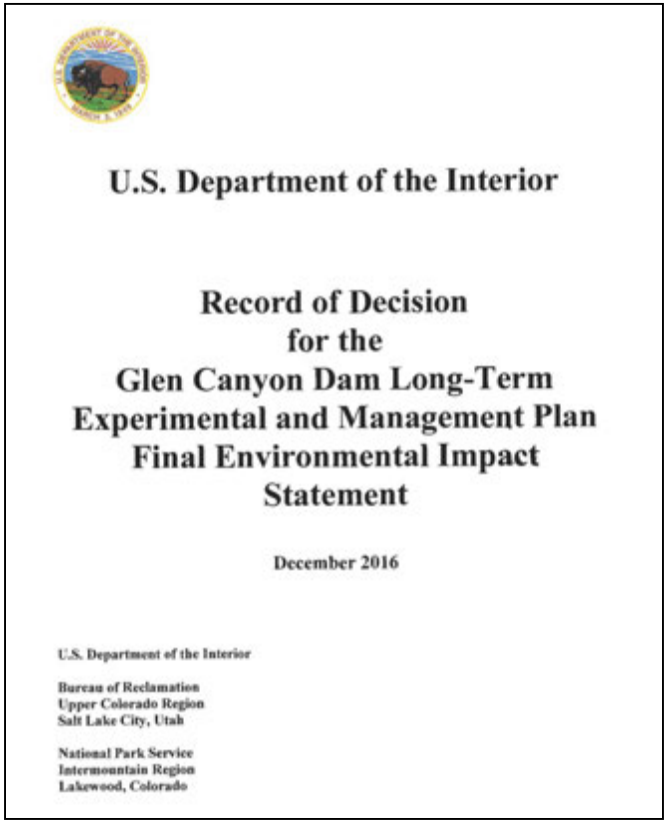
Long-term Monitoring

David Rogowski, Jan Boyer,
Pilar Wolters, Cory Nielson, Marshall Lindsay

Goals

- **Lees Ferry** – monitor Rainbow Trout fishery
- **Downstream** – system wide monitoring of the fish assemblage



U.S. Department of the Interior

Record of Decision
for the
Glen Canyon Dam Long-Term
Experimental and Management Plan
Final Environmental Impact
Statement

December 2016

U.S. Department of the Interior

Bureau of Reclamation
Upper Colorado Region
Salt Lake City, Utah

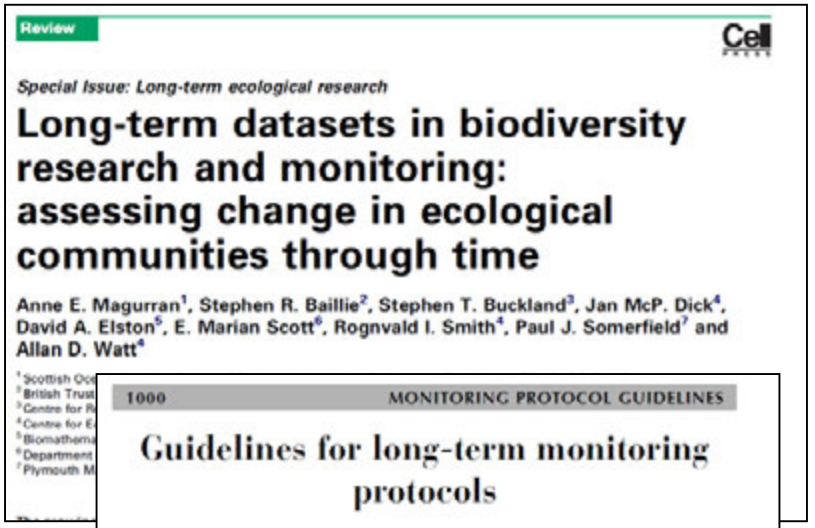
National Park Service
Intermountain Region
Lakewood, Colorado

4.1 LTEMP Purpose, Need, Objectives and – Resource Goals

3) Humpback Chub
5) other native fish
6) recreational experience
9) Rainbow Trout fishery
10) nonnative invasive species

Benefits

- Detect patterns over time (baseline data)
- Historical context for emerging concerns
- Novel ways to use data

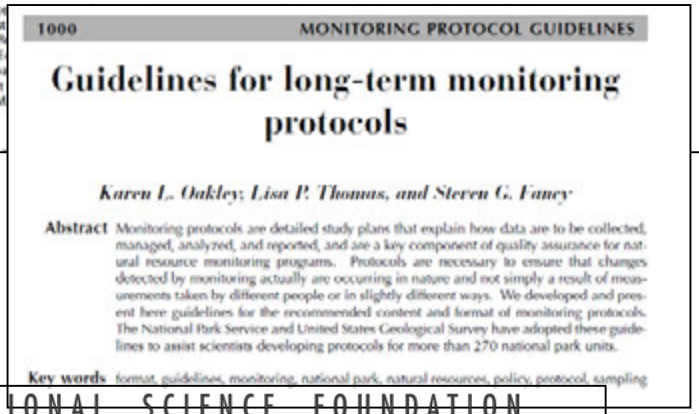

Review

Cell

Special Issue: Long-term ecological research

Long-term datasets in biodiversity research and monitoring: assessing change in ecological communities through time

Anne E. Magurran[1], Stephen R. Baillie[2], Stephen T. Buckland[3], Jan McP. Dick[4], David A. Elston[5], E. Marian Scott[6], Rognvald I. Smith[4], Paul J. Somerfield[7] and Allan D. Watt[4]


1000 MONITORING PROTOCOL GUIDELINES

Guidelines for long-term monitoring protocols

Karen L. Oakley, Lisa P. Thomas, and Steven G. Fancy

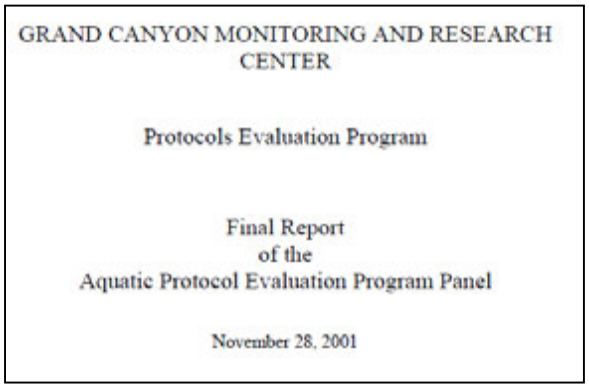
Abstract Monitoring protocols are detailed study plans that explain how data are to be collected, managed, analyzed, and reported, and are a key component of quality assurance for natural resource monitoring programs. Protocols are necessary to ensure that changes detected by monitoring actually are occurring in nature and not simply a result of measurements taken by different people or in slightly different ways. We developed and present here guidelines for the recommended content and format of monitoring protocols. The National Park Service and United States Geological Survey have adopted these guidelines to assist scientists developing protocols for more than 270 national park units.

Key words format, guidelines, monitoring, national park, natural resources, policy, protocol, sampling

NATIONAL SCIENCE FOUNDATION

LTER NETWORK

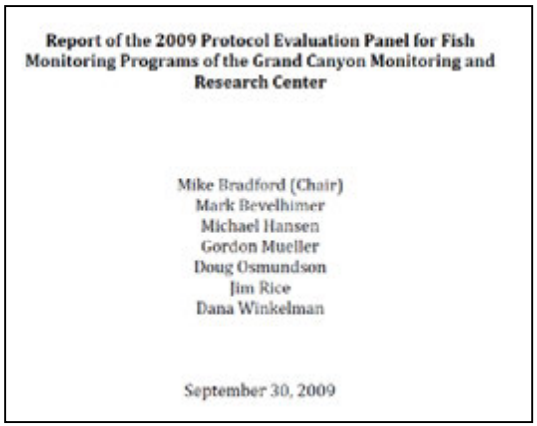
LONG TERM ECOLOGICAL RESEARCH


GRAND CANYON MONITORING AND RESEARCH CENTER

Protocols Evaluation Program

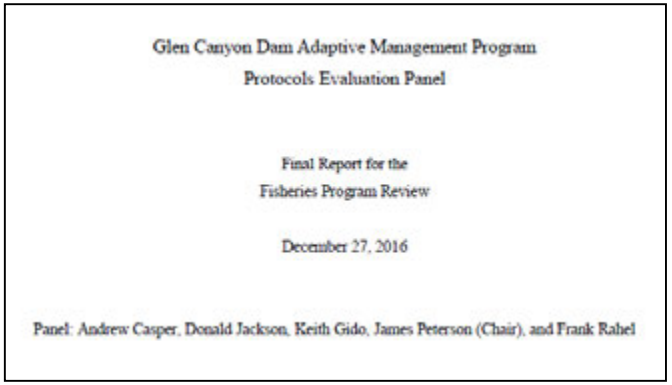
Final Report
of the
Aquatic Protocol Evaluation Program Panel

November 28, 2001


Report of the 2009 Protocol Evaluation Panel for Fish Monitoring Programs of the Grand Canyon Monitoring and Research Center

Mike Bradford (Chair)
Mark Bevelhimer
Michael Hansen
Gordon Mueller
Doug Osmundson
Jim Rice
Dana Winkelman

September 30, 2009


Glen Canyon Dam Adaptive Management Program
Protocols Evaluation Panel

Final Report for the
Fisheries Program Review

December 27, 2016

Panel: Andrew Casper, Donald Jackson, Keith Gido, James Peterson (Chair), and Frank Rahel

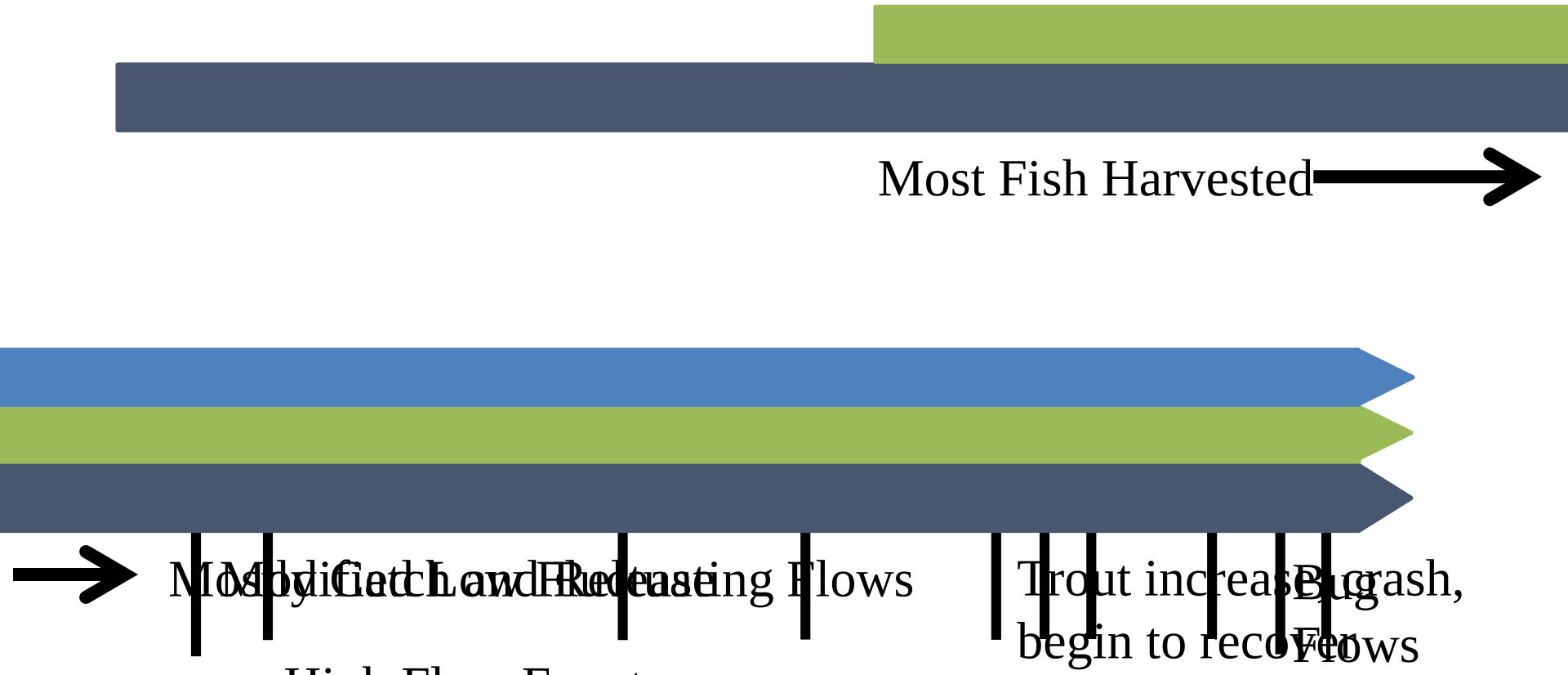
Problems

- Continuity – compare data across time
- Pressure to change methods for short term goals/objectives
- Funding $$$
- Criticisms

Lees Ferry Monitoring

Jan Boyer, David Rogowski, Pilar Wolters, Cory Nielson, Marshall Lindsay

Long term data



Findings

- AGFD data used in a variety of products

ARTICLE

Economic Value of Angling on the Colorado River at Lees Ferry: Using Secondary Data to Estimate the Influence of Seasonality

Lucas S. Bair*
U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center, 2255 North Gemini Drive, Flagstaff, Arizona 86001, USA

David L. Rogowski
Arizona Game and Fish Department, Research Branch, 5000 West Carefree Highway, Phoenix, Arizona 85086, USA

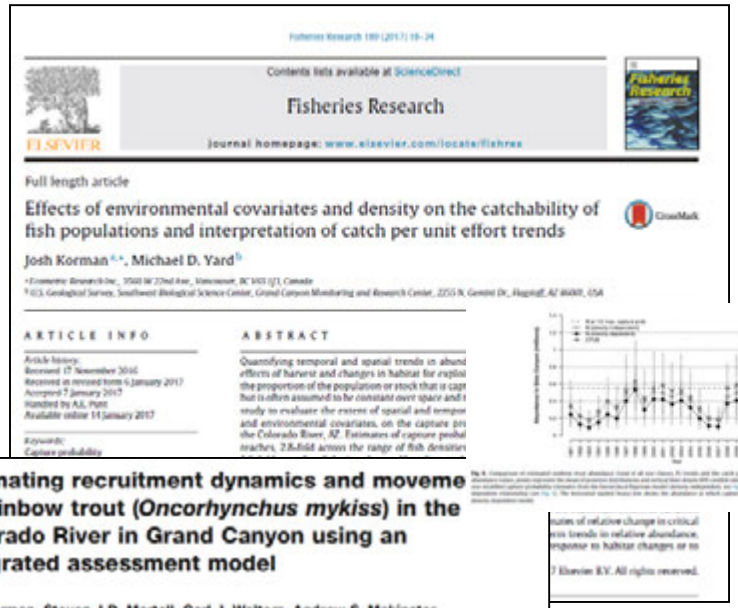
Chris Neher
Department of Mathem
Missoula, Montana 59

Effects of Intraspecific Density and Environmental Variables on Electrofishing Catchability of Brown and Rainbow Trout in the Colorado River

David W. Speas*[1]
Arizona Game and Fish Department, Research Branch, 2221 West Greenway Road, Phoenix, Arizona 85023, USA

Carl J. Walters
Fisheries Centre, 2204 Main Mall, University of British Columbia, Vancouver, British Columbia V6T 1Z4, Canada

David L. Ward and R. Scott Rogers
Arizona Game and Fish Department, Research Branch, 2221 West Greenway Road, Phoenix, Arizona 85023, USA



Fisheries Research

Contents lists available at ScienceDirect

Fisheries Research

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

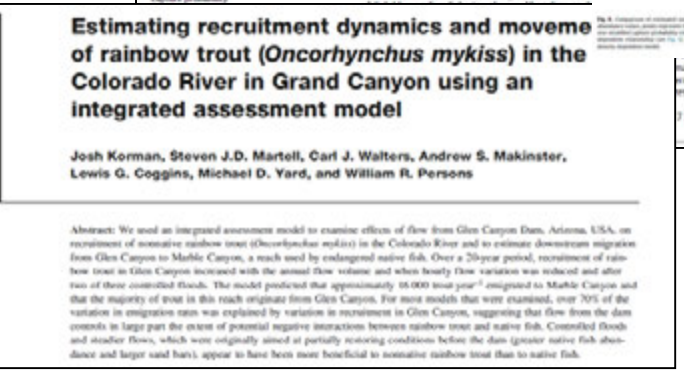
Full length article

Effects of environmental covariates and density on the catchability of fish populations and interpretation of catch per unit effort trends

Josh Korman*, Michael D. Yard

ARTICLE INFO

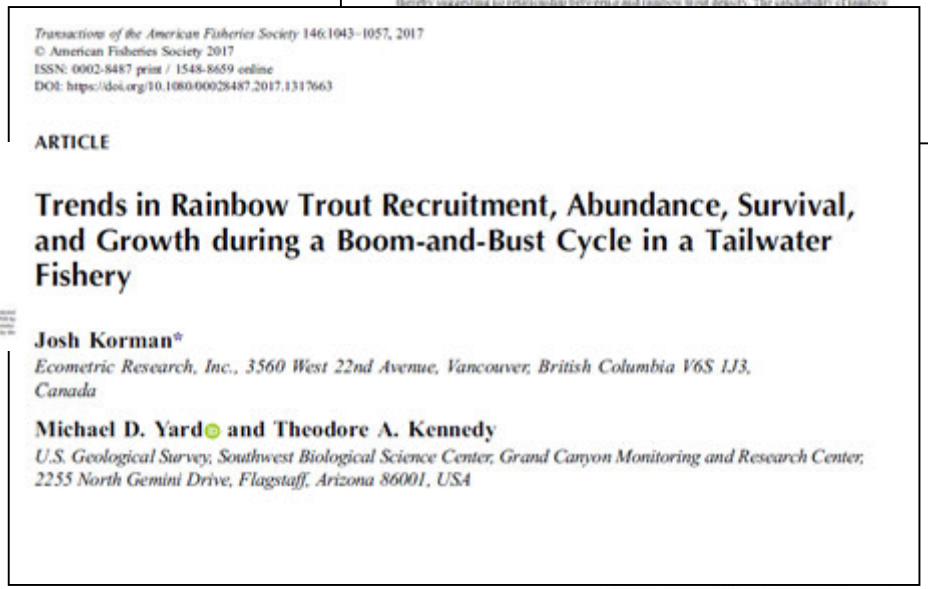
ABSTRACT



Estimating recruitment dynamics and movement of rainbow trout (*Oncorhynchus mykiss*) in the Colorado River in Grand Canyon using an integrated assessment model

Josh Korman, Steven J.D. Martell, Carl J. Walters, Andrew S. Makinster, Lewis G. Coggins, Michael D. Yard, and William R. Persons

Abstract: We used an integrated assessment model to examine effects of flow from Glen Canyon Dam, Arizona, USA, on recruitment of nonnative rainbow trout (*Oncorhynchus mykiss*) in the Colorado River and to estimate downstream migration from Glen Canyon to Marble Canyon, a reach used by endangered native fish. Over a 20-year period, recruitment of rainbow trout in Glen Canyon increased with the annual flow volume and when hourly flow variation was reduced and after two of three controlled floods. The model predicted that approximately 18,000 trout year^{-1} emigrated to Marble Canyon and that the majority of trout in this reach originate from Glen Canyon. For most models that were examined, over 70% of the variation in emigration rates was explained by variation in recruitment in Glen Canyon, suggesting that flow from the dam controls in large part the extent of potential negative interactions between rainbow trout and native fish. Controlled floods and steadier flows, which were originally aimed at partially restoring conditions before the dam (greater native fish abundance and larger sand bars), appear to have been more beneficial to nonnative rainbow trout than to native fish.



Transactions of the American Fisheries Society 146:1043–1057, 2017
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ISSN: 0002-8487 print / 1548-8659 online
DOI: https://doi.org/10.1080/00028487.2017.1317663

ARTICLE

Trends in Rainbow Trout Recruitment, Abundance, Survival, and Growth during a Boom-and-Bust Cycle in a Tailwater Fishery

Josh Korman*
Ecometric Research, Inc., 3560 West 22nd Avenue, Vancouver, British Columbia V6S 1J3, Canada

Michael D. Yard and Theodore A. Kennedy
U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center, 2255 North Gemini Drive, Flagstaff, Arizona 86001, USA

FIGURE 2. Trends in annual CPUE of Rainbow Trout based on the Arizona Game and Fish Department's boat electrofishing survey; the annual minimum elevation (in above sea level [masl]) of the reservoir behind Glen Canyon Dam (i.e., Lake Powell); and the mean annual discharge from Glen Canyon Dam. The horizontal dotted line shows the full pool elevation of Lake Powell.

LTEMP/ROD goals

- Quality recreational rainbow trout fishery at Lees Ferry
- Reduce downstream movement of trout to protect native fishes in Grand Canyon
- Minimize emigration of nonnative warmwater fish into the mainstem Colorado River

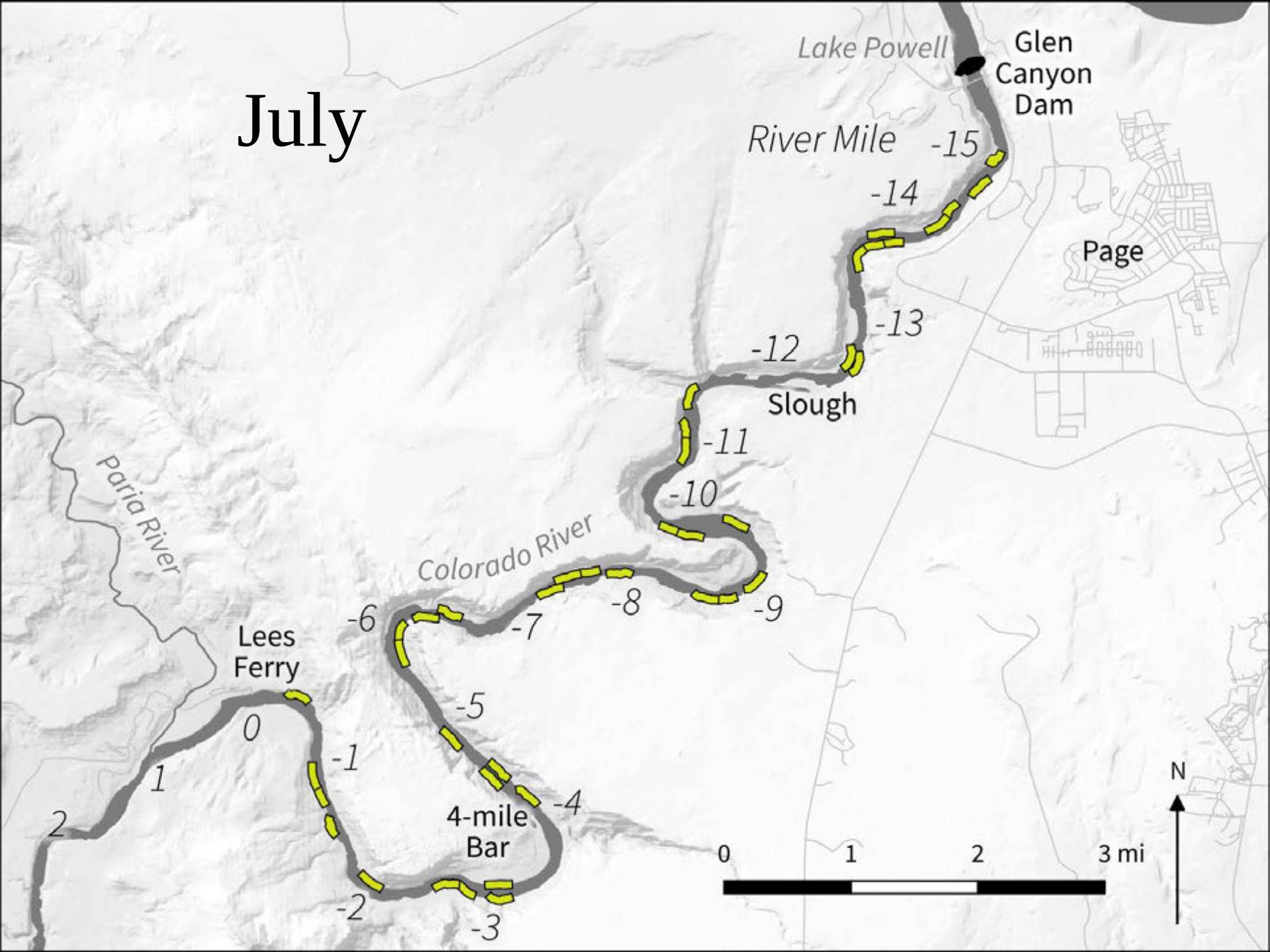
Fish Monitoring 2018

2 trips: July, September

- 3 nights monitoring – stratified random sampling
- 1 night - target warmwater nonnatives

Angler Monitoring

- Angler Interviews
  6x month, boat and walk-in area
- Citizen Science – length data from guides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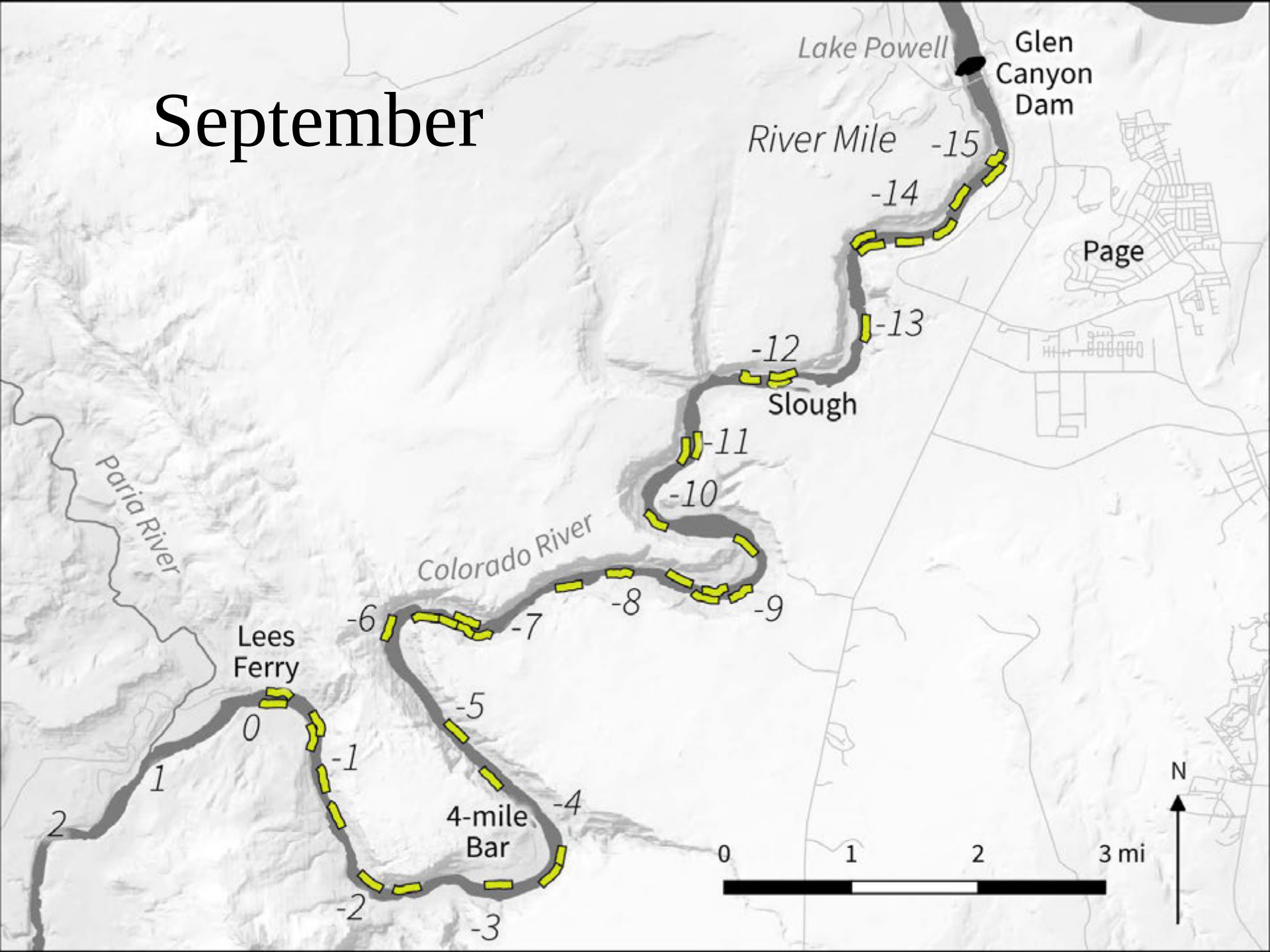
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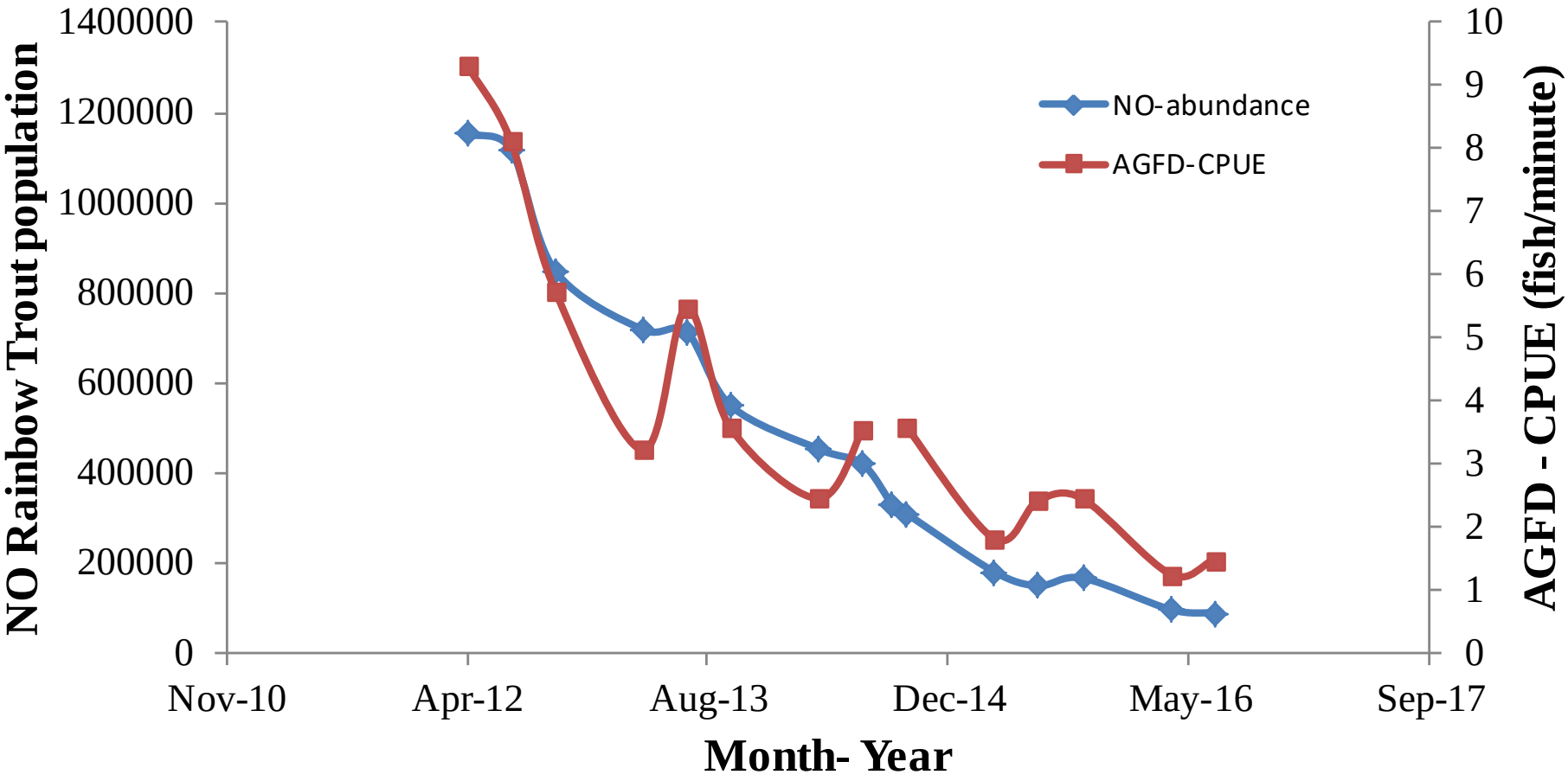
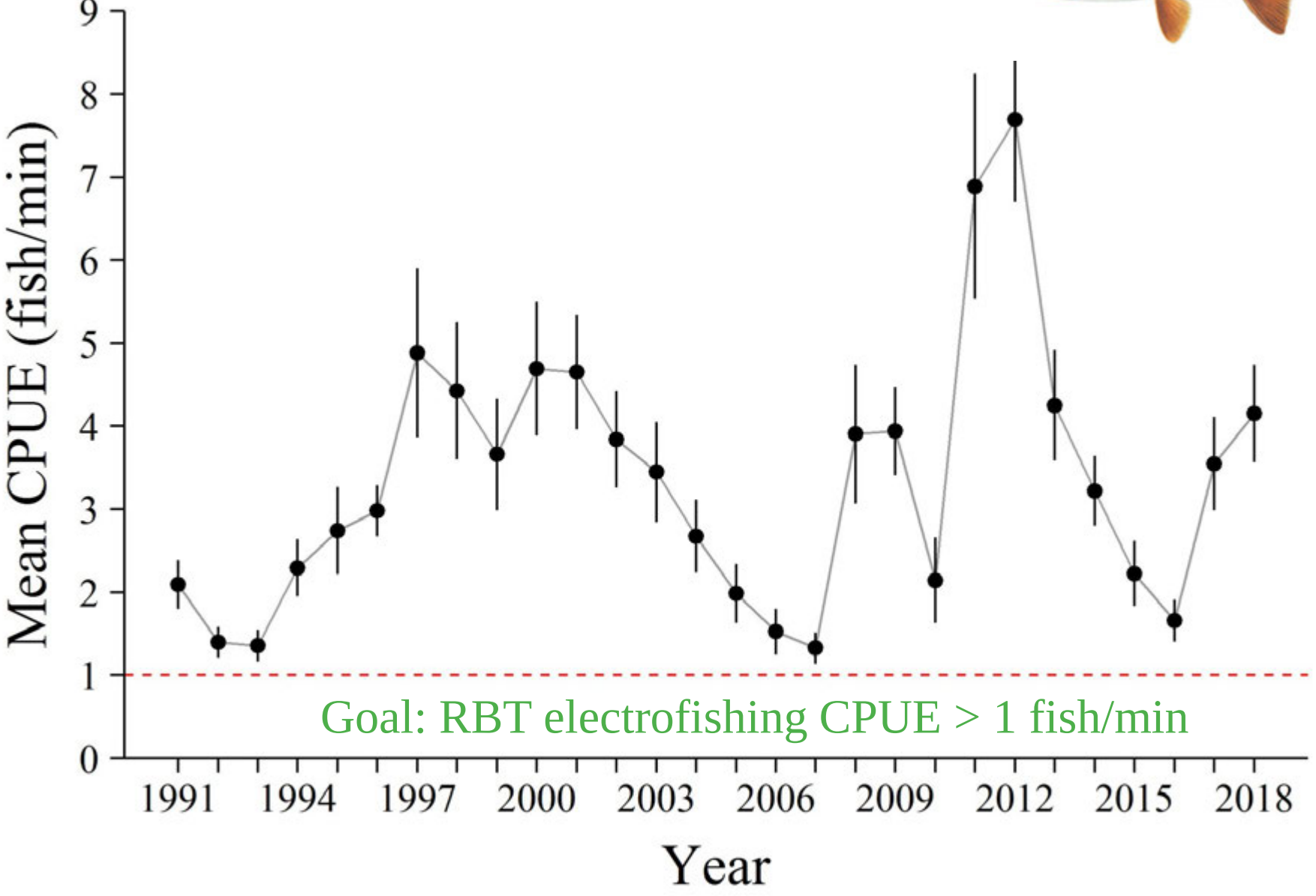
Rainbow Trout Monitoring

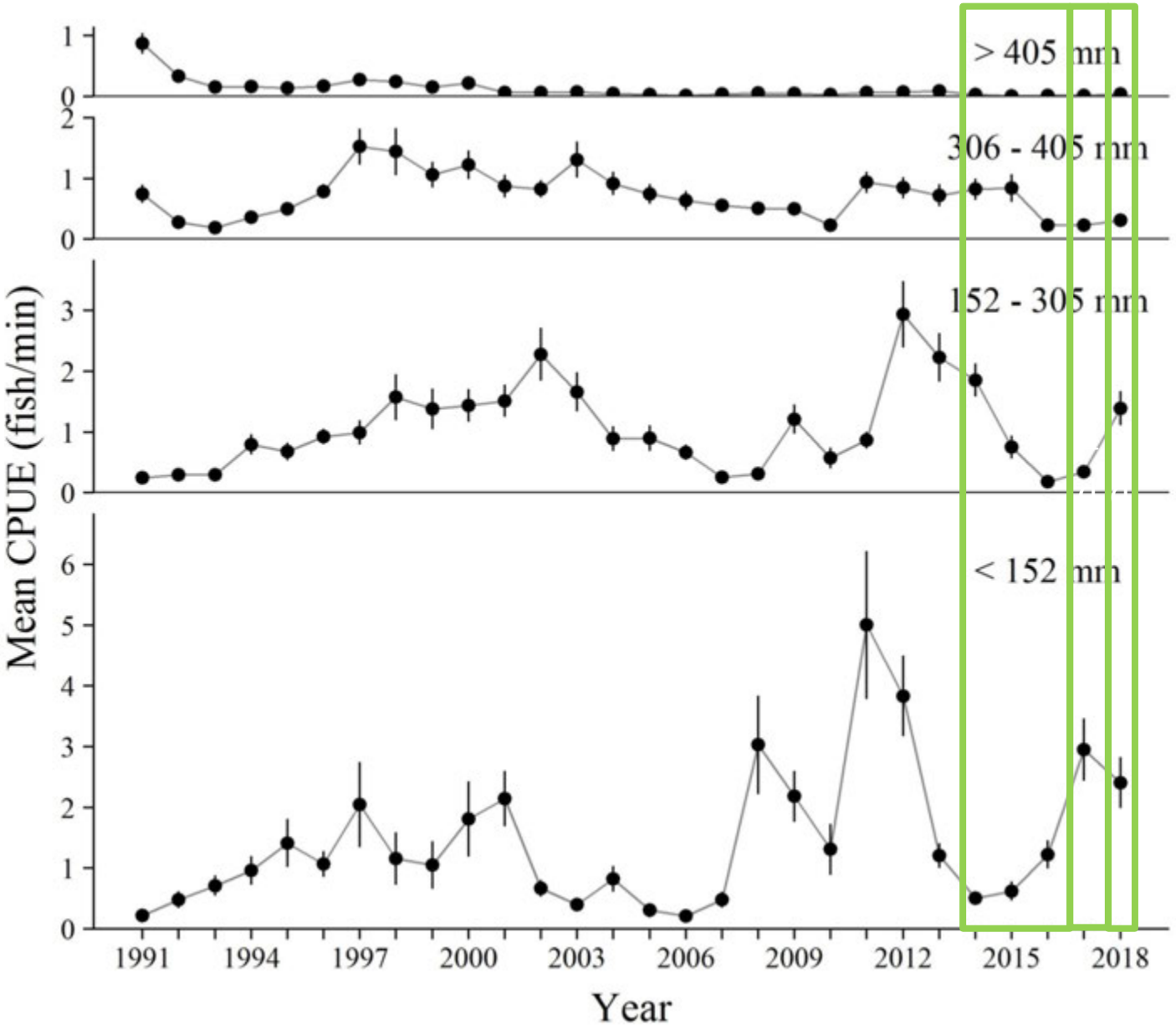
CPUE vs Abundance



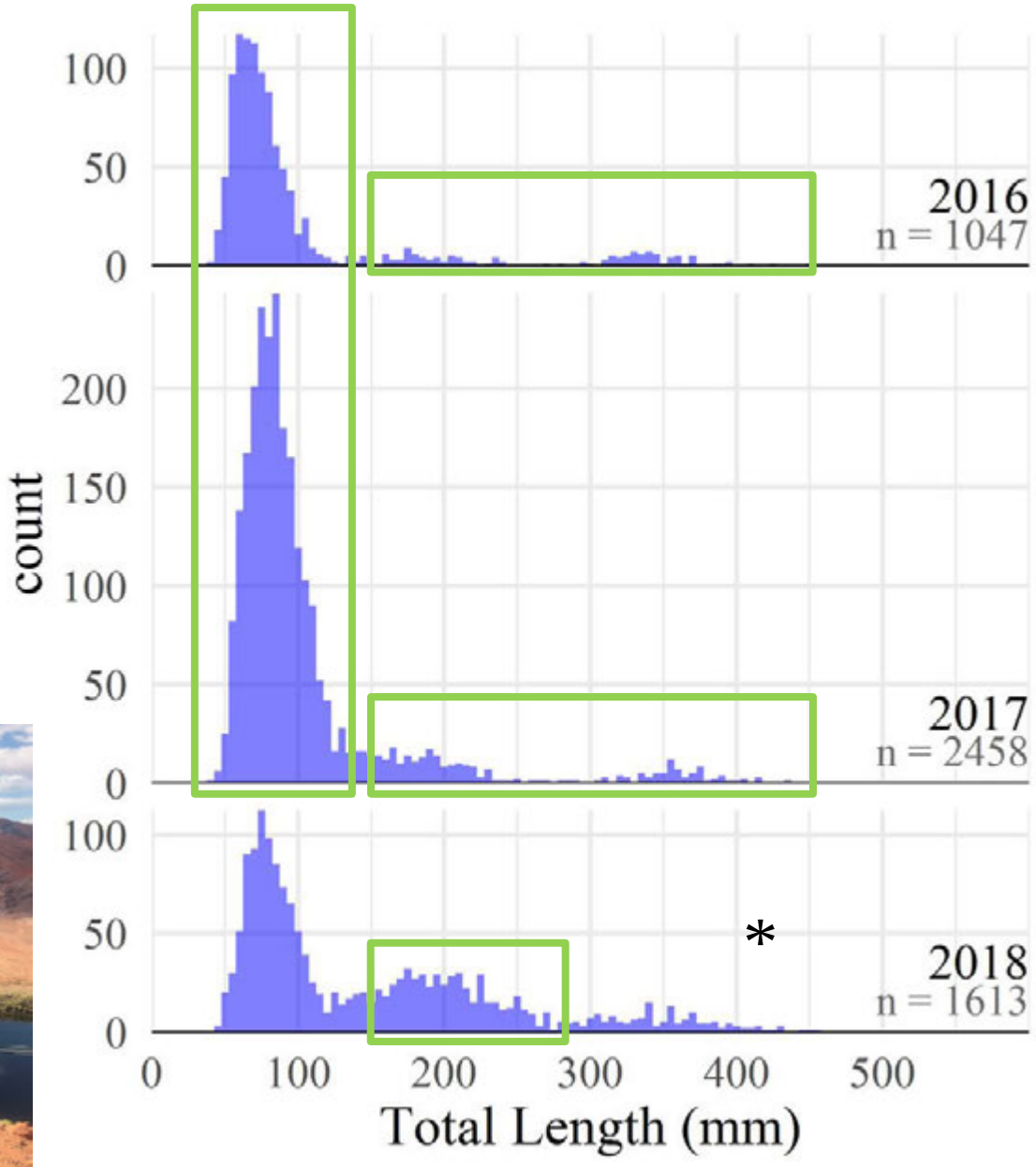
Rainbow Trout CPUE



Lees Ferry Rainbow Trout (fall)

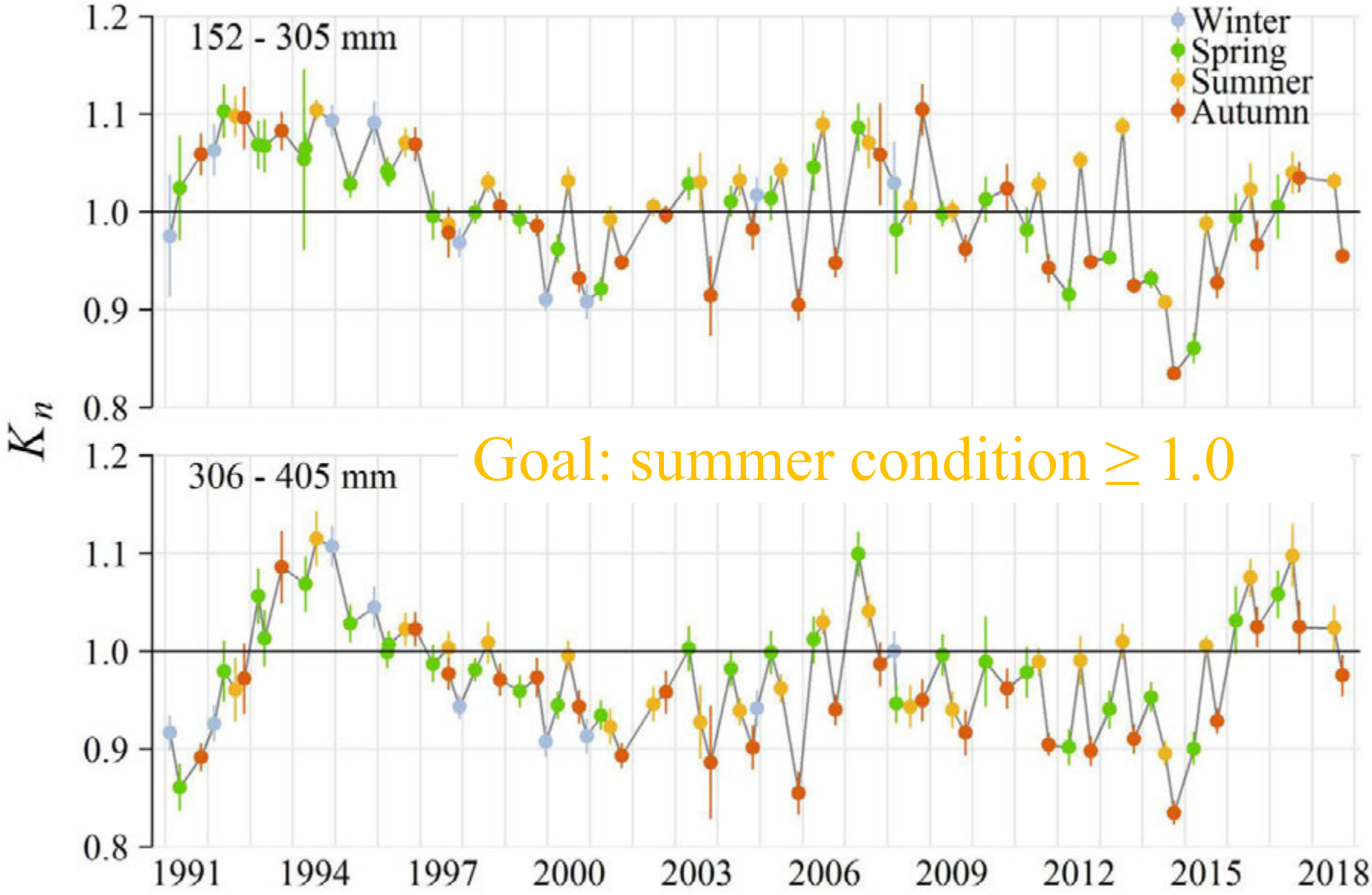


Lees Ferry Rainbow Trout length frequency histograms



*No Spring trip in 2018

Relative Rainbow Trout condition



Rainbow Monitoring

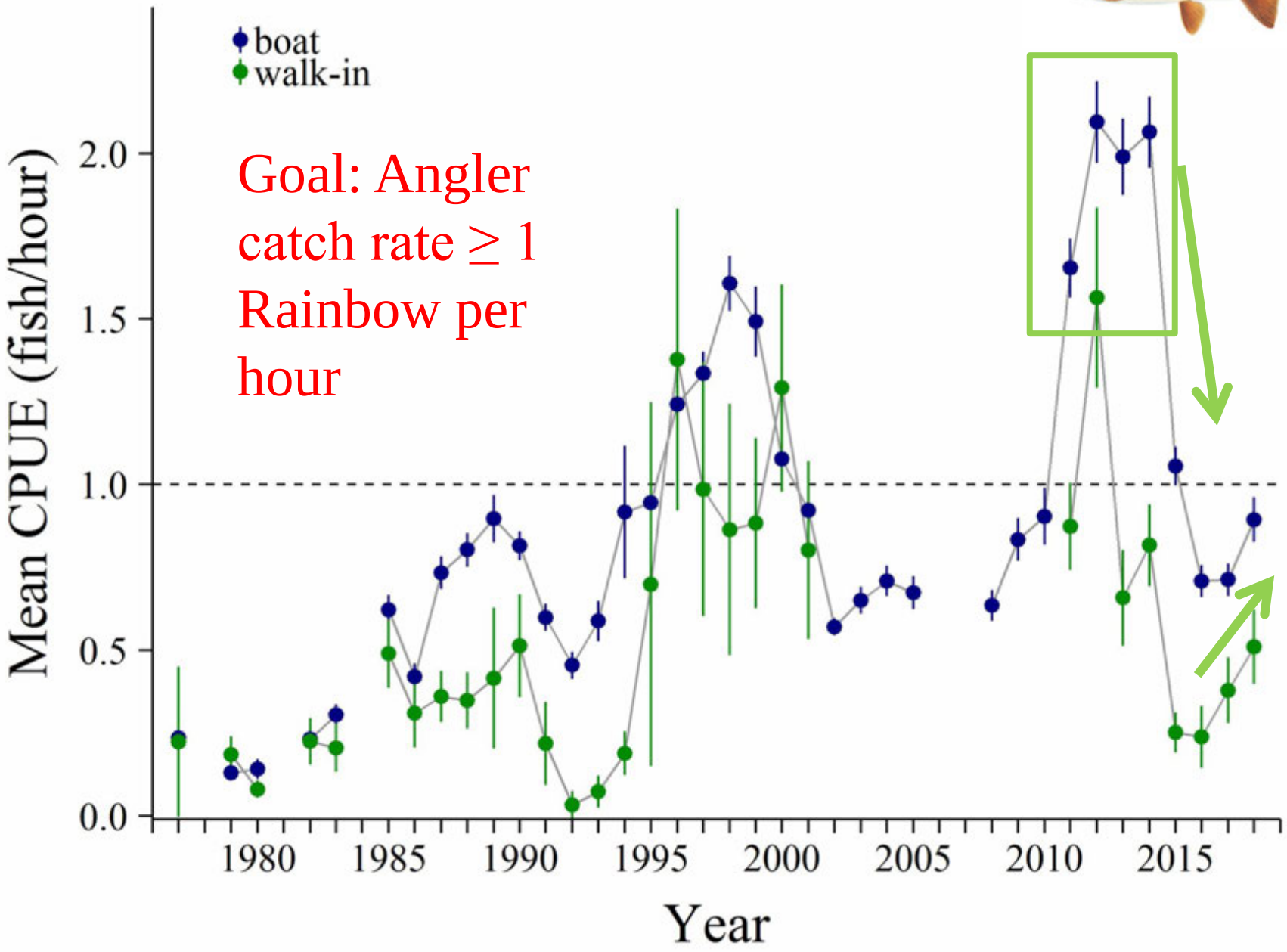
CPUE increasing

especially 152-305 mm size class

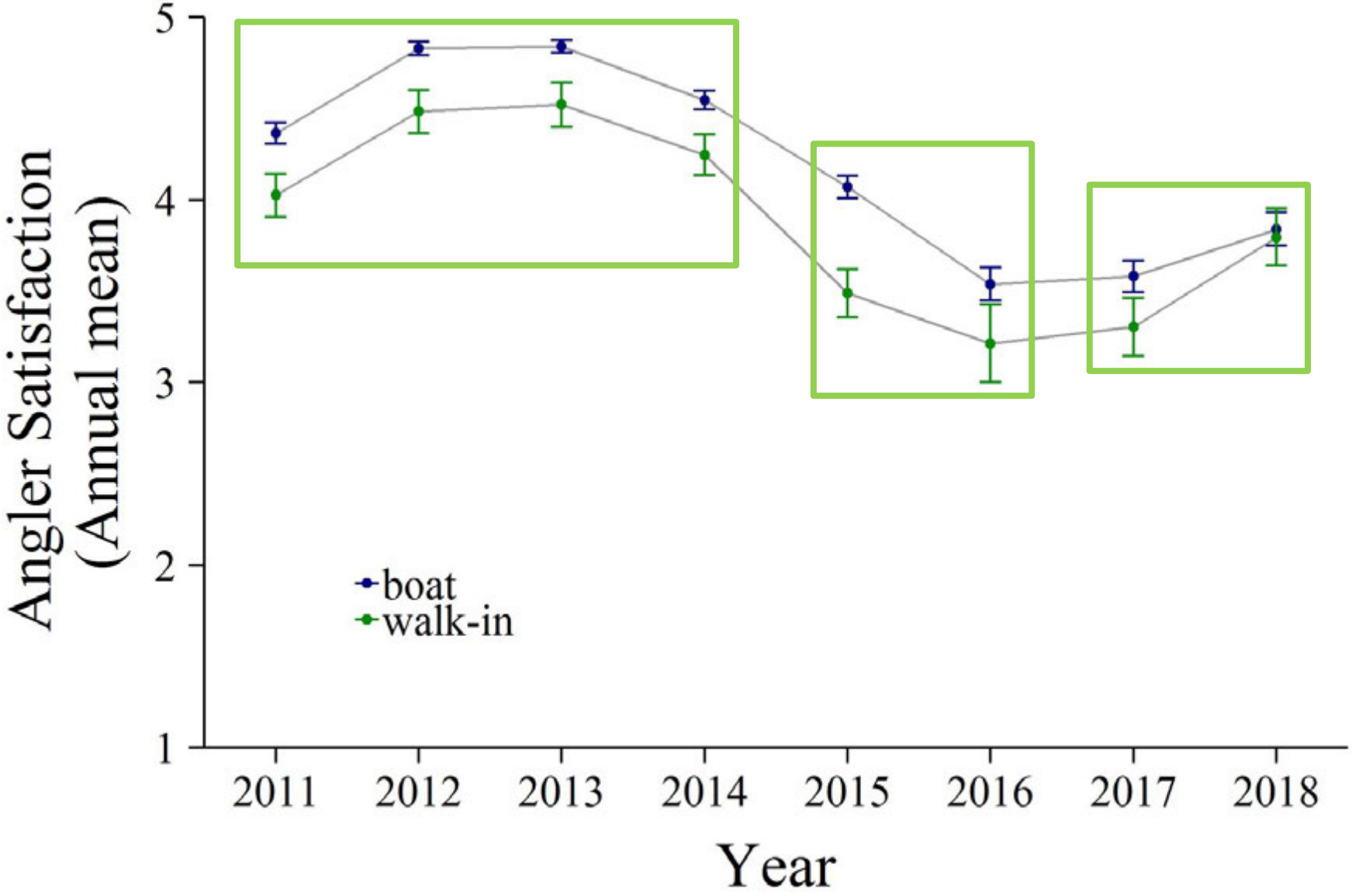
Good fish condition

Creel Results

Angler Rainbow Trout CPUE

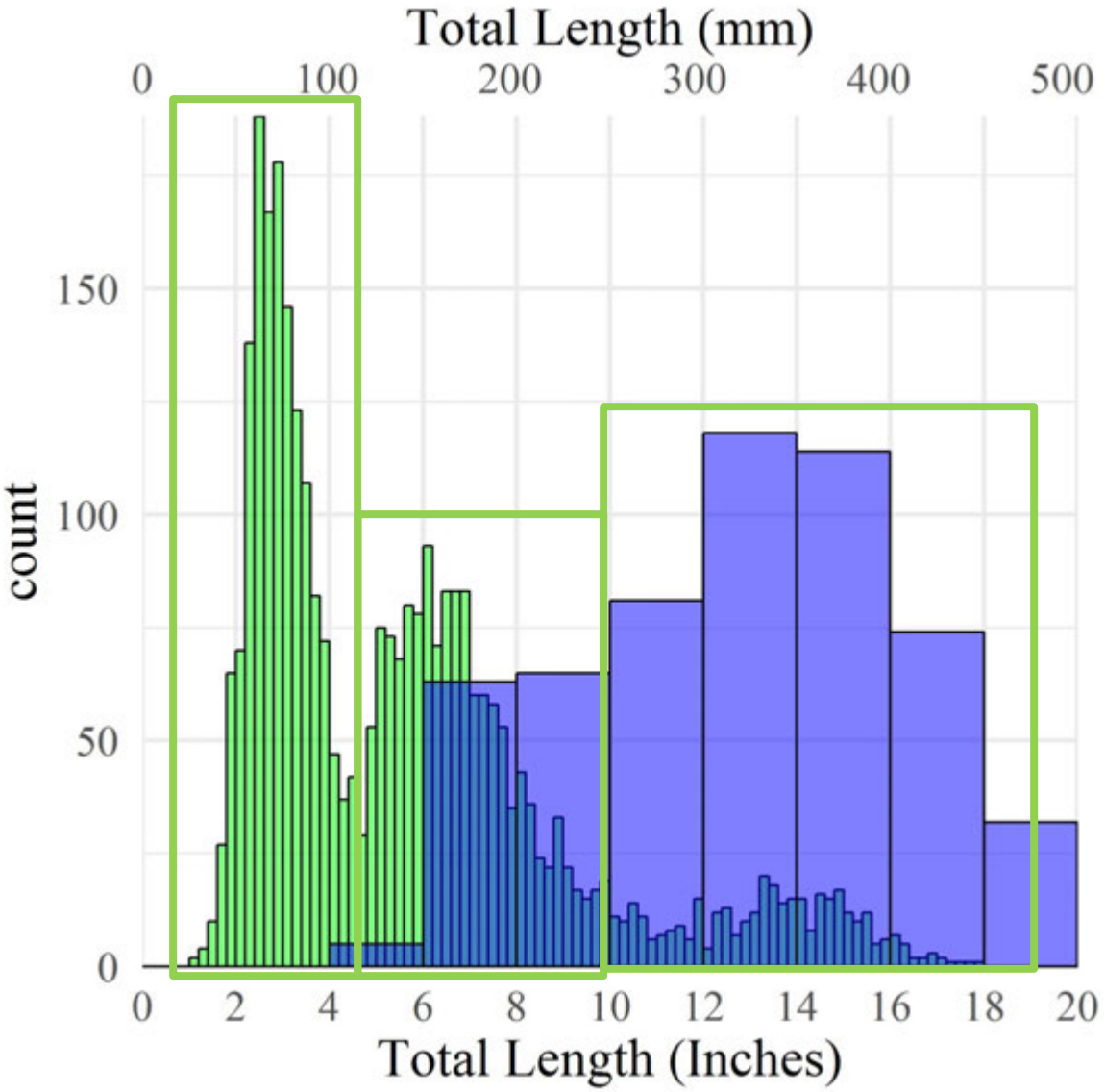


Angler satisfaction



Citizen science

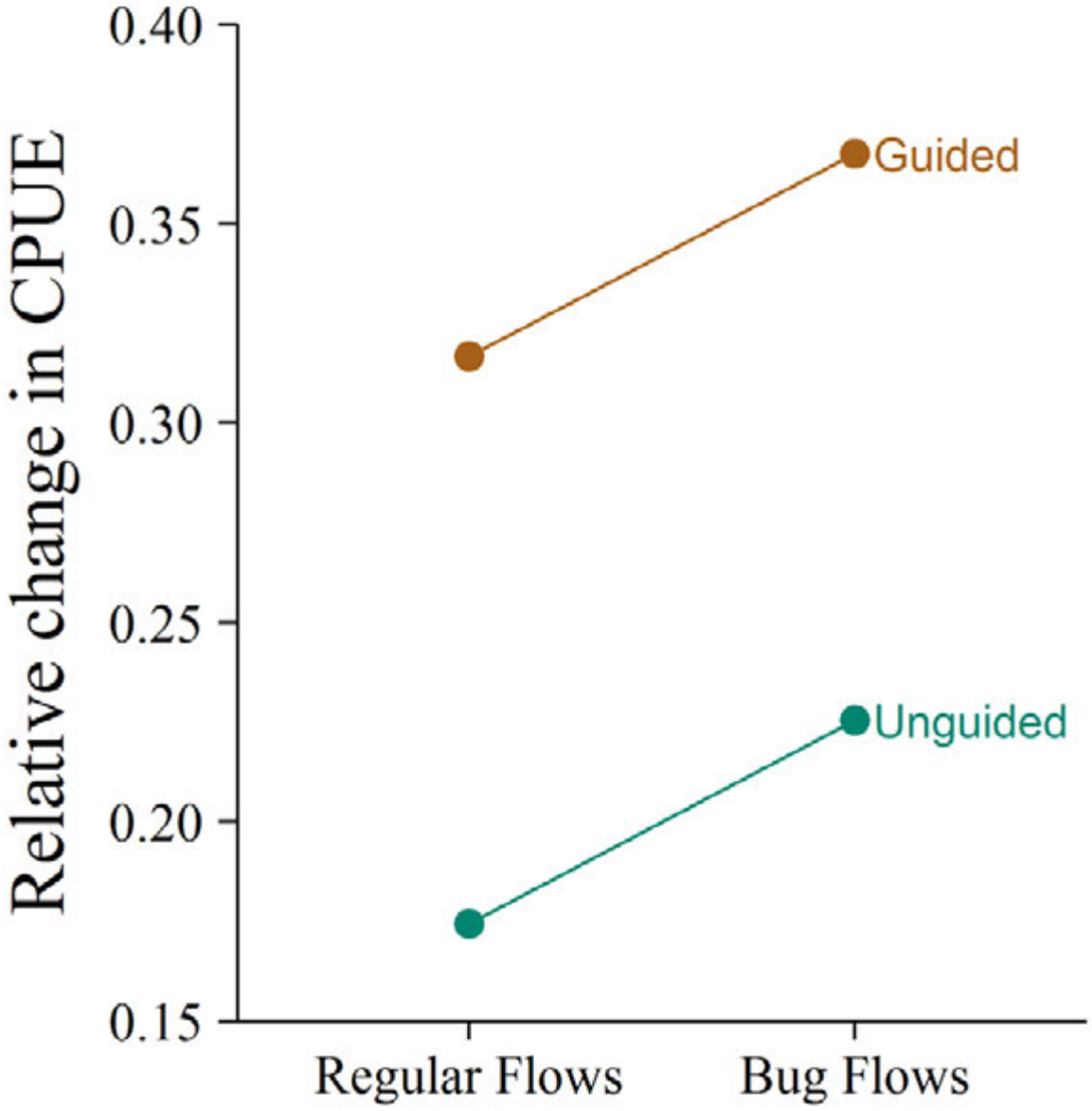
Goal: In 10 hr day, angler catches at least 10 Rainbow Trout ≥ 14 inches and one ≥ 20 inches



26% of anglers caught at least one 14” fish/hr

0 anglers caught 20” fish

Bug Flows Improved Fishing

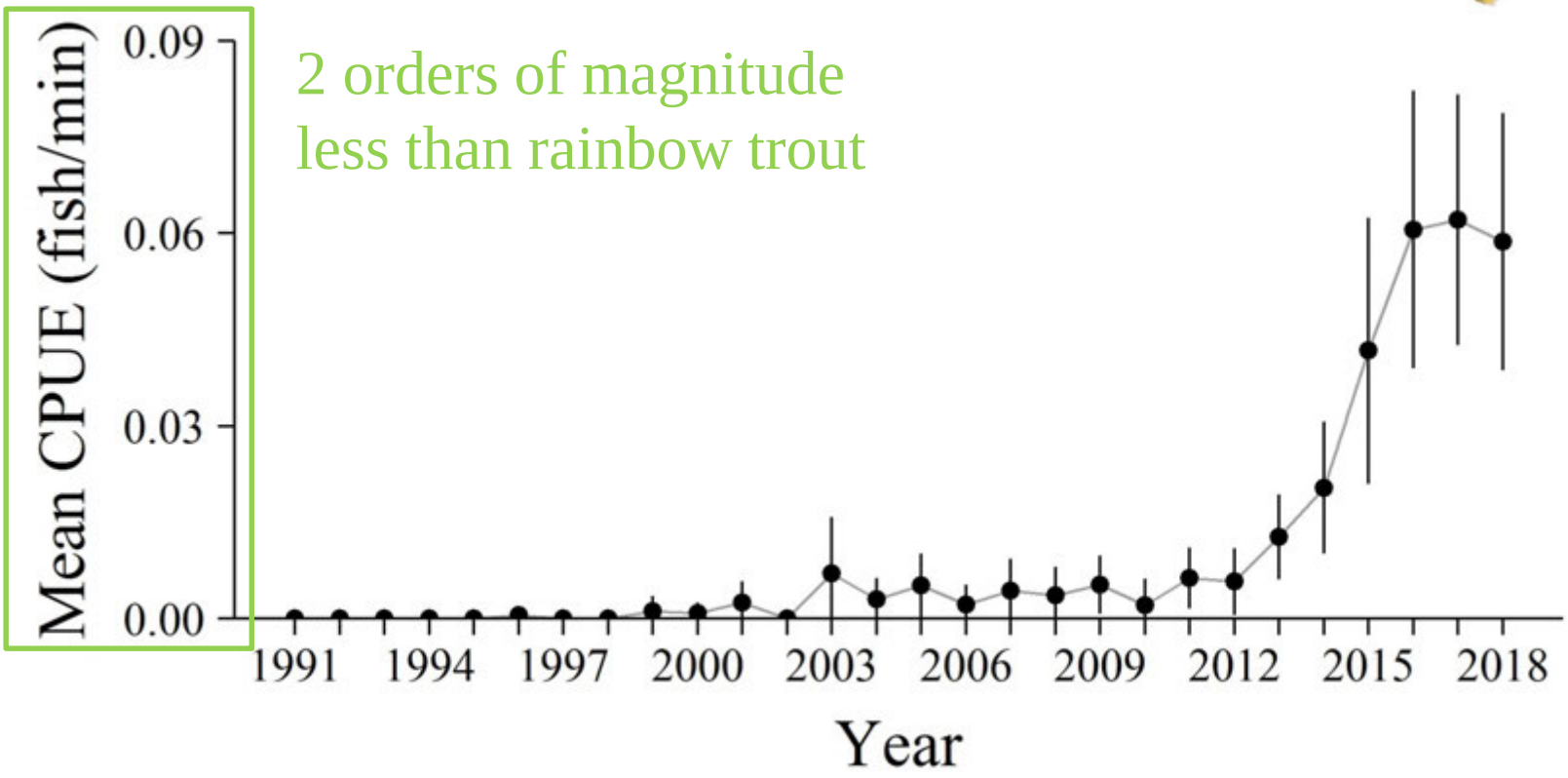


Angler Recap

- Catch rates improving, but lower than goal
- Not meeting length goals
- Bug flows – anglers like them, improve fishing

Brown Trout

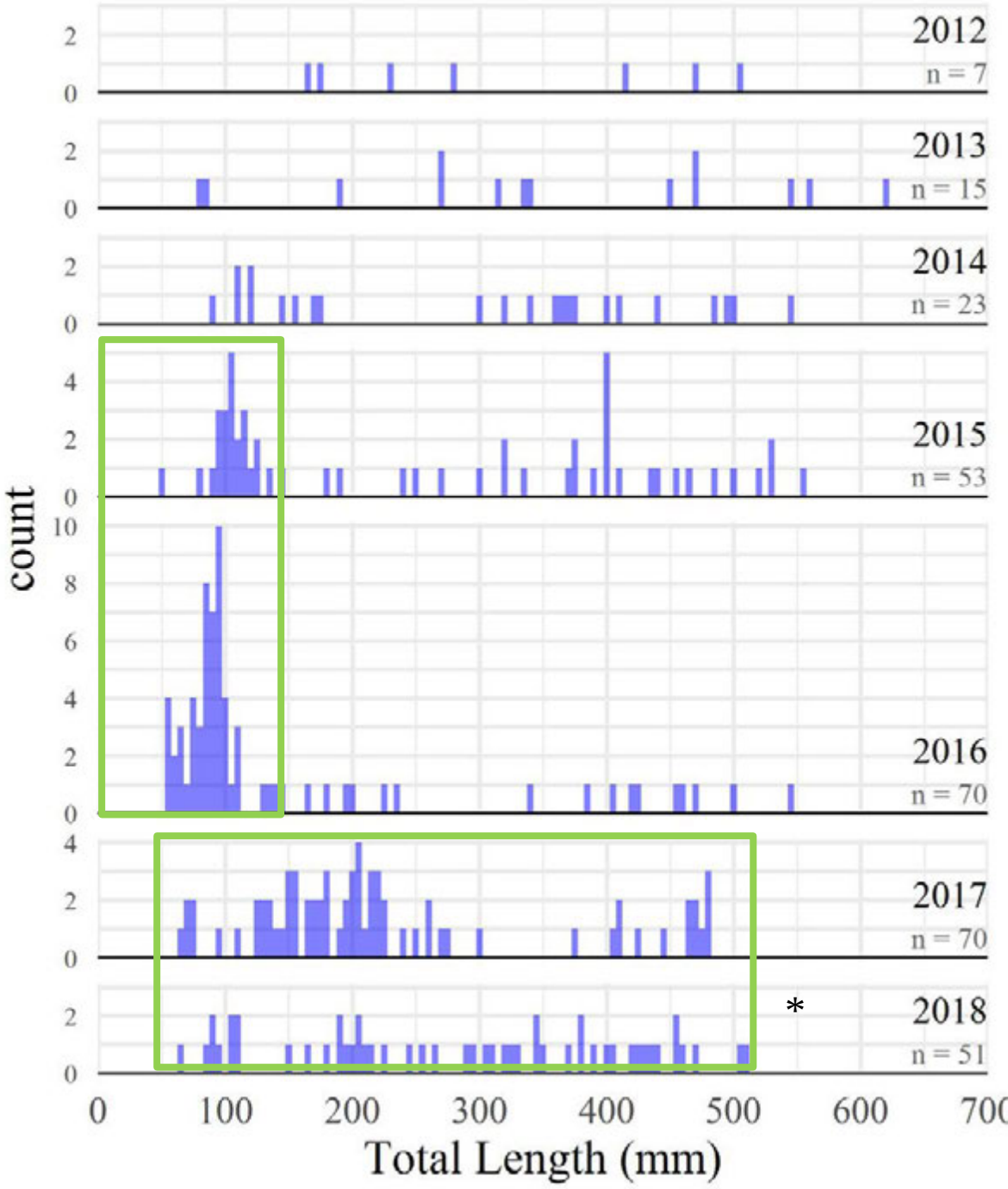
Brown Trout CPUE



2 orders of magnitude
less than rainbow trout

- In 2018: 51 Brown Trout captured
  - Released 9 in TRGD reaches (5 tagged, 4 recaptures)
  - Removed 42 elsewhere (including 2 recaptures)

Brown Trout Length



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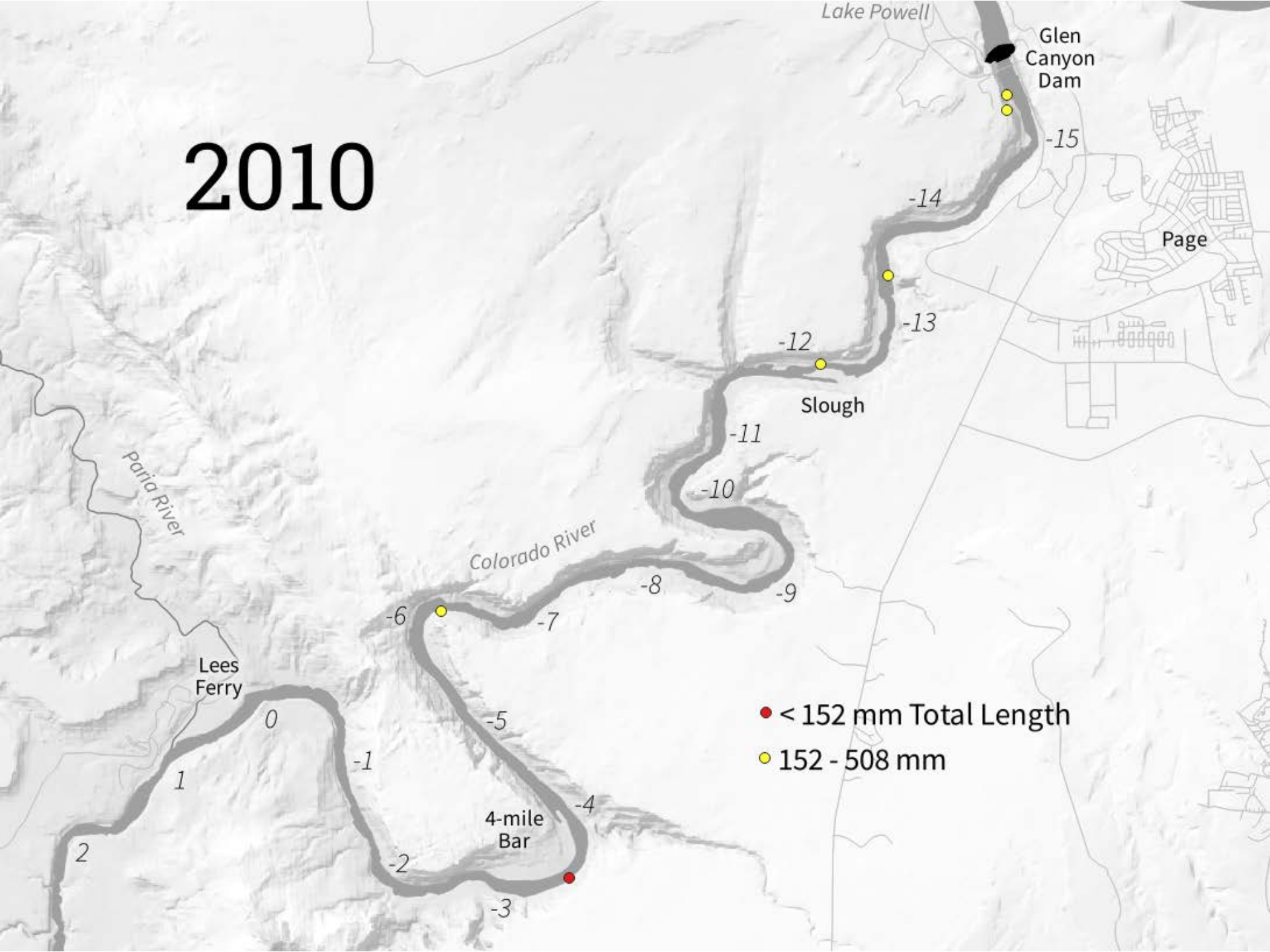
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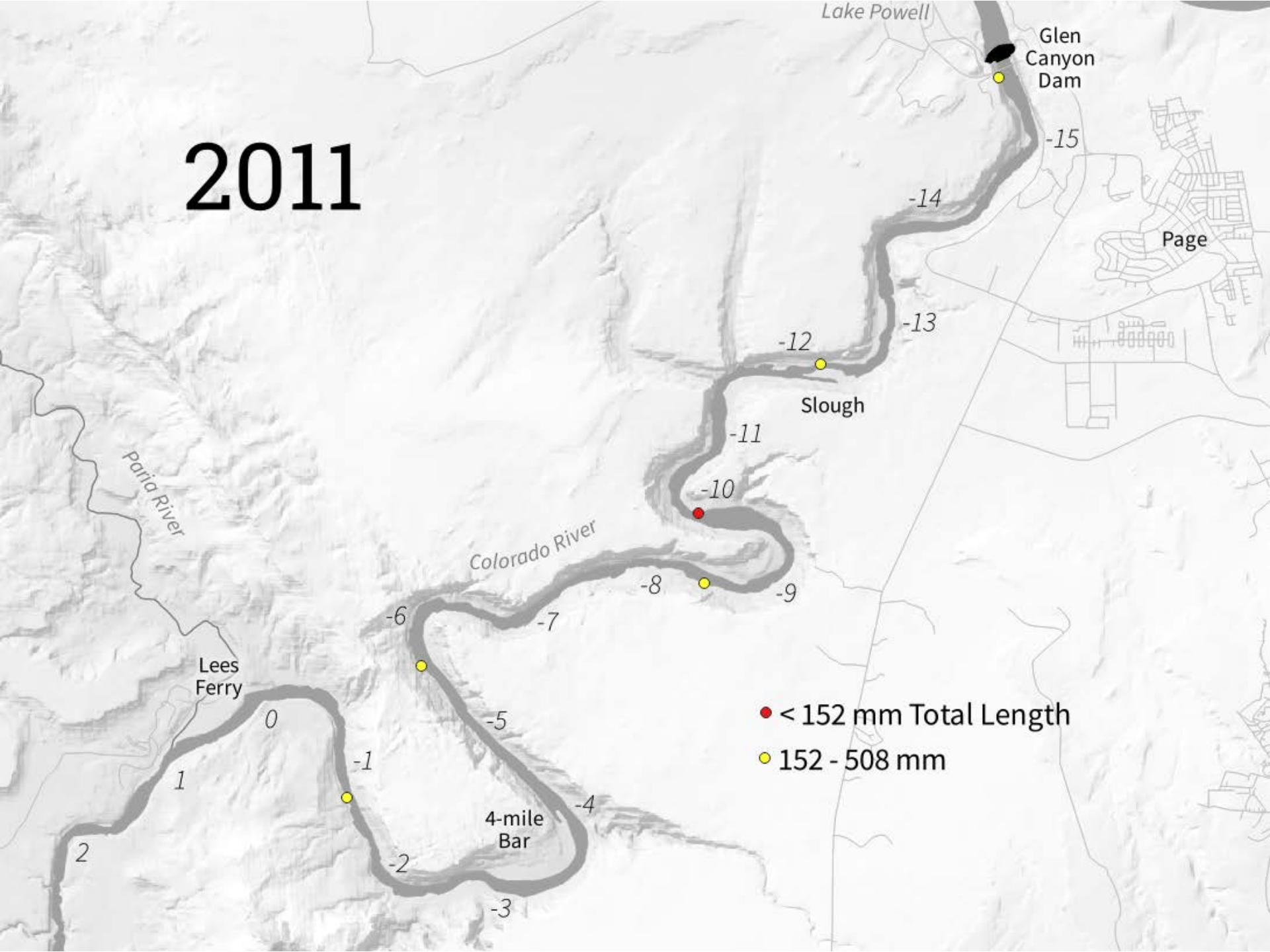
152 - 508 mm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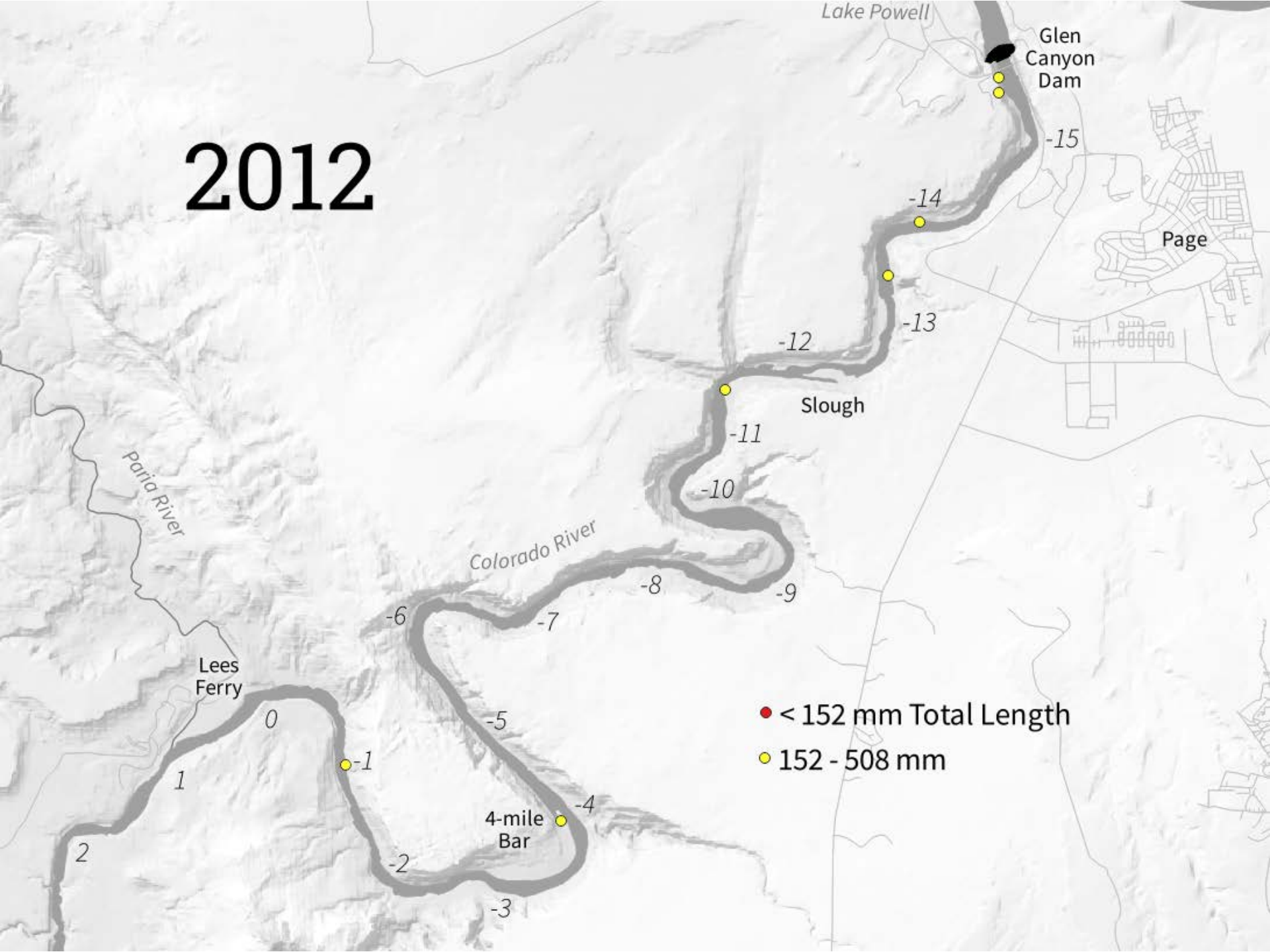
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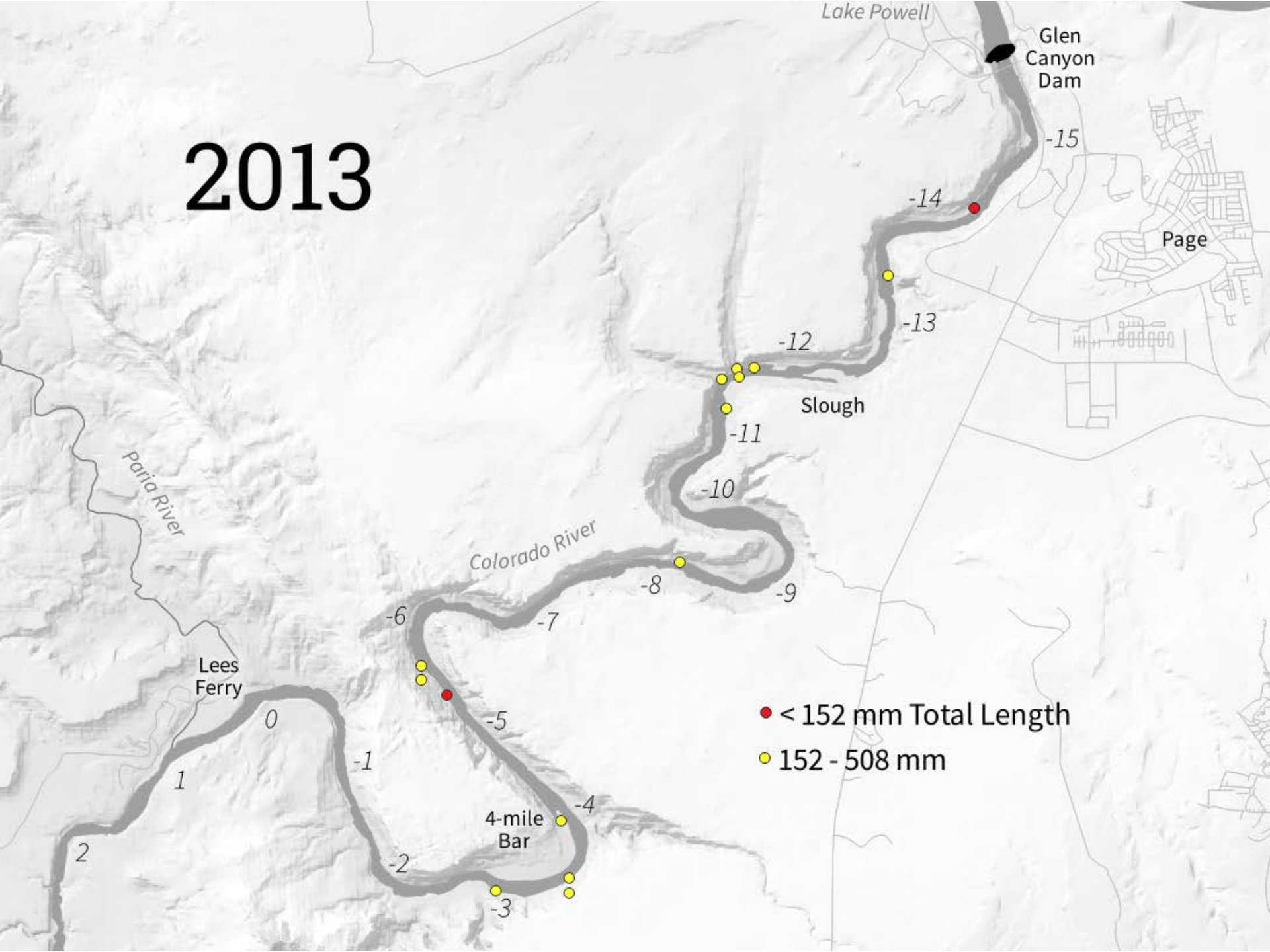
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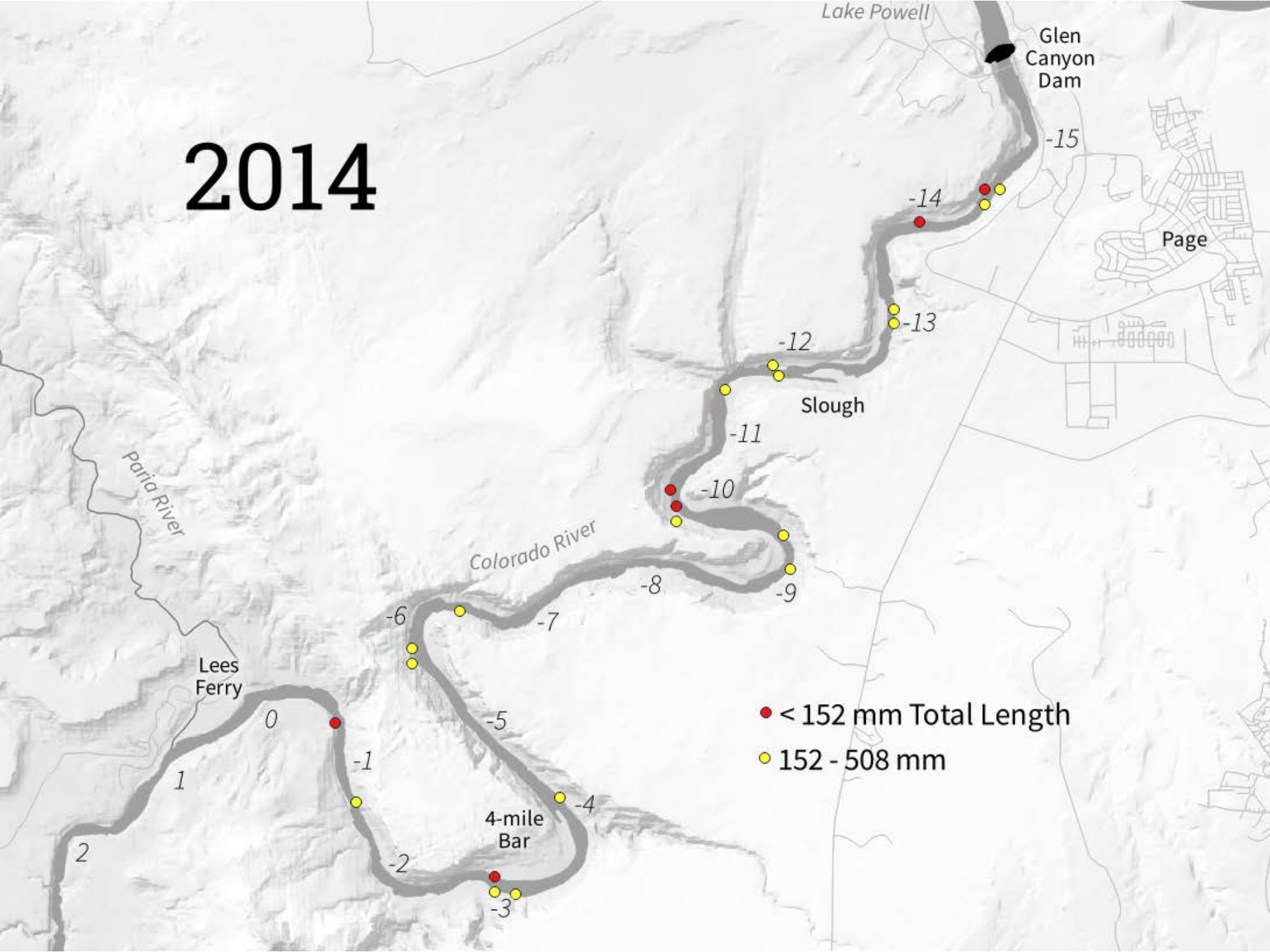
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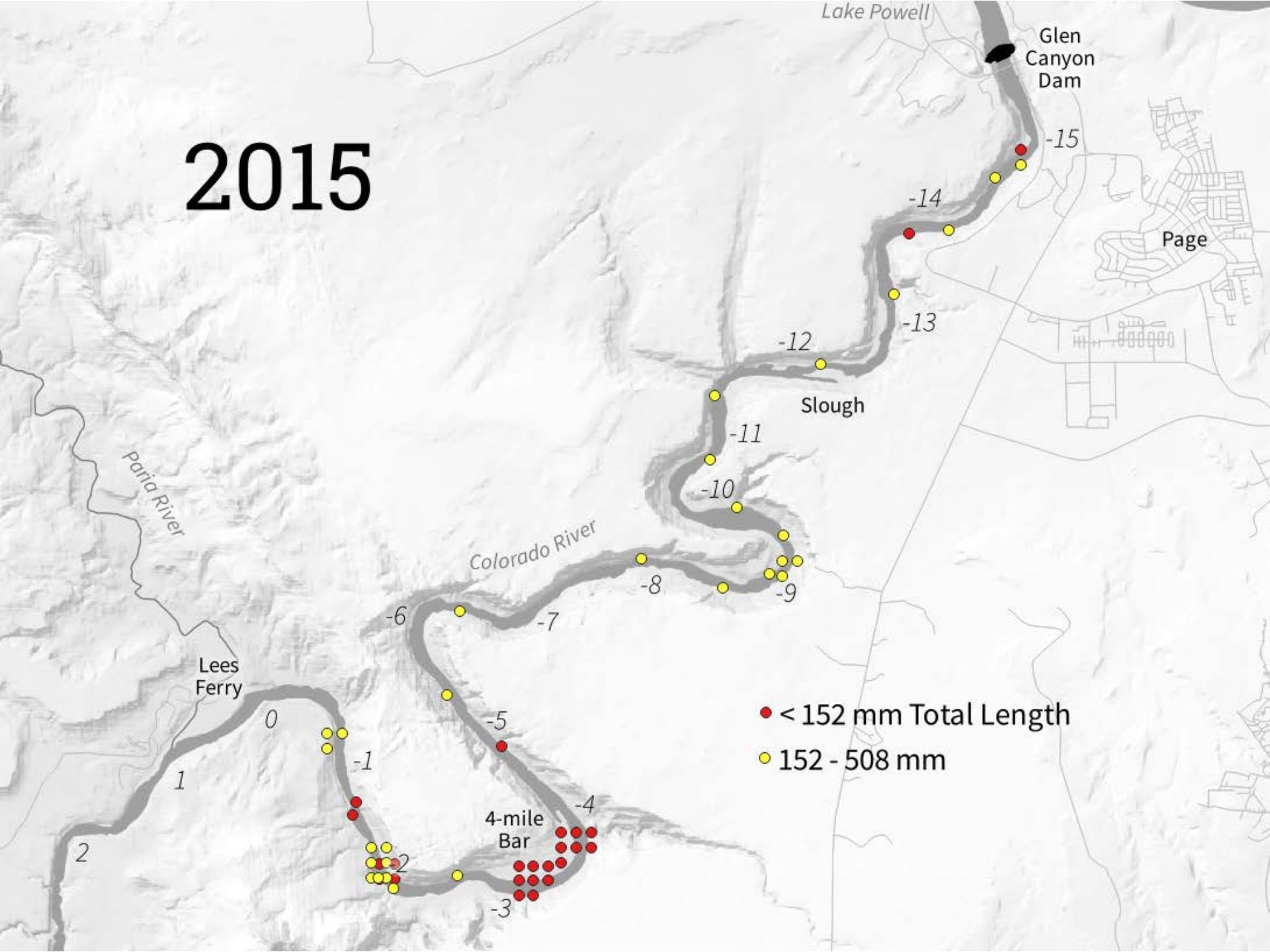
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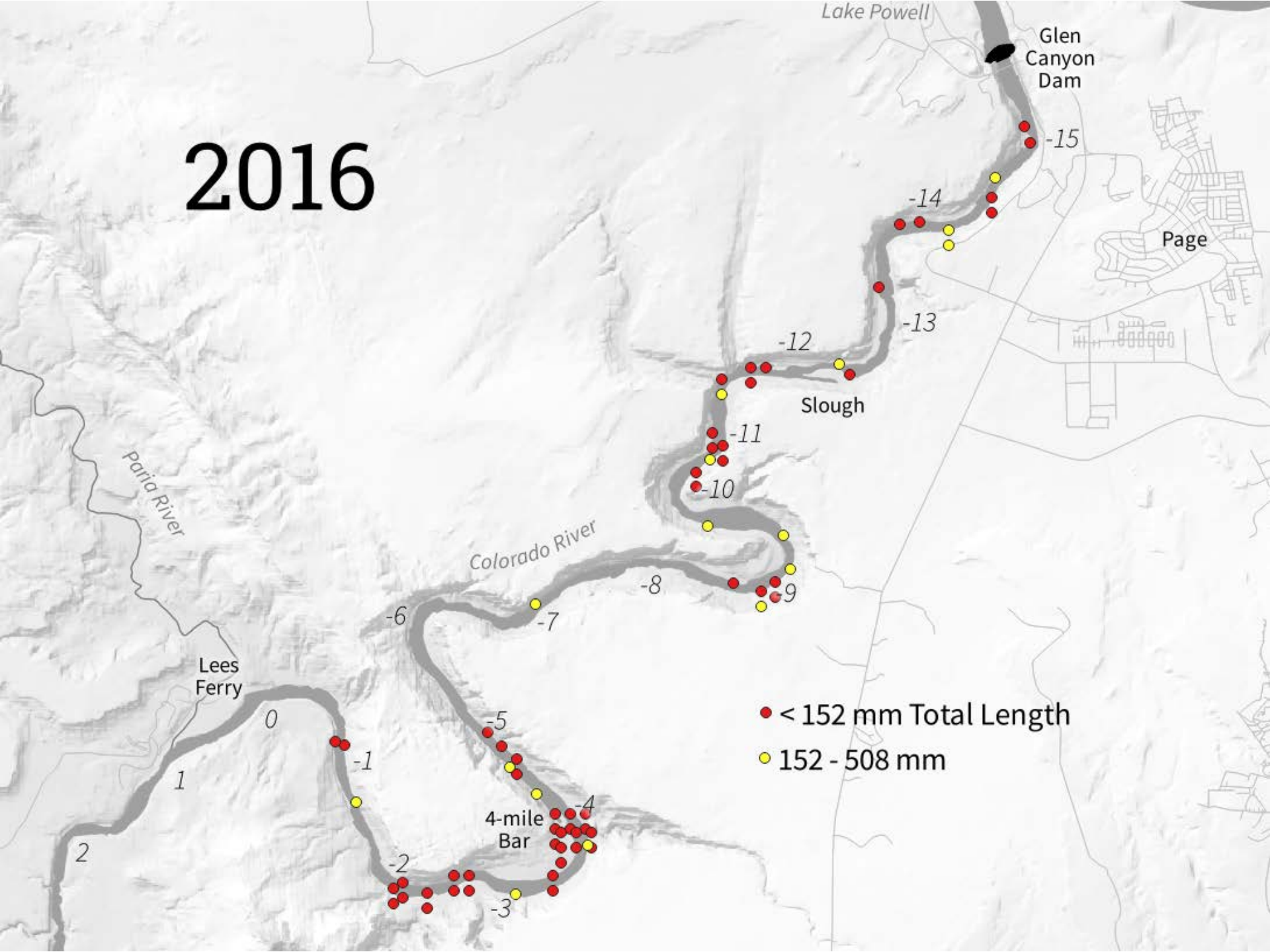
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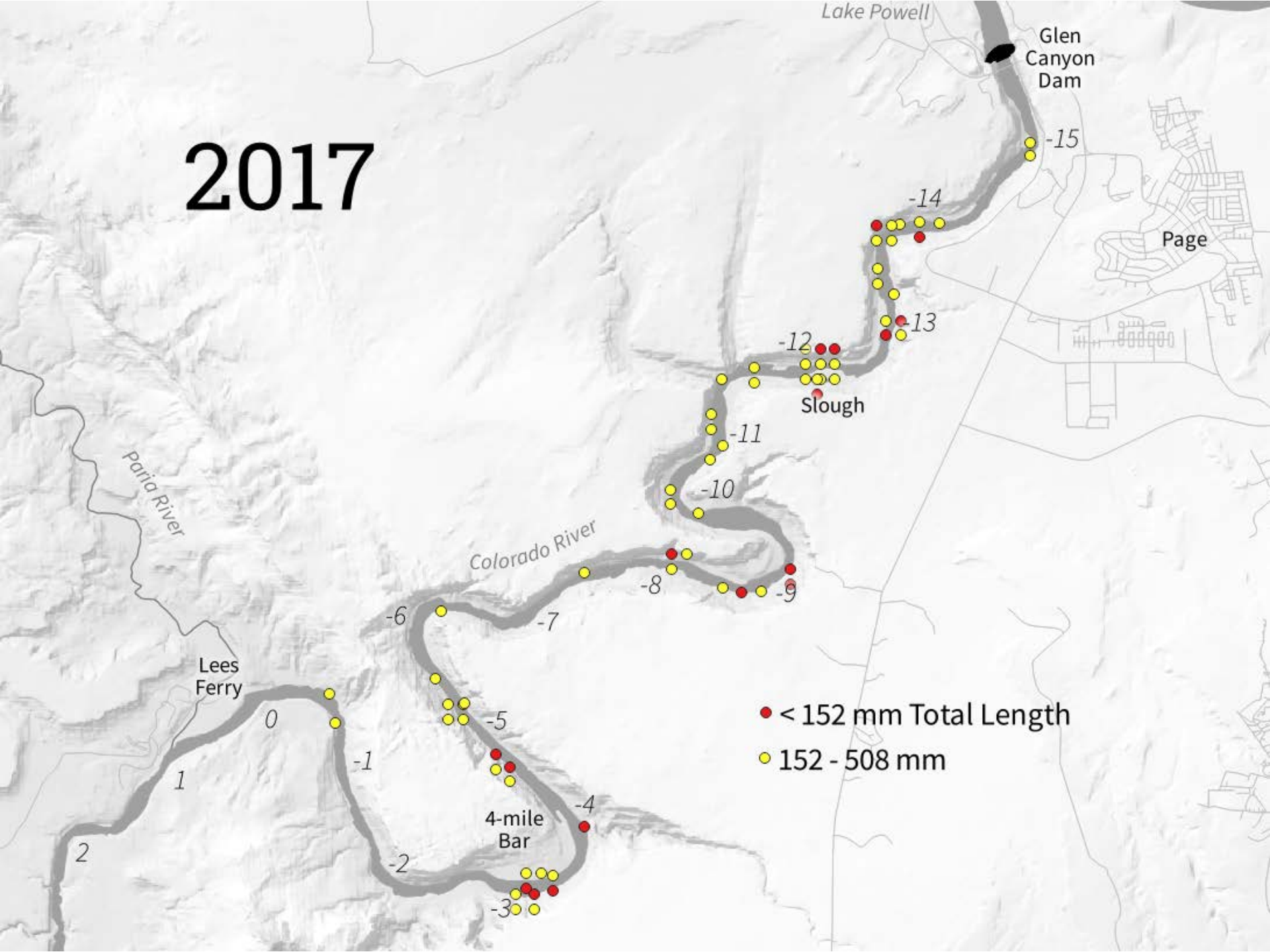
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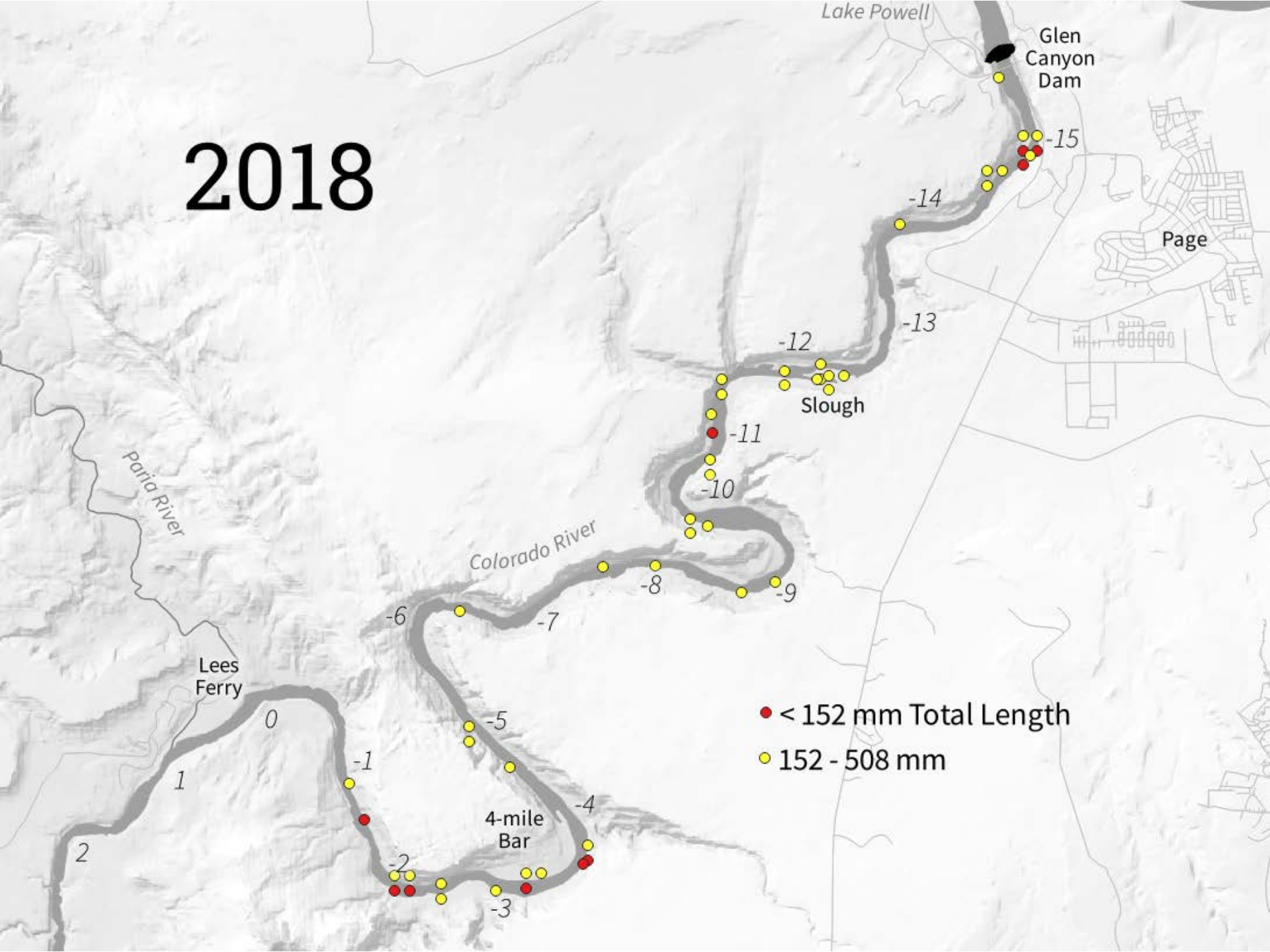
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Creel Survey question

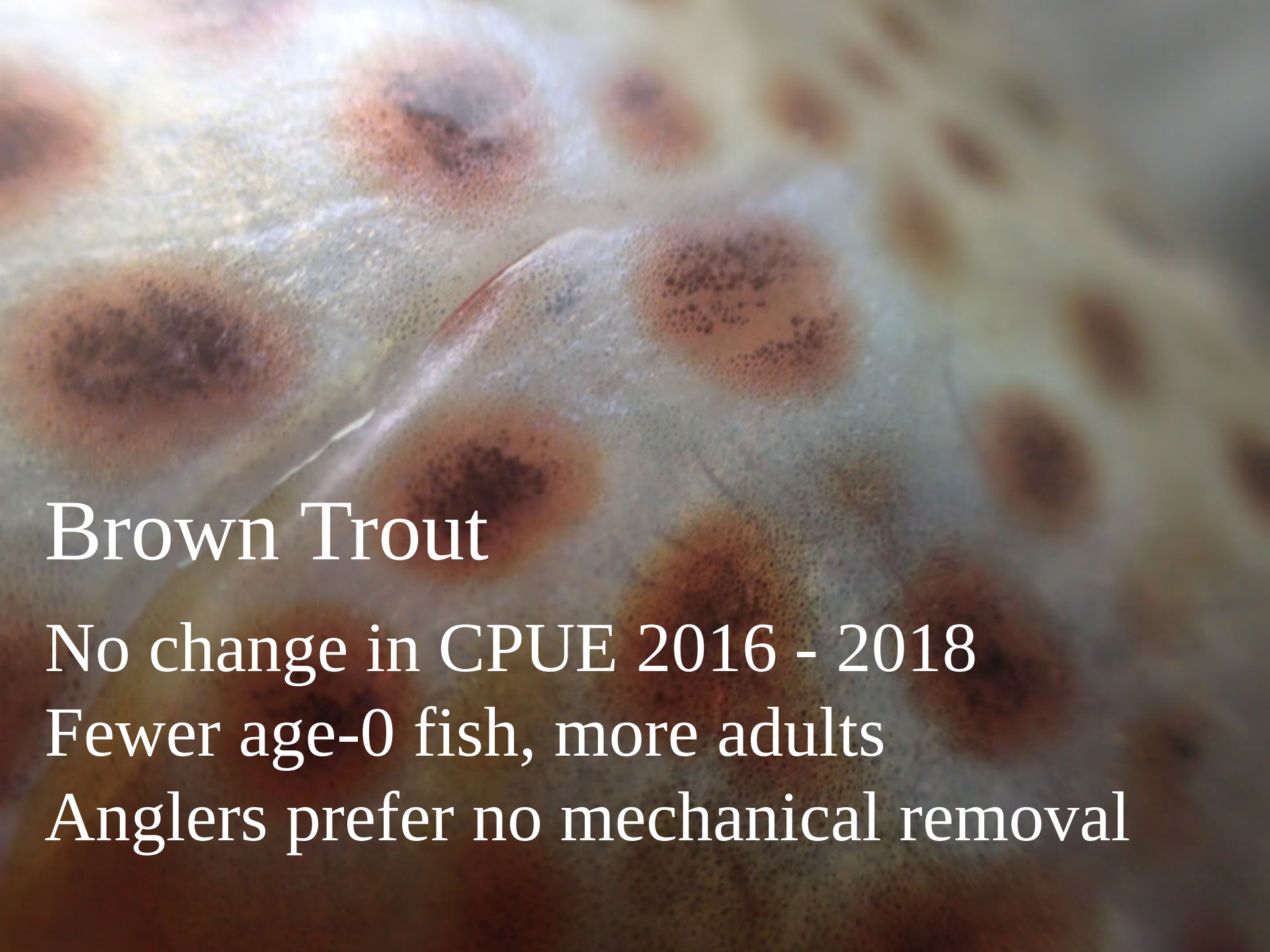
"If brown trout removal is warranted, would you prefer removal by government scientists or anglers?"

95% prefer anglers (890 of 932)

5% prefer scientists (35) or both (7)

Creel Surveys: Brown Trout catch

Year	Caught	Harvested	Percent Harvested
2013	11	0	0%
2014	14	2	14%
2015	22	2	9%
2016	6	1	17%
2017	30	8	27%
2018	96	14	15%



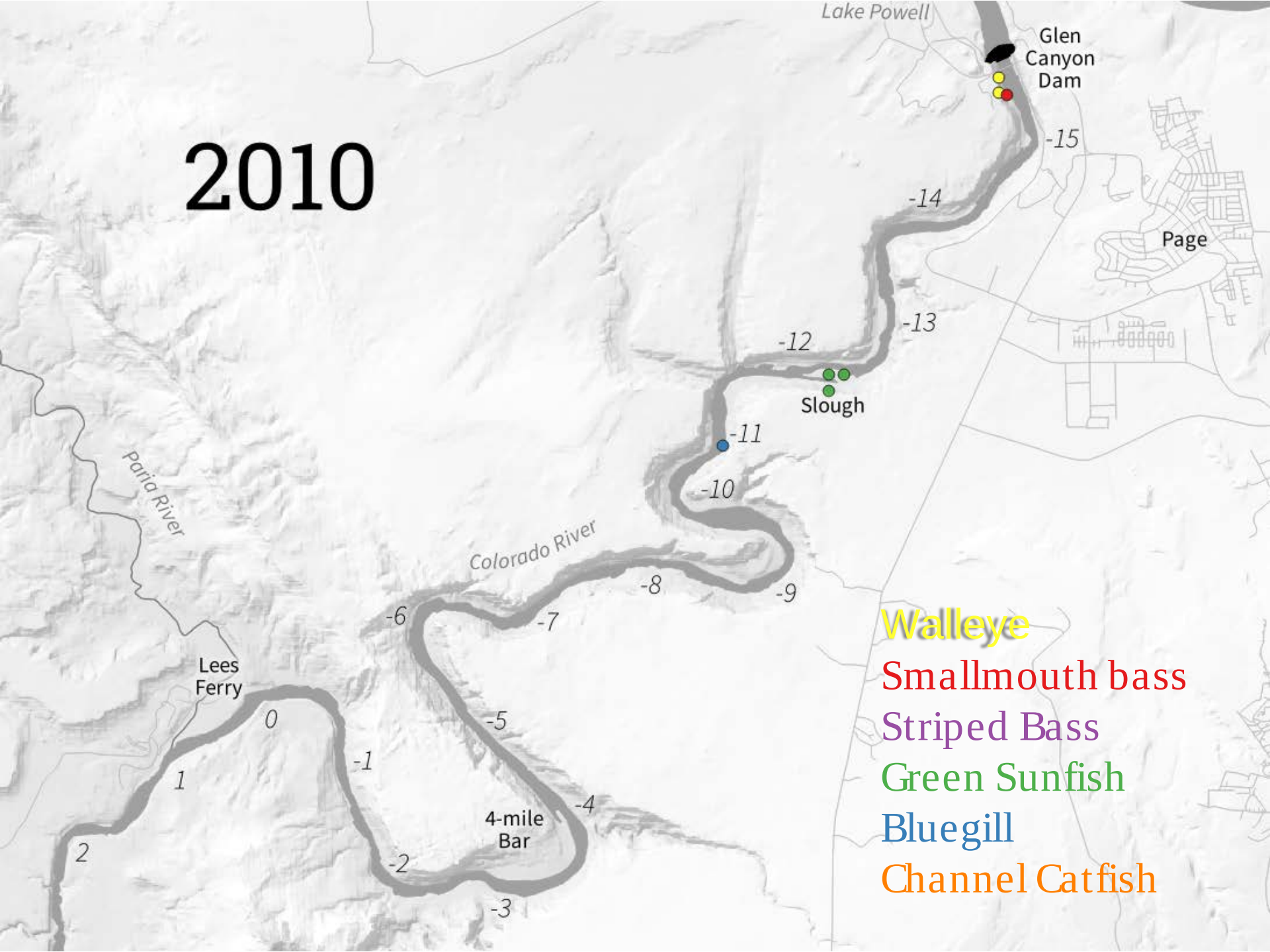
Brown Trout

No change in CPUE 2016 - 2018

Fewer age-0 fish, more adults

Anglers prefer no mechanical removal

Warmwater nonnatives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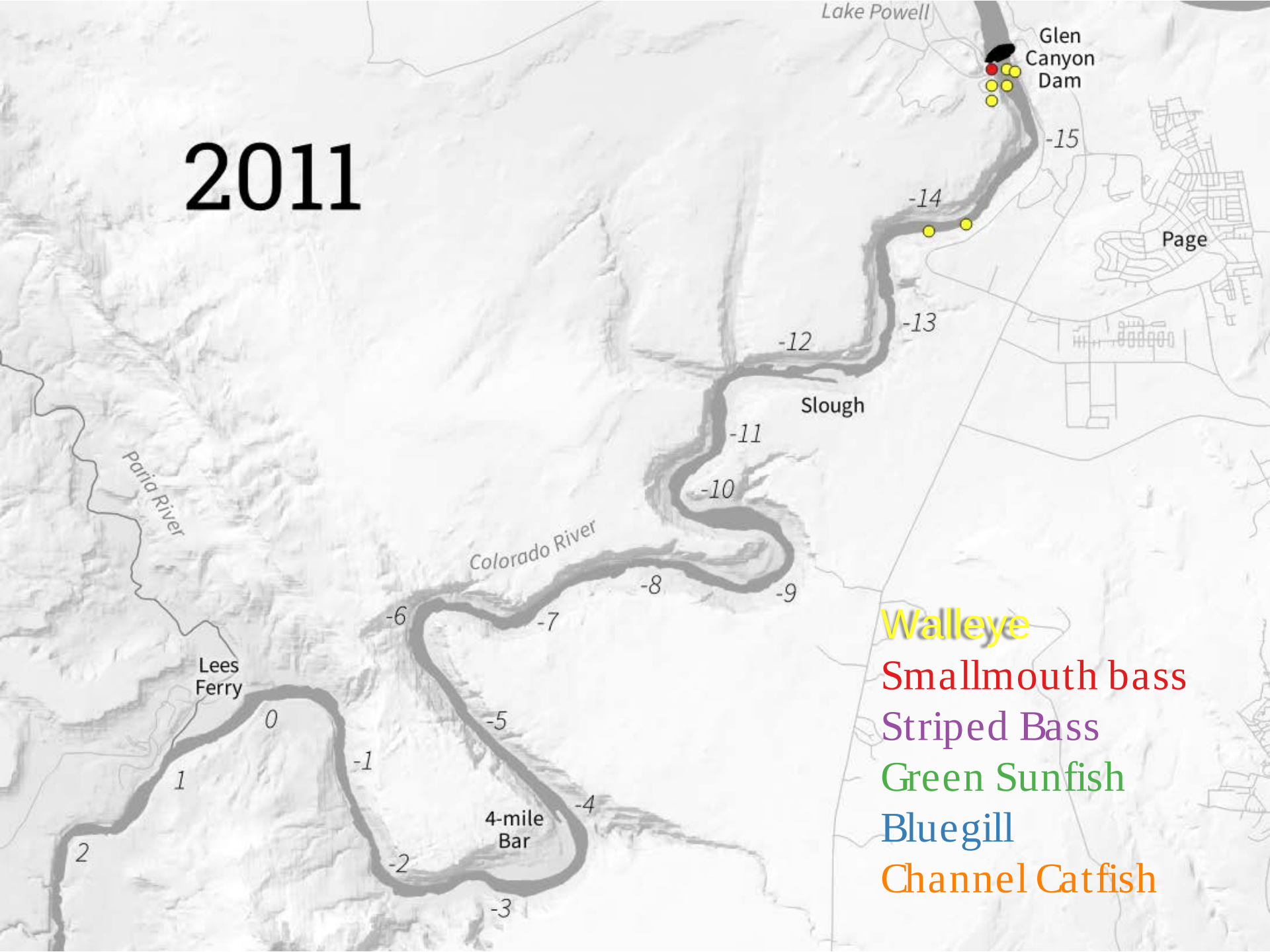
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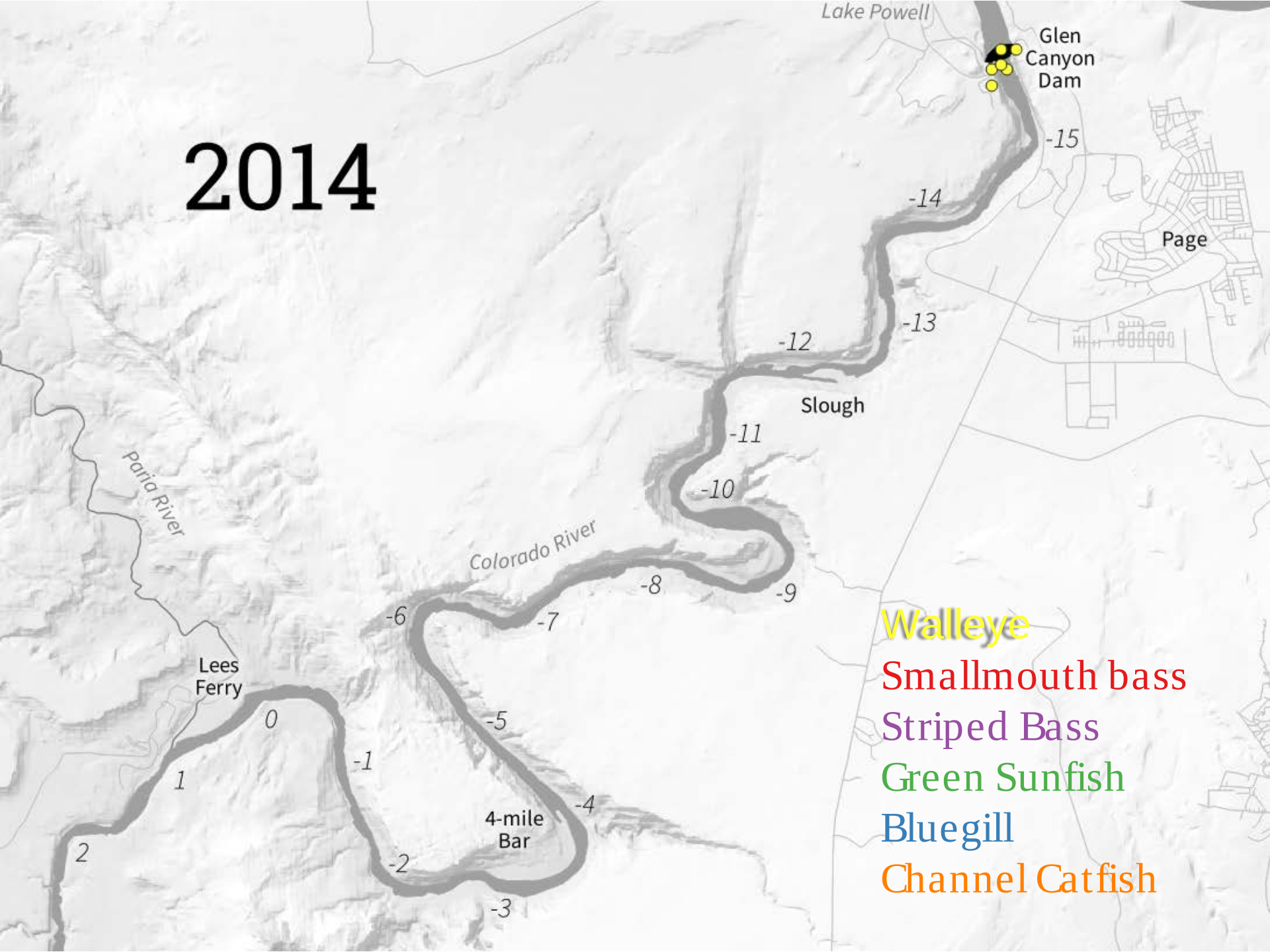
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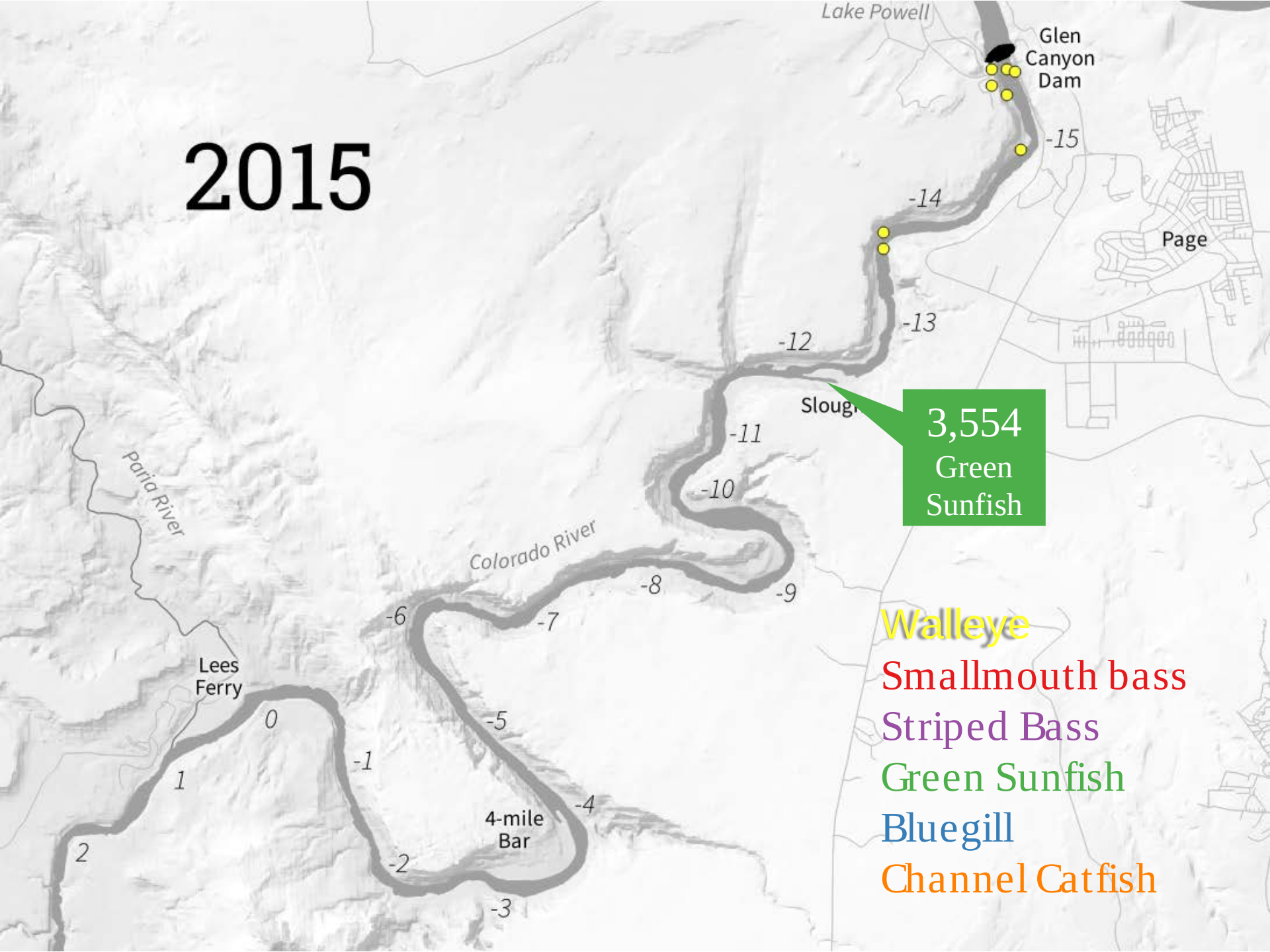
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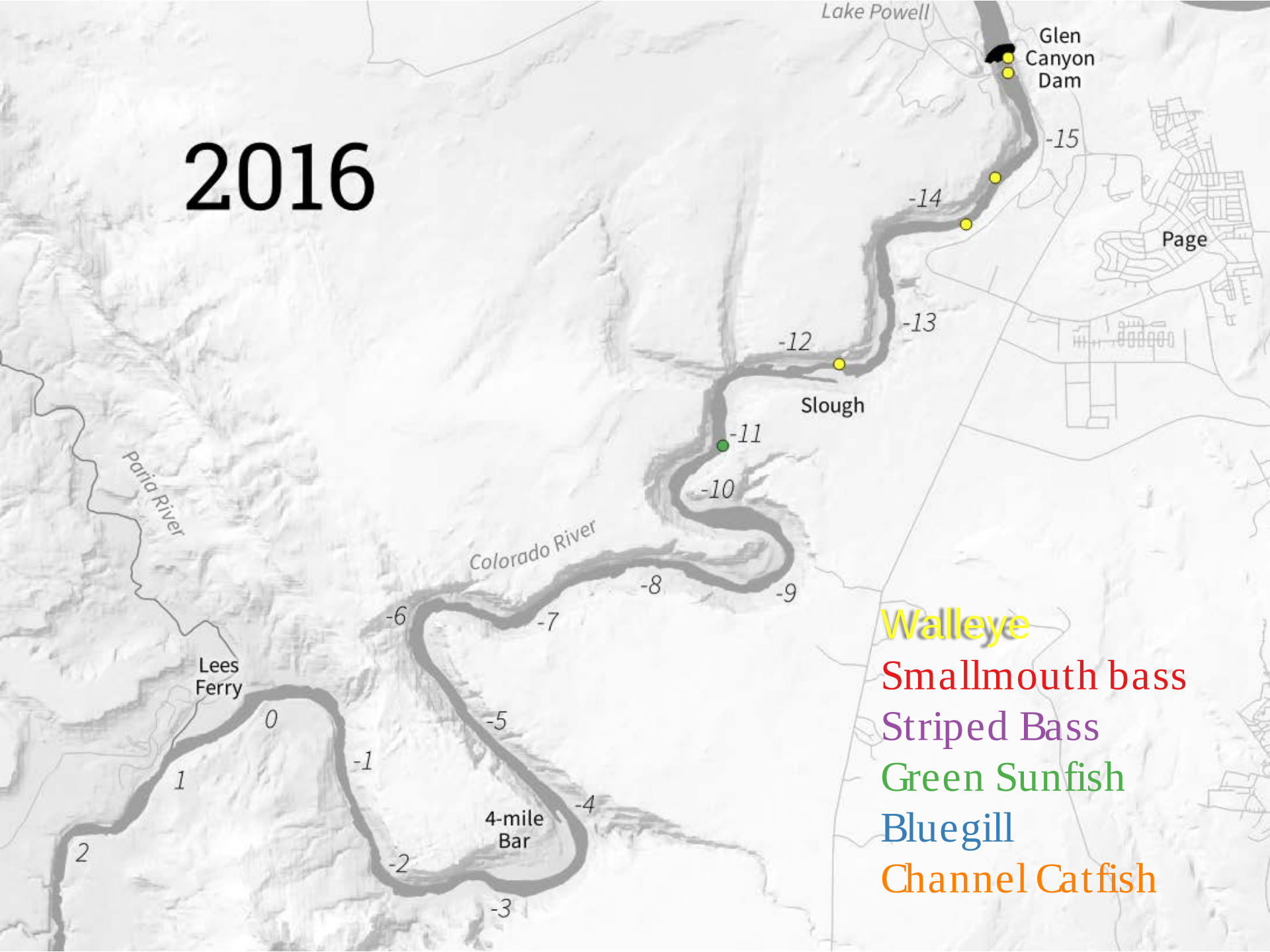
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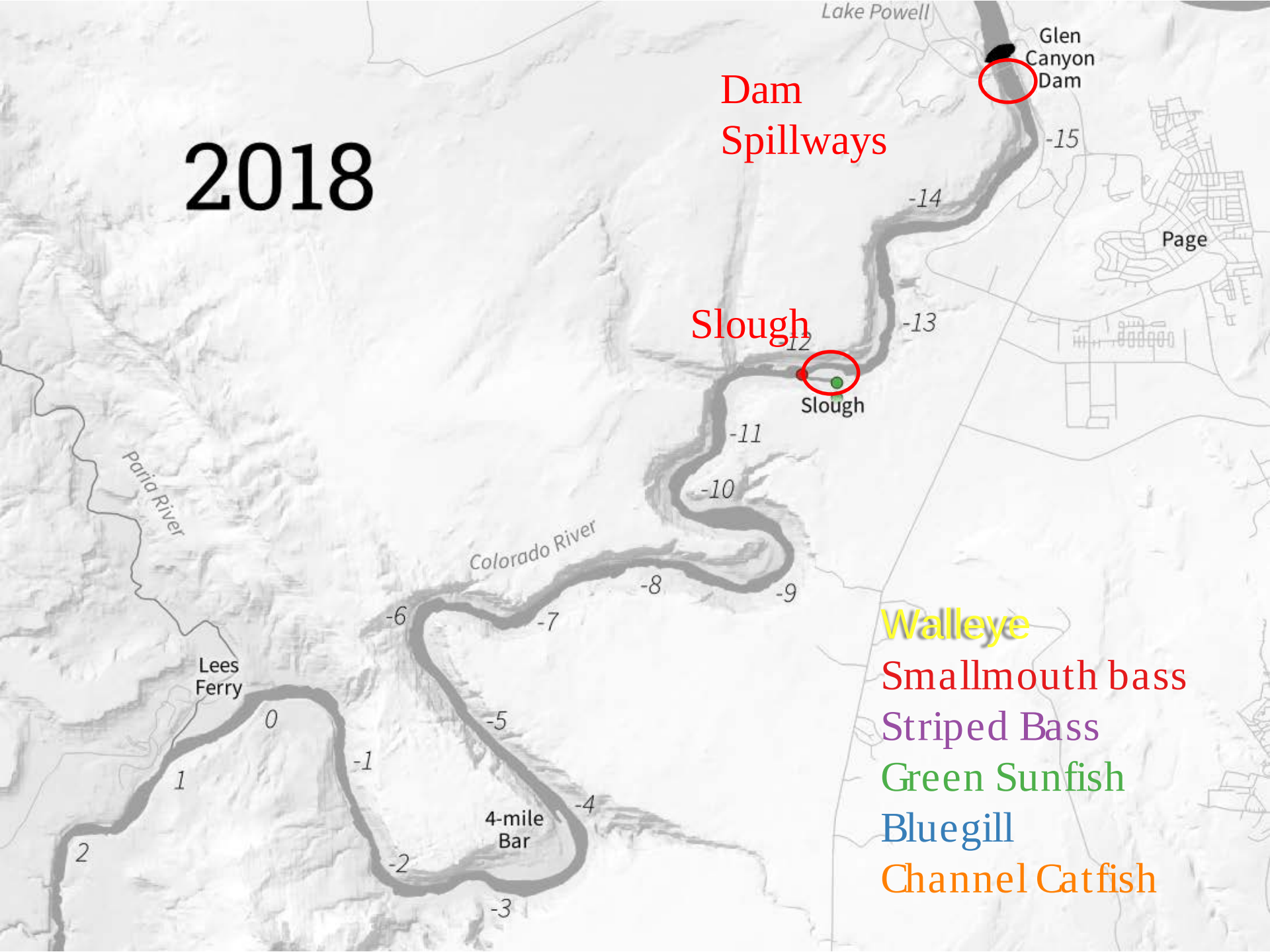
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Green Sunfish
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Warmwater nonnatives

Similar to past years:

- rare non-natives detected
- only green sunfish are established
- Spillways, slough are hotspots

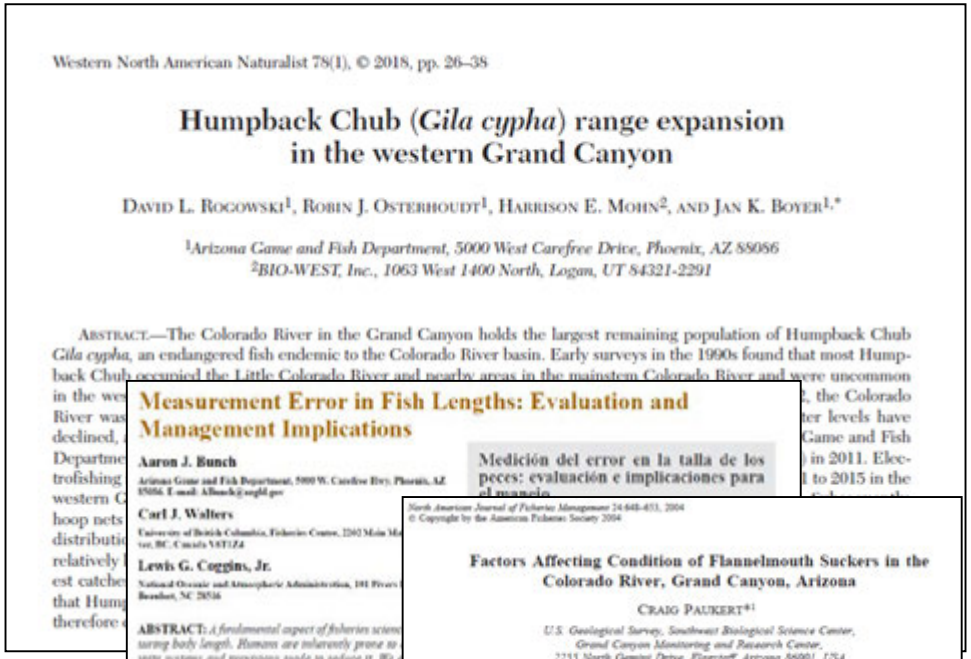
Grand Canyon

Objectives

- Representative sample of the fish assemblage
  - Native
  - nonnative

Benefits

- Detect patterns over time
- Novel ways to use data



Western North American Naturalist 78(1), © 2018, pp. 26–38

Humpback Chub (*Gila cypha*) range expansion in the western Grand Canyon

David L. Rogowski[1], Robin J. Osterhoudt[1], Harrison E. Mohn[2], and Jan K. Boyer[1,*]

[1]*Arizona Game and Fish Department, 5000 West Carefree Drive, Phoenix, AZ 85086*
[2]*BIO-WEST, Inc., 1063 West 1400 North, Logan, UT 84321-2291*

Abstract.—The Colorado River in the Grand Canyon holds the largest remaining population of Humpback Chub *Gila cypha*, an endangered fish endemic to the Colorado River basin. Early surveys in the 1990s found that most Humpback Chub occupied the Little Colorado River and nearby areas in the mainstem Colorado River and were uncommon

Measurement Error in Fish Lengths: Evaluation and Management Implications

Medición del error en la talla de los peces: evaluación e implicaciones para el manejo

Aaron J. Bunch

Carl J. Walters

Lewis G. Coggins, Jr.

Factors Affecting Condition of Flannelmouth Suckers in the Colorado River, Grand Canyon, Arizona

Craig Paukert*[1]

U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center, 2255 North Gemini Drive, Flagstaff, Arizona 86001, USA

R. Scott Rogers

Arizona Game and Fish Department, 2221 West Greenway Road, Phoenix, Arizona 85023, USA

Abstract.—The impoundment of the Colorado River by Glen Canyon Dam, Arizona, in 1963 created a highly regulated environment in the Grand Canyon that altered the native fish populations, including the flannelmouth sucker *Catostomus latipinnis*. Flannelmouth suckers were sampled from 1991 to 2001 to determine seasonal, annual, and spatial trends in fish condition (i.e., relative weight [W_r]). Mean W_r peaked during the prespawn and spawning periods and was lowest in summer and fall, but it was never lower than 93. Condition was variable throughout the Grand Canyon but was typically greatest at intermediate distances from Glen Canyon Dam, possibly because of the increased number of warmwater tributaries in this reach. Flannelmouth sucker condition in September was positively correlated with Glen Canyon Dam discharge during summer

Juvenile Growth of Native Fishes in the Little Colorado River and in a Thermally Modified Portion of the Colorado River

Anthony T. Robinson* and Michael R. Childs

Arizona Game and Fish Department, 2221 West Greenway Road, Phoenix, Arizona 85023, USA

Abstract.—We estimated juvenile growth rates of four native fish species using the von Berta-

Dispersal of Larval Fishes in a Regulated River Tributary

Anthony T. Robinson,* Robert W. Clarkson,[1] and Robert E. Forrest[1]

Arizona Game and Fish Department, 2221 West Greenway Road, Phoenix, Arizona 85023, USA

Abstract.—We investigated longitudinal downstream, upstream movements, and drift of larval native fishes (humpback chub *Gila cypha*, speckled dace *Rhinichthys osculus*, bluehead sucker *Catostomus discobolus*, and flannelmouth sucker *Catostomus latipinnis*) in the Little Colorado River,

REGULATED RIVERS: RESEARCH & MANAGEMENT
Regul. Rivers: Res. Mgmt. 16: 73–81 (2000)

Short Communication

ZOOPLANKTON DENSITY AND COMMUNITY COMPOSITION FOLLOWING AN EXPERIMENTAL FLOOD IN THE COLORADO RIVER, GRAND CANYON, ARIZONA

DAVID W. SPEA

Arizona Game and Fish Department, Page Research Offic

ABSTRACT

Zooplankton density and community composition were examine March–7 April 1996) in the Colorado River, Grand Canyon, nort made across sampling locations and habitat types. The flood community composition of zooplankton. Prior to the flood, zooplan ($R^2 = 0.76$) but declined with the fourth power of distance downri community similarity indices between mainchannel and backwater flood but increased significantly to 0.64–0.98 after the flood, indicati The flood displaced resident (i.e. benthic, littoral and/or phytoplyt them with limnetic organisms. Total zooplankton density was greate but the increase may have been an artifact of normal seasonal cy reservoir (Lake Powell). Copyright © 2000 John Wiley & Sons, Lt

KEY WORDS: experimental flood; homogeneity; zooplankton density

DISPERSAL OF NONNATIVE FISHES AND PARASITES IN THE INTERMITTENT LITTLE COLORADO RIVER, ARIZONA

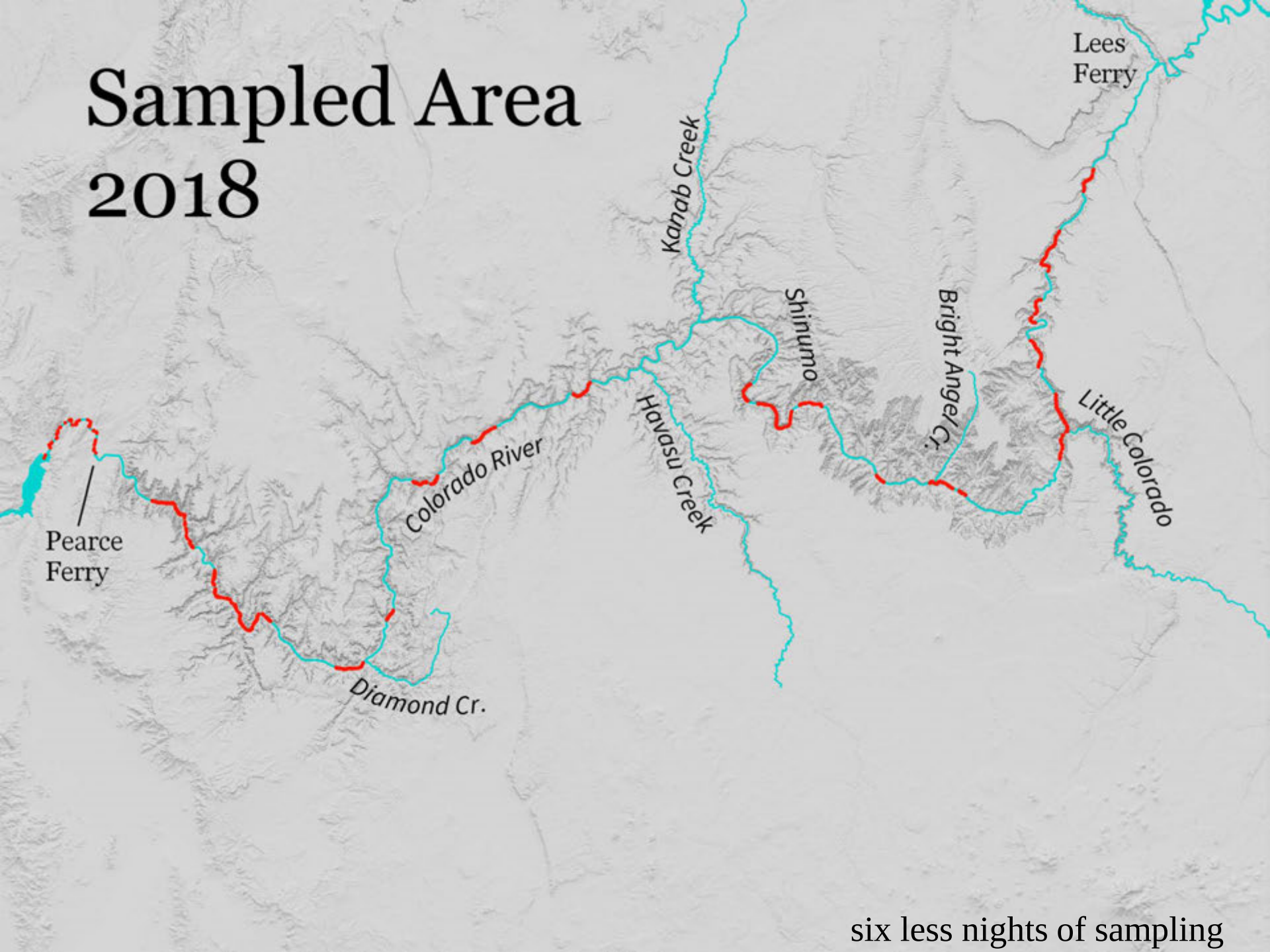
Dennis M. Stone,* David R. Van Haverbeke, David L. Ward, and Teresa A. Hunt

U.S. Fish and Wildlife Service, P.O. Box 338, Flagstaff, AZ 86002 (DMS, DRV)
Arizona Game and Fish Department, 506 North Grant, Suite 1, Flagstaff, AZ 86004 (DLW, TAH)
**Correspondent: Dennis_Stone@fws.gov*

Abstract.—We sampled nonnative fishes stranded in isolated pools near Grand Falls in the Little Colorado River (LCR), Arizona, after the river ceased flowing (21 June and 12 July 2005) to evaluate whether nonnative fishes can invade the perennial, lower 21 km of the LCR from upriver sources. The encroachment of nonnative fishes could jeopardize resident populations of endangered humpback chubs, *Gila cypha*, and other native fishes in the lower LCR. We captured red shiner, *Cyprinella lutrensis*; common carp, *Cyprinus carpio*; fathead minnow, *Pimephales promelas*; black bullhead, *Ameiurus melas*; and plains killifish, *Fundulus zebrinus*, all of which have been captured >132 km downriver in the lower LCR and >127 km upriver in the closest perennial sources. Moreover, we detected Asian tapeworms, *Bothriocephalus acheilognathi*, in 9 of 30 common carp examined. Our findings suggest that nonnative fishes, including those hosting parasites, can invade the lower LCR from upriver sources >250 km away during freshets and provide a mechanism for the dispersal of invasive aquatic species in intermittent river systems.

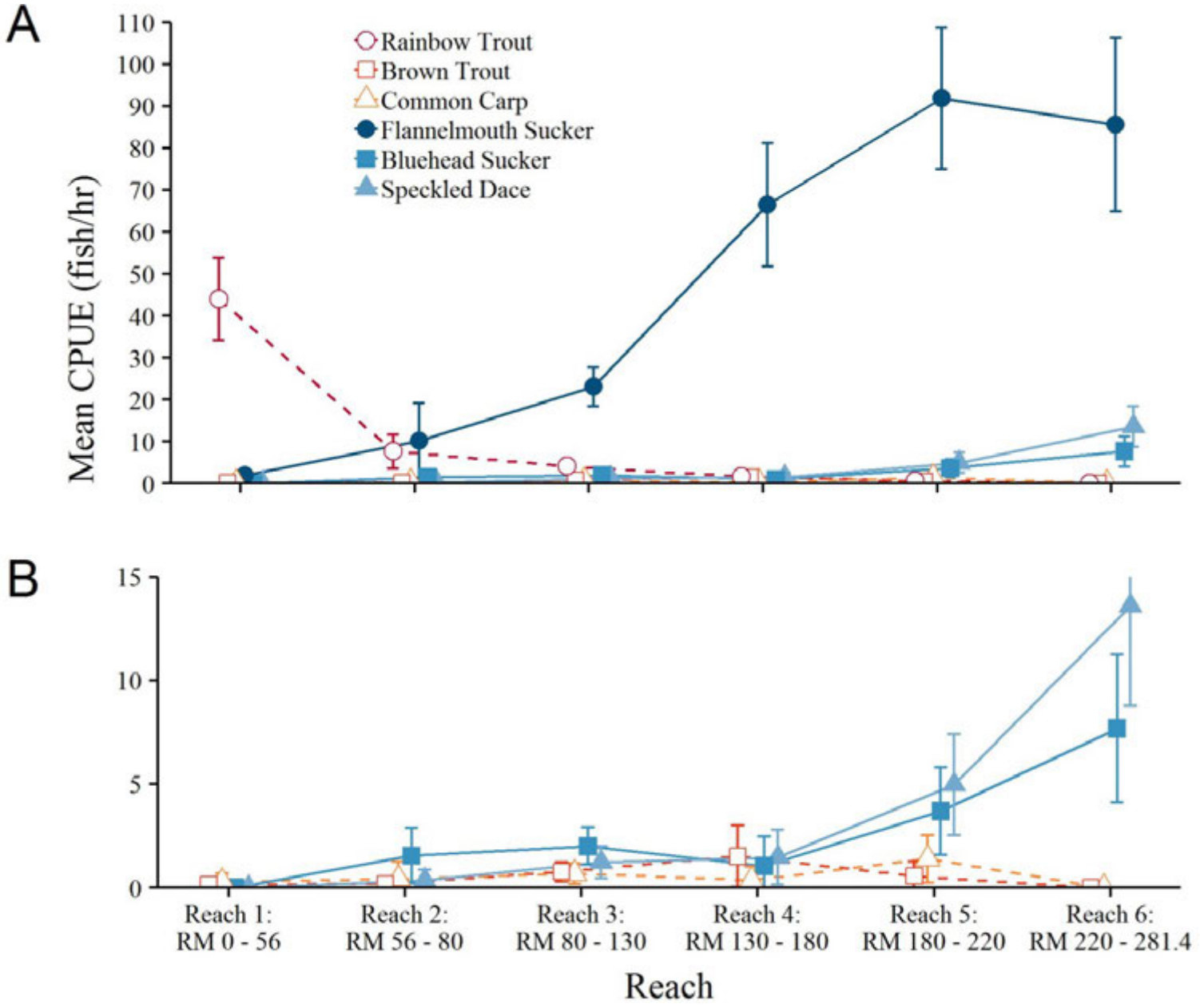
Methods

- 2 spring trips
- Fall:
  - below Diamond Creek
  - Below Pearce Ferry

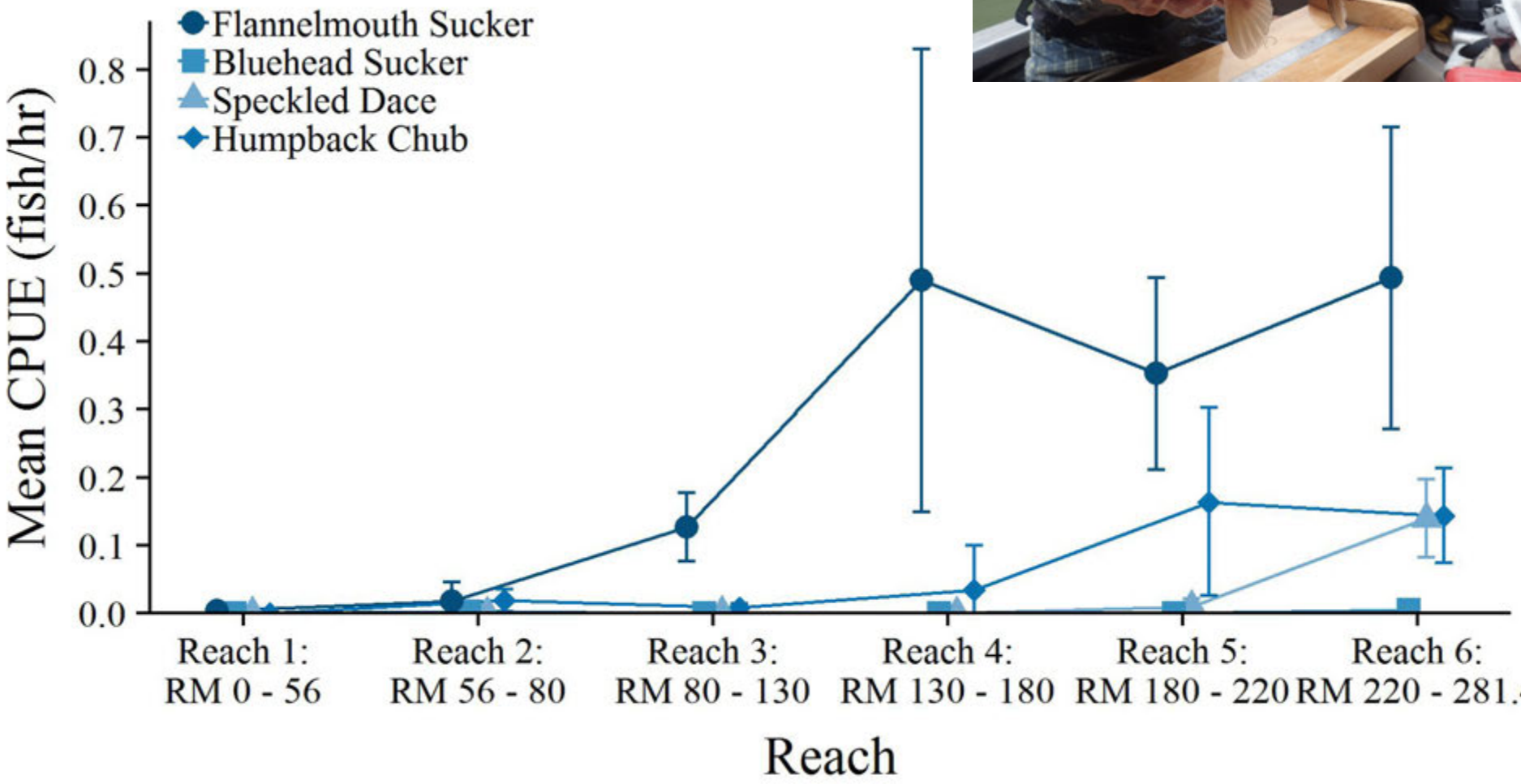


six less nights of sampling

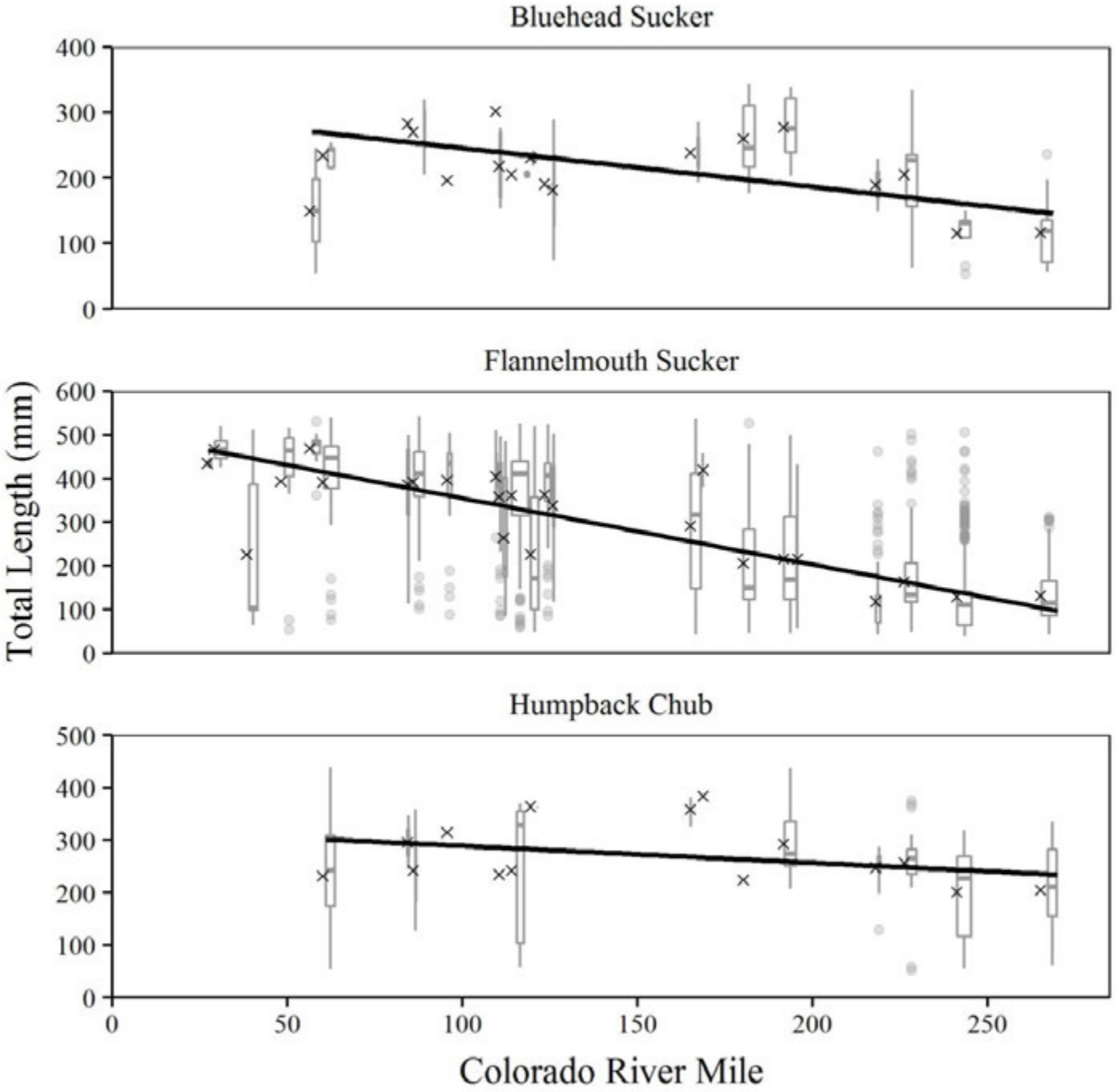
Electrofishing CPUE 2018



Hoop net CPUE 2018

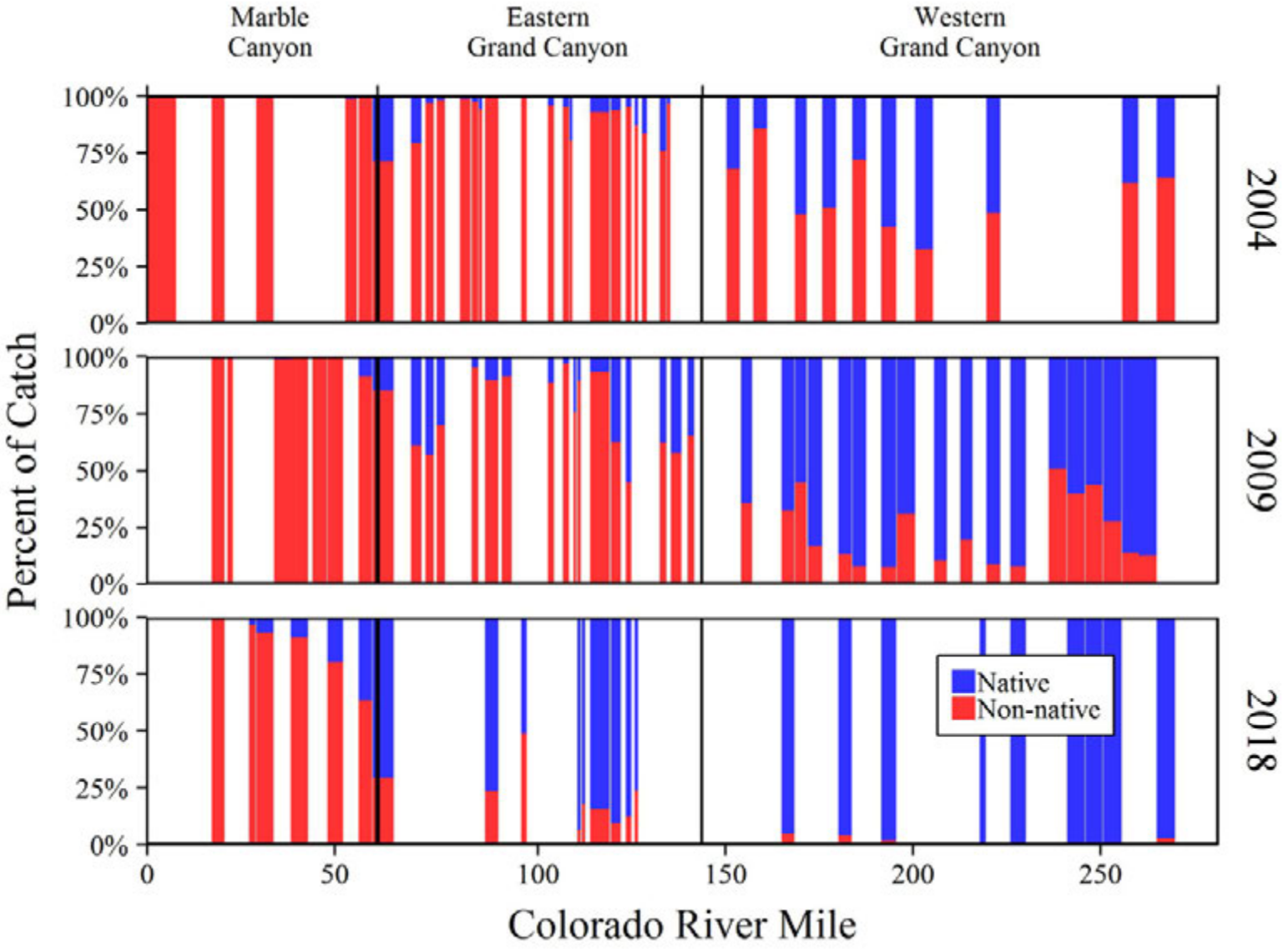


Native fish length by river mile

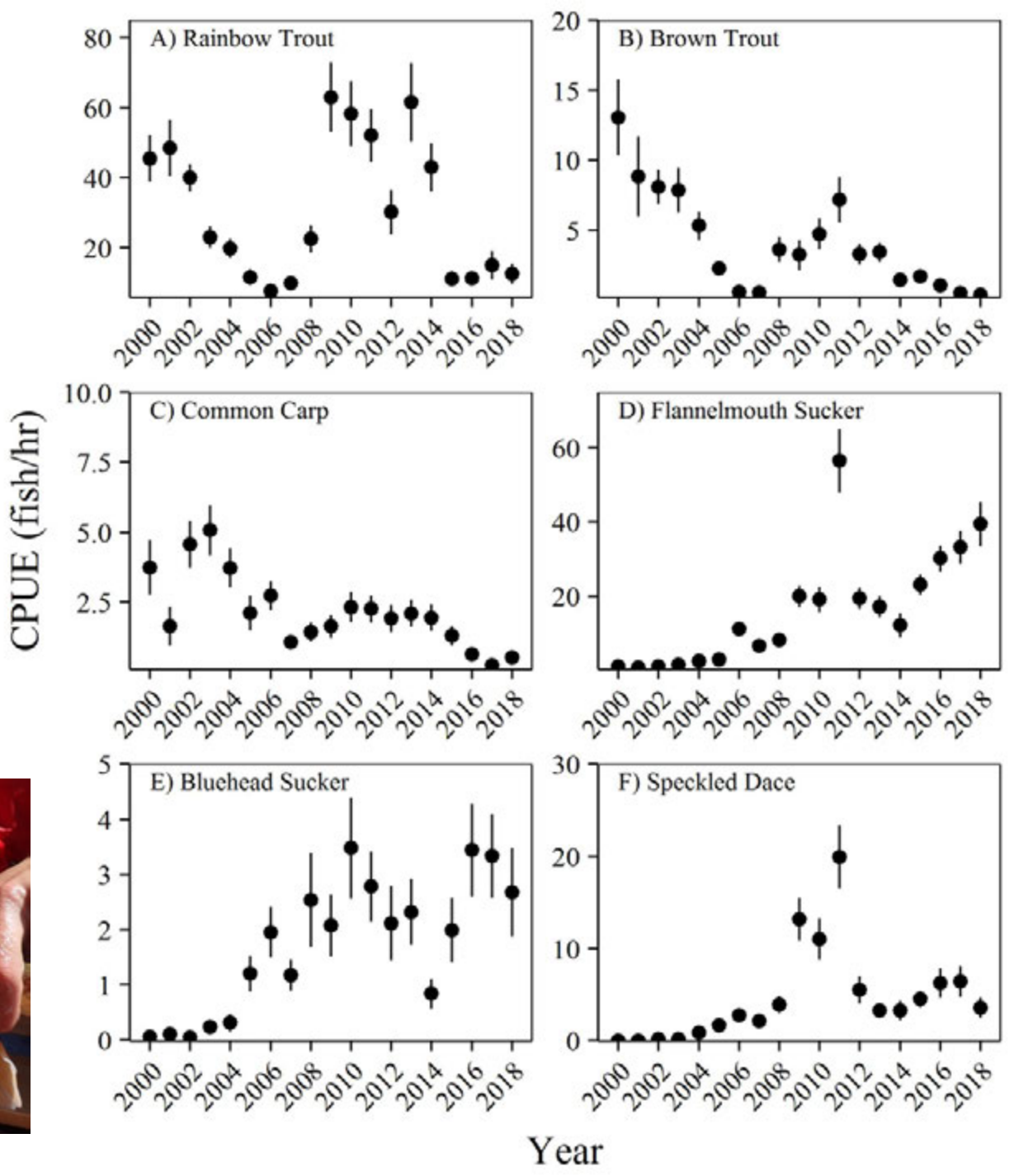


Humpback Chub length by river mile 2018

Percent native fish Grand Canyon



CPUE system wide



Interesting

- Wild Razorback Sucker (543 mmm TL, 1146 g) at RM 243.0
- See our posters

- Recaptured two translocated Humpback Chubs (Havasu 2011, Shinumo 2009)

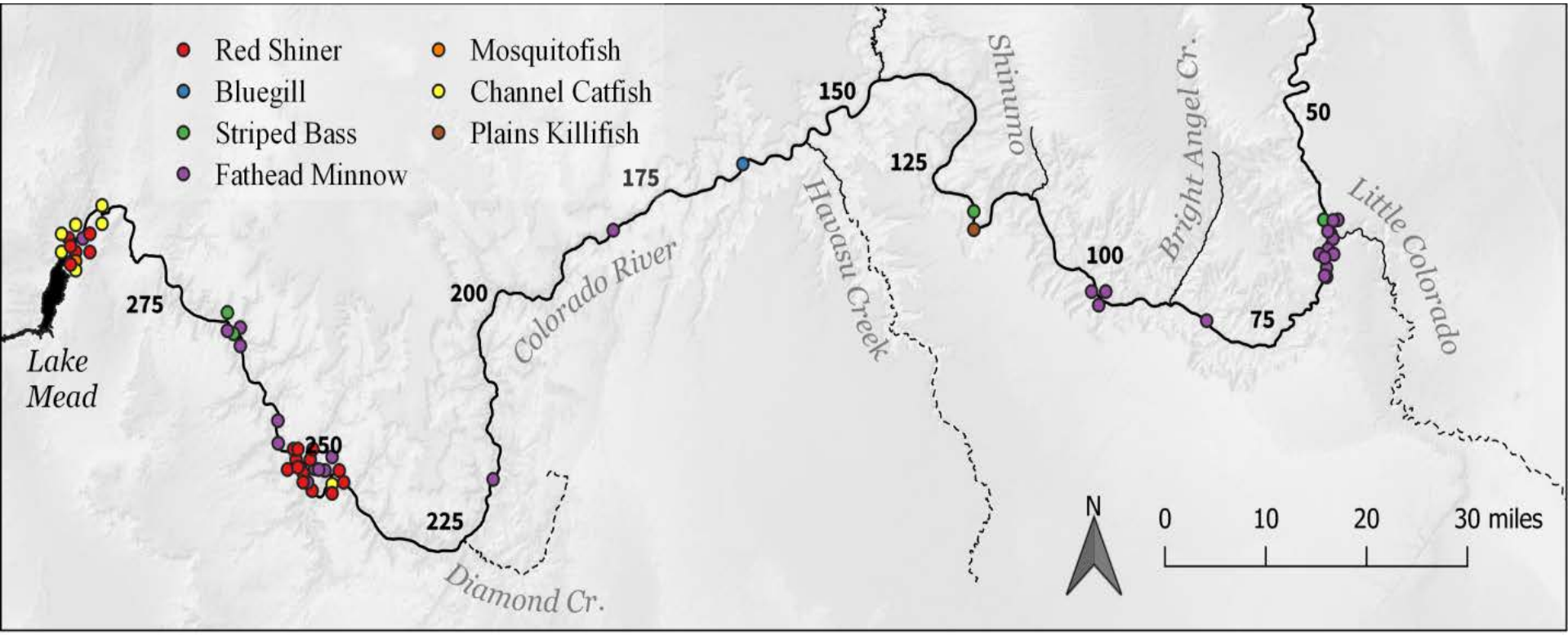
Nonnative fish 2018

Species	Number	Location
Bluegill	1	165.37
Brown Trout	21	29-195
Channel Catfish	7	One at 243, rest below Pearce
Common Carp	33	95-293
Fathead Minnow	30	(12) 61-71, (4) 84-98, (1) 181, (1) 219, rest > 242
Mosquitofish	1	294.56
Plains Killifish	1	117.69
Rainbow Trout	623	17-168
Red Shiner	19	249-296
Striped Bass	4	61, 118, 266, 267

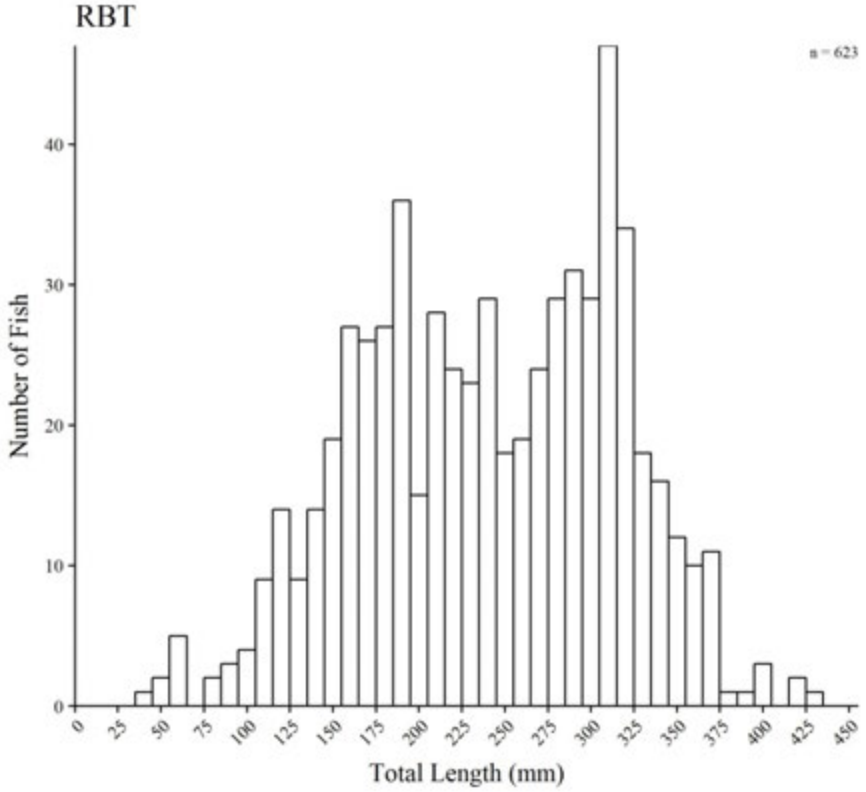

Plains Killifish

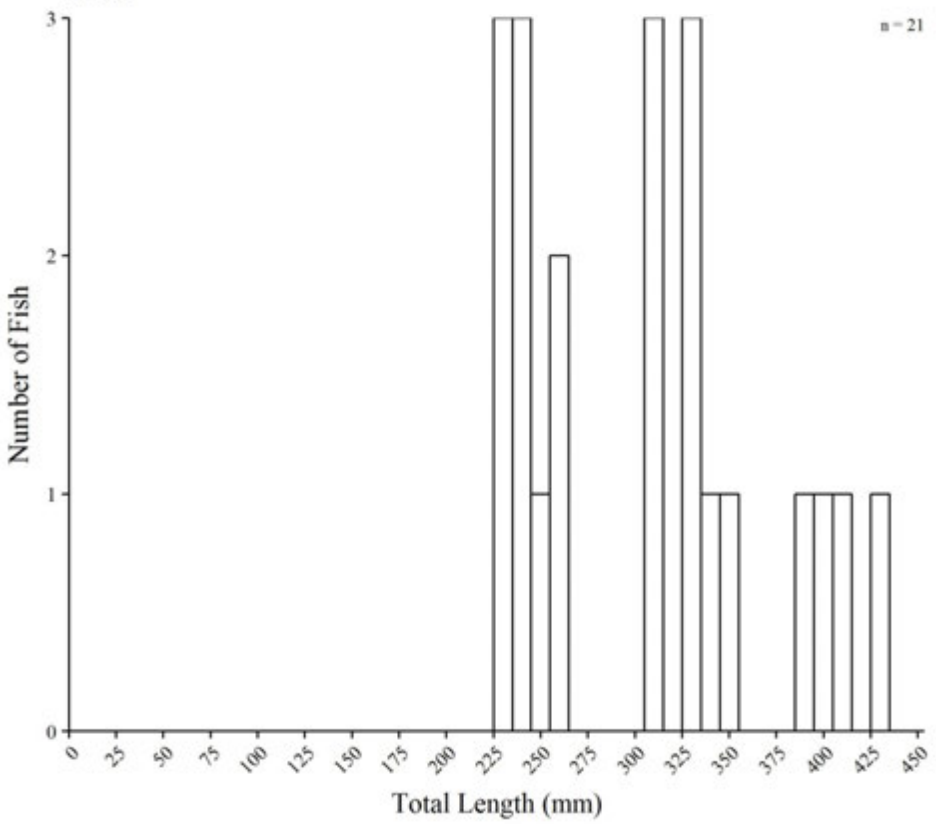

Red Shiner

Location of rare nonnatives 2018

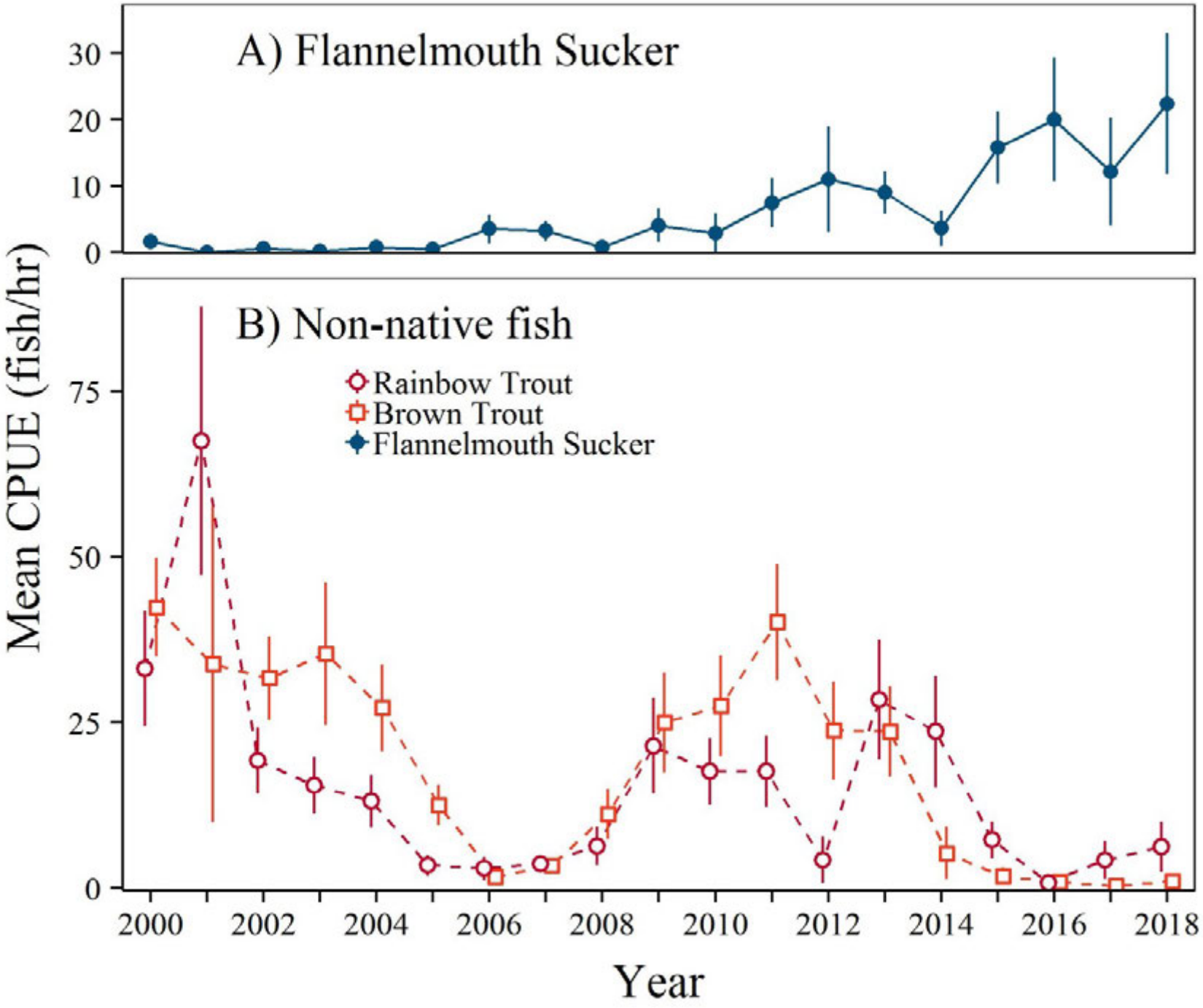


Trout in the Grand Canyon 2018

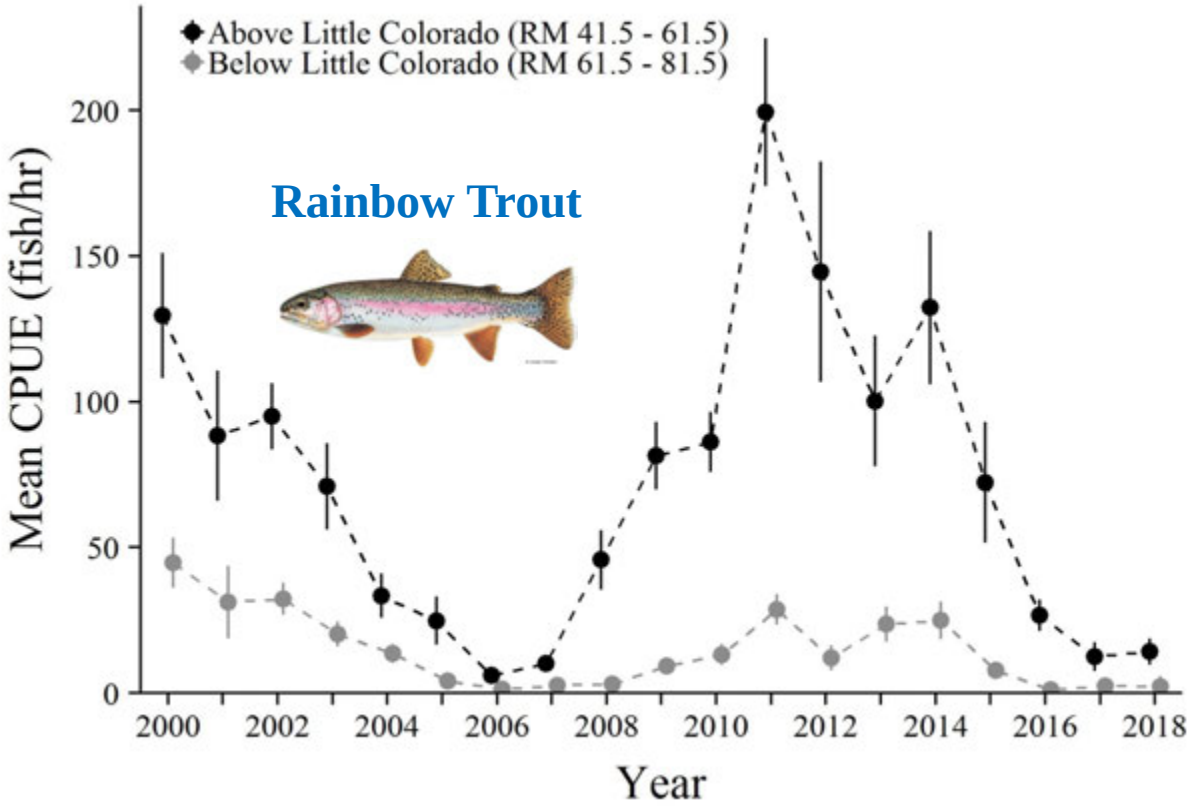




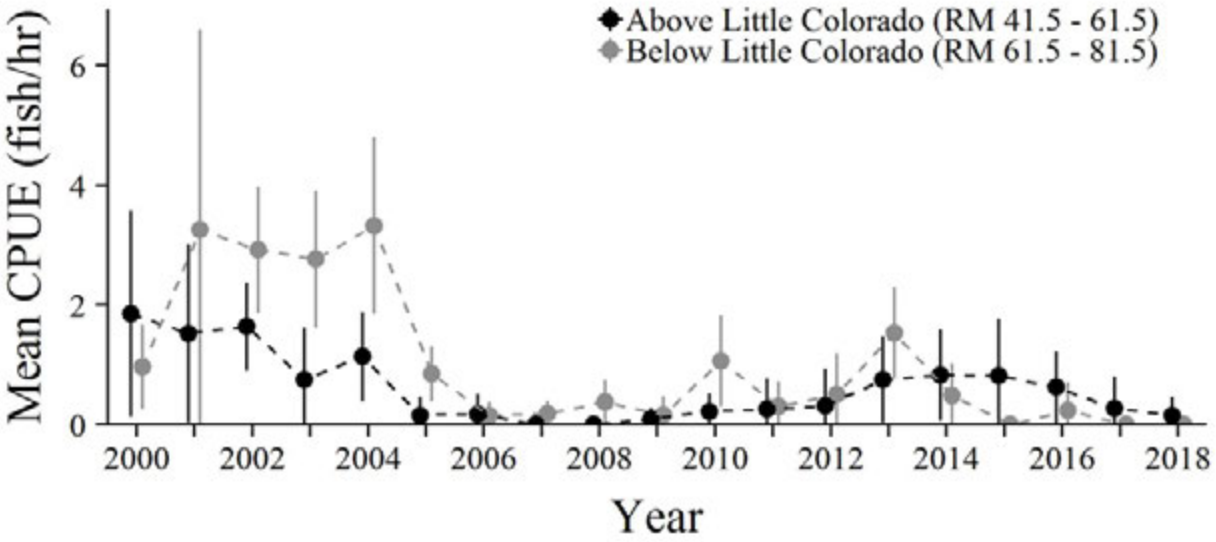
Bright Angel Reach



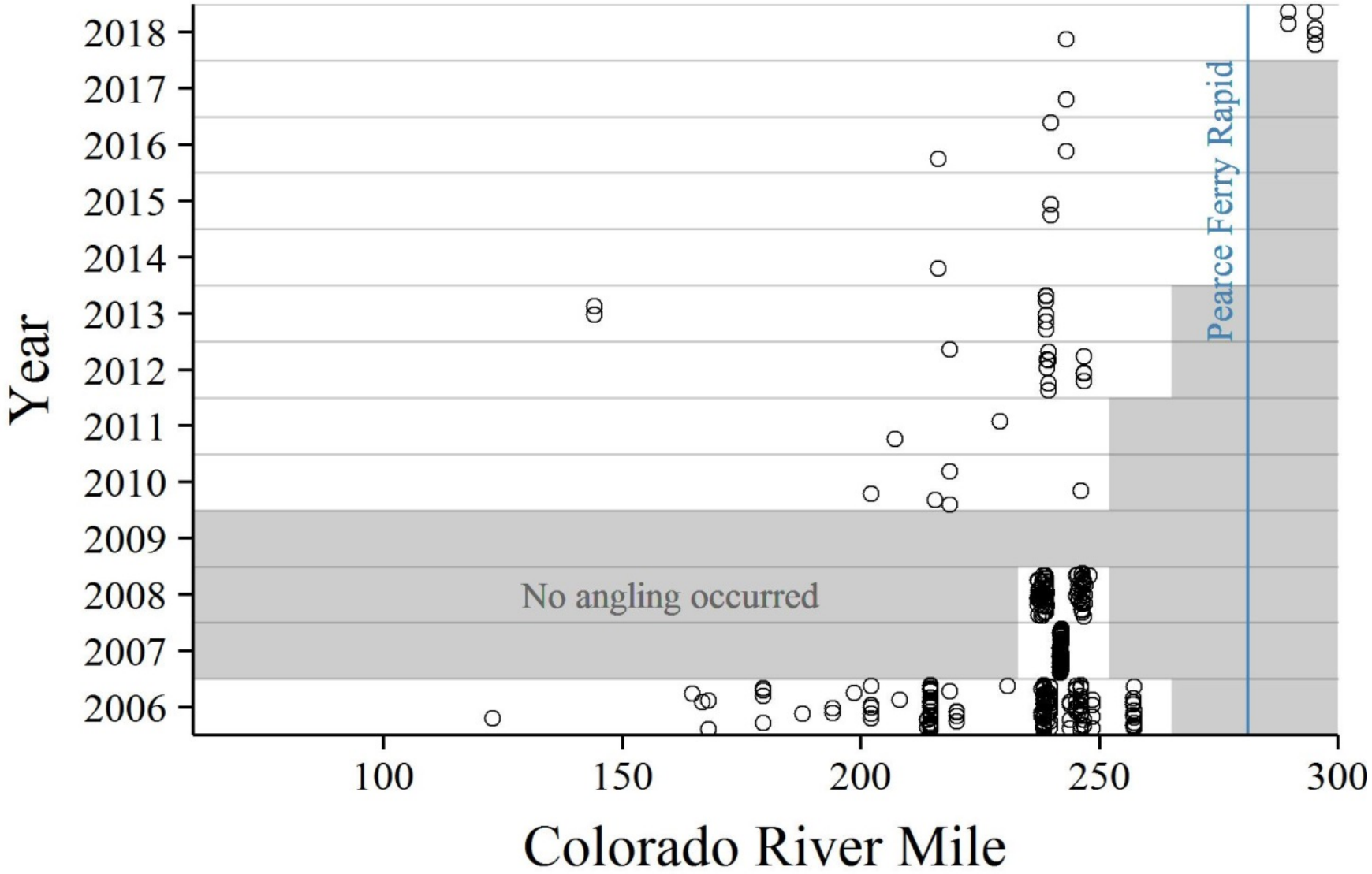
Little Colorado River reach



Brown Trout



Angling & Channel Catfish



Below Pearce Ferry Rapid

23-26 Oct 2018

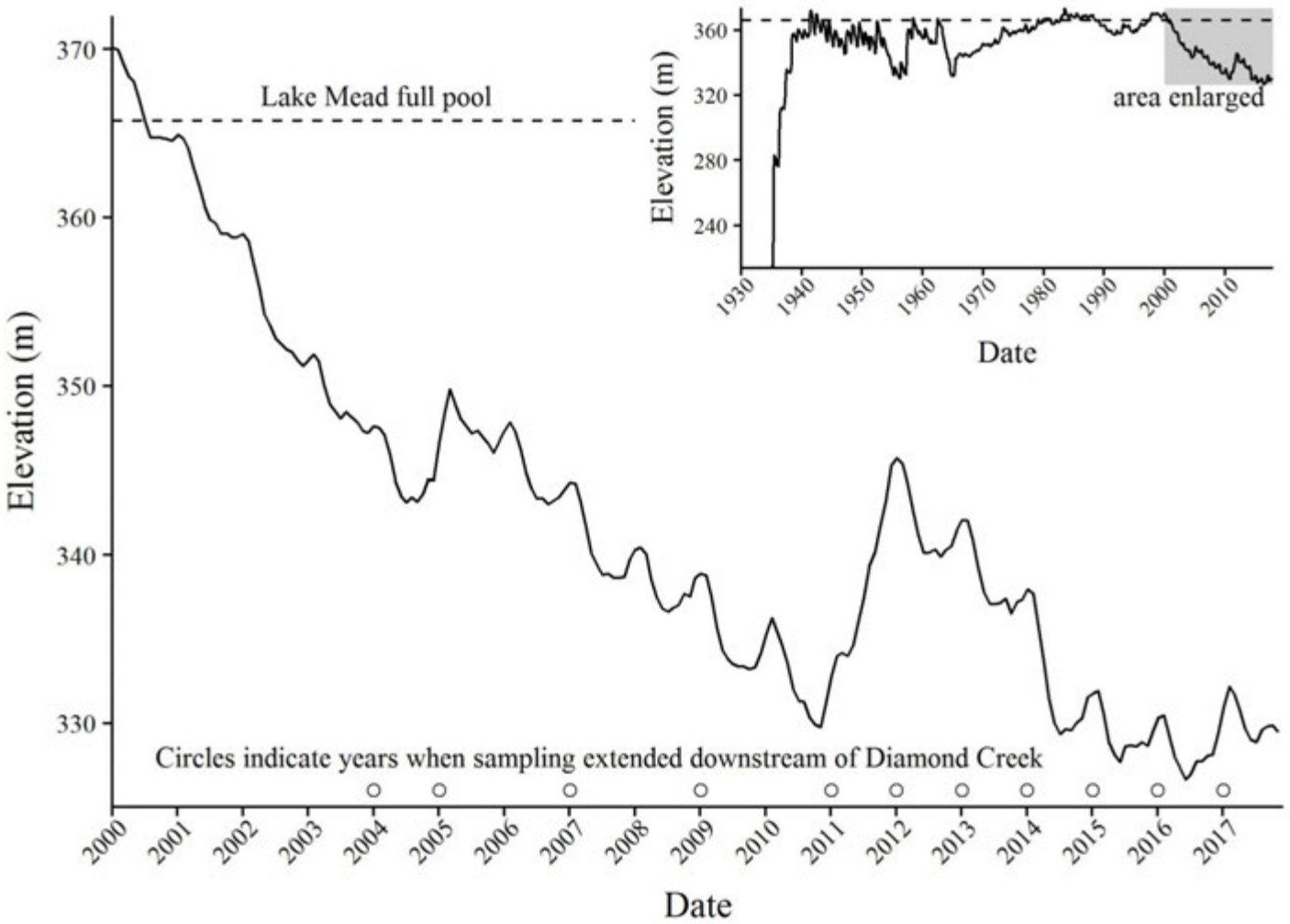
- **Hoop nets (45)**
  - Flannelmouth Sucker (3)
  - Speckled Dace (16)
  - Red shiners (6)
  - Mosquitofish (1)
  - Common Carp (2)
  - Fathead Minnow (1)
- **Angling**
  - 5.7 hours total, 4 locations
  - Channel Catfish (6)

Pearce Ferry Rapid

Hypotheses

- a long, continuous reach of increasing river habitat

Lake Mead Elevation




2015
Current Inlet
Pearce Ferry
Grand Wash Cliffs

Summary

- Native fish doing well
- Nonnative numbers declining
  - Brown Trout numbers – lowest in a long time
- Razorback Suckers
- Colorado Pike Minnow

- Annual reports will be available

Recaptures

- 1,662 rainbows tagged 2017-2018
- 222 recaptures
  - 17 tagged by AGFD
  - 205 tagged by other projects (NO/TRGD)