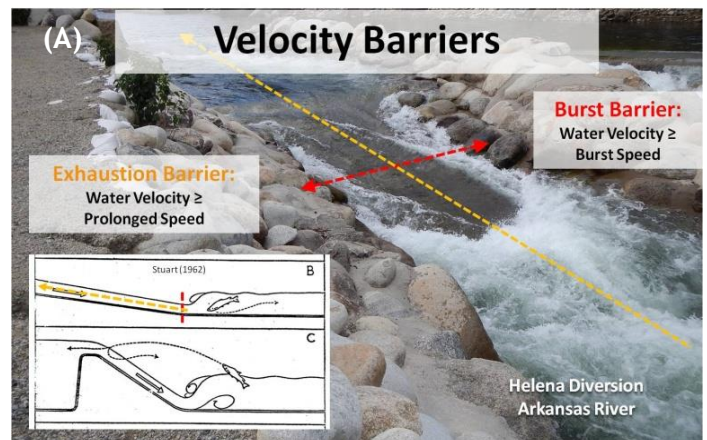
The primary goal of fish passage research is to restore connectivity in fragmented river systems by: (1) evaluating the effectiveness of existing fishways; (2) evaluating the barrier-potential of common river structures; and (3) establishing fish swim performance criteria for native and sport fishes.

Current Fish Passage Research Projects

Active fish passage research projects include: (1) evaluation of native fish passage at existing fishways located on Front Range transition zone streams; (2) evaluation of fish passage at instream whitewater park structures; (3) laboratory studies to develop fish swim and jump performance criteria for Colorado fishes where data is lacking; and (4) development of new techniques and technologies for investigating fish movement and passage in rivers.

Fishway Design

Fishways, or "fish ladders", are engineered structures designed to facilitate passage around an obstacle or barrier. Fishways attempt to incorporate species- and life stage-specific swimming and jumping abilities into designs. Common elements of successful fishways include: (1) low velocity pathways that do not exceed burst speeds or endurance capabilities for target species (Figure A); (2) water depths that do not limit swimming performance (Figure B); (3) vertical drops that do not exceed the jumping ability for target species - note that many species native to Colorado do not exhibit jumping behaviors (Figure C); (4) sufficient attraction flow, or the flow that emanates from a fishway entrance, to ensure that fish can locate the fishway; and (5) maintenance of the above design elements over the expected range of streamflows.



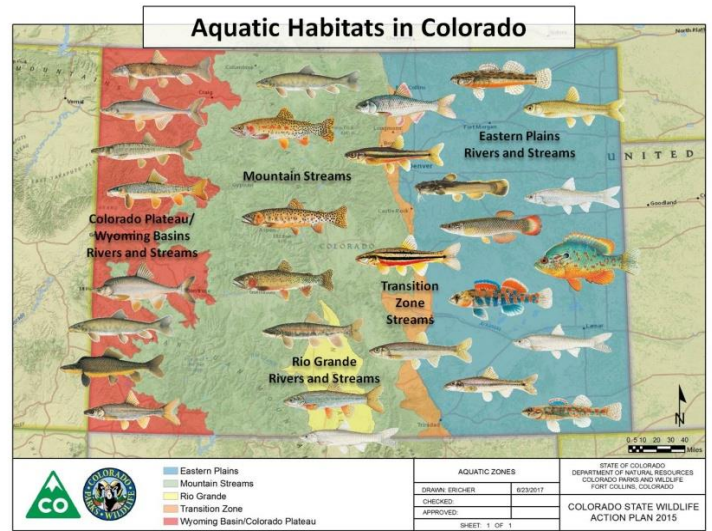
Fishway Examples

Some examples of successful fishways include engineered rock ramps (Figure D), constructed riffles (Figure E), and vertical slot fishways (Figure F). Each type of fishway has advantages and disadvantages related to which fish species and life stages are present and the conditions of the project site.



Aquatic Habitat Types

From the high-gradient, boulder-dominated, step-pool channels of snowmelt fed mountain streams to the low-gradient, well-vegetated, pool-riffle rivers of the eastern plains to the majestic, vertically-confined canyons on the arid Colorado Plateau, aquatic habitats in Colorado are as diverse as the geographic regions where they are found. Native Colorado fishes have unique morphological characteristics that are adapted to the natural conditions found in each aquatic habitat type. These adaptations affect the swimming abilities of fish, influencing how they move through and use diverse habitats. Fisheries managers must take the diversity of fish species into consideration when evaluating river structures and designing fishways.



Fish Swimming Performance by Family

Family Name	SGCN (#)	Prolonged Speed (ft/s)	Burst Speed (ft/s)	Jump Height (ft)	Habitat Types
Percidae (Perches)	3	0.4 - 1.2	NA - 2.4	0*	EP
Fundulidae (Topminnows)	1	1.3 - 1.6	2.6 - 3.4	0.1 - 0.2	EP
Cottidae (Sculpin)	0	1.4 - 1.7	3.3 - 3.9	0*	CP, MS
Ictaluridae (Catfish)	1	1.3 - 2.0	2.0 - NA	NA - 0.2	EP, TZ
Cyprinidae (Minnows)	13	1.3 - 2.4	2.4 - 4.4	0* - 0.5	CP, EP, MS, RG, TZ
Catostomidae (Suckers)	5	1.3 - 2.5	2.2 - 3.2	NA - 0.8	CP, EP, MS, RG, TZ
Centrarchidae (Sunfish)	1	1.1 - 2.9	2.6 - NA	0.4 - NA	EP
Salmonidae (Trout)	3	2.3 - 4.0	4.5 - 7.5	1.0 - 7.0	MS, RG, TZ

SGCN = Species of Greatest Conservation Need, # of species/subspecies; * = fish species does not exhibit jumping behavior; NA = data were not available; CP = Colorado Plateau, EP = Eastern Plains, MS = Mountain Streams, RG = Rio Grande; TZ = Transition Zone

The values reported above are summarized from multiple species within each family and are intended to support passage for juvenile life stages. Swim speeds and jumping abilities within species are size dependent. Species-specific performance criteria should be used whenever possible. The selection of target species for individual projects should be based on the management objectives for the site in question. Consultation with the local Area Aquatic Biologist at CPW is strongly encouraged during the early planning stages for any fish passage project in Colorado. The information in this fact sheet is based on the best available data and knowledge, but is subject to revision as more information becomes available.