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# Turbidity as a management tool to constrain Rainbow Trout downstream of the Paria River

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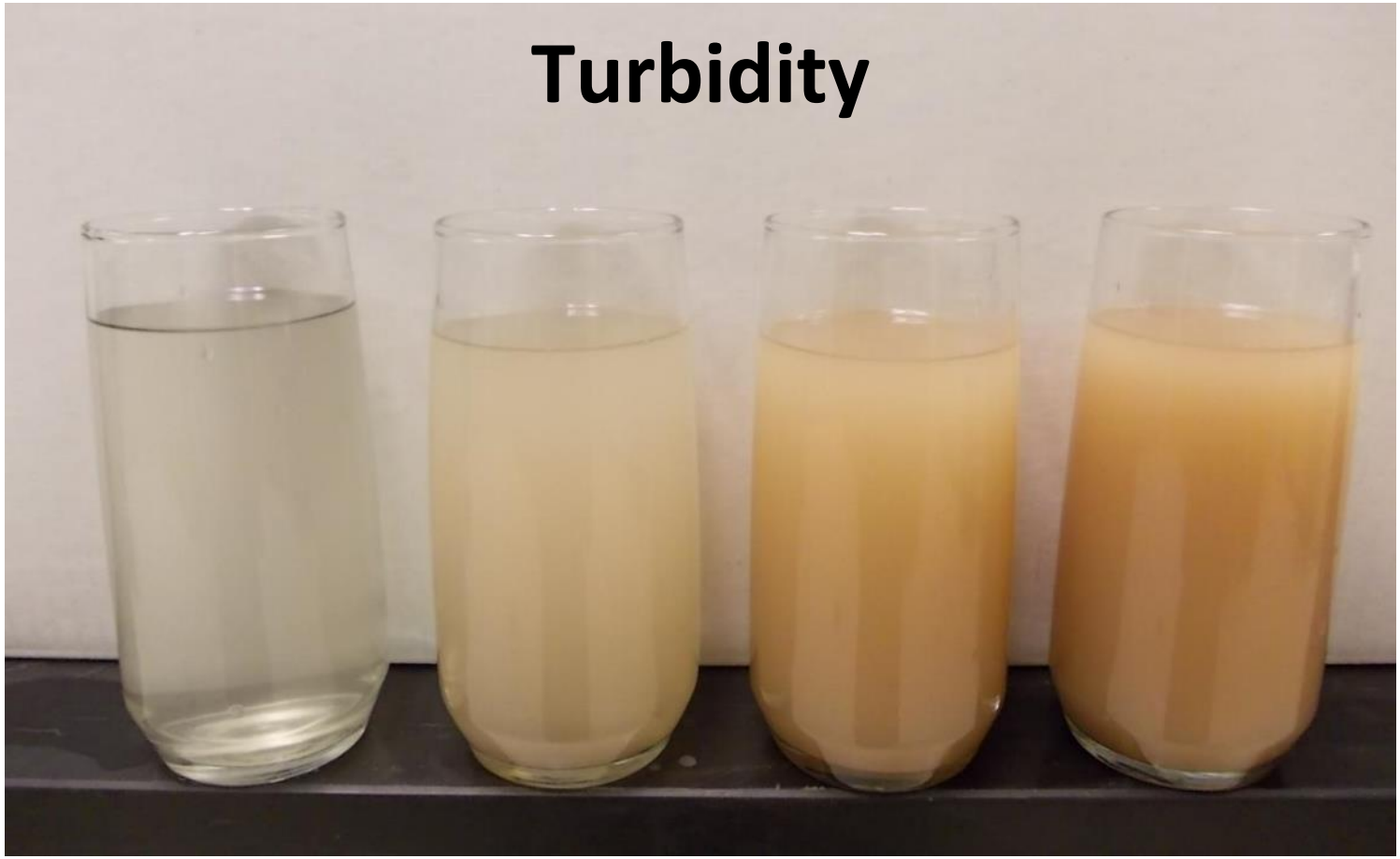
U.S. Geological Survey

# Turbidity



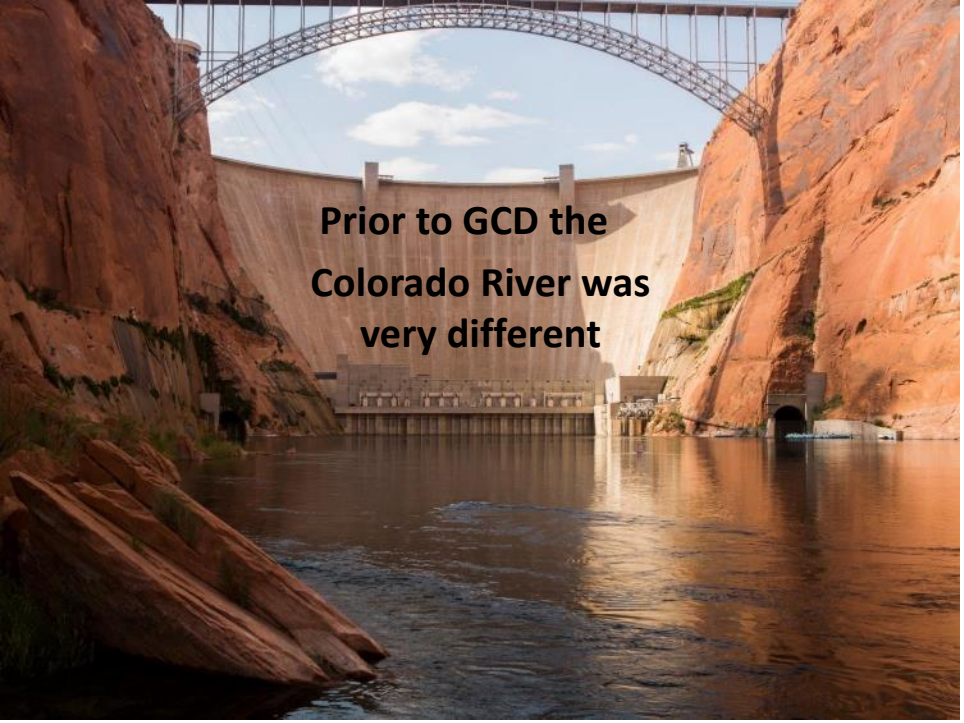
Clear → Muddy

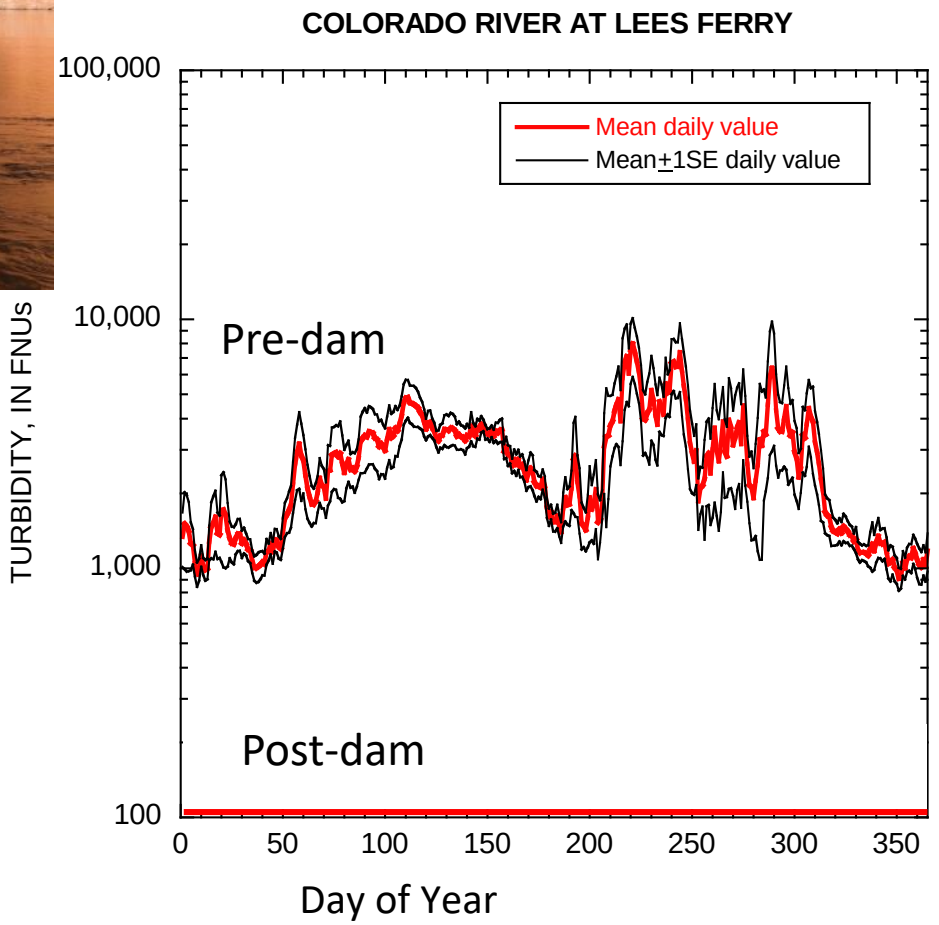
NTU vs FNU vs TSS

**Nephlometric Turbidity Units**

**Formazin Turbidity Units**

**Total Suspended Solids ppm or mg/L**




*Voichick and Topping 2014, Scientific Investigations Report 2014-5097*

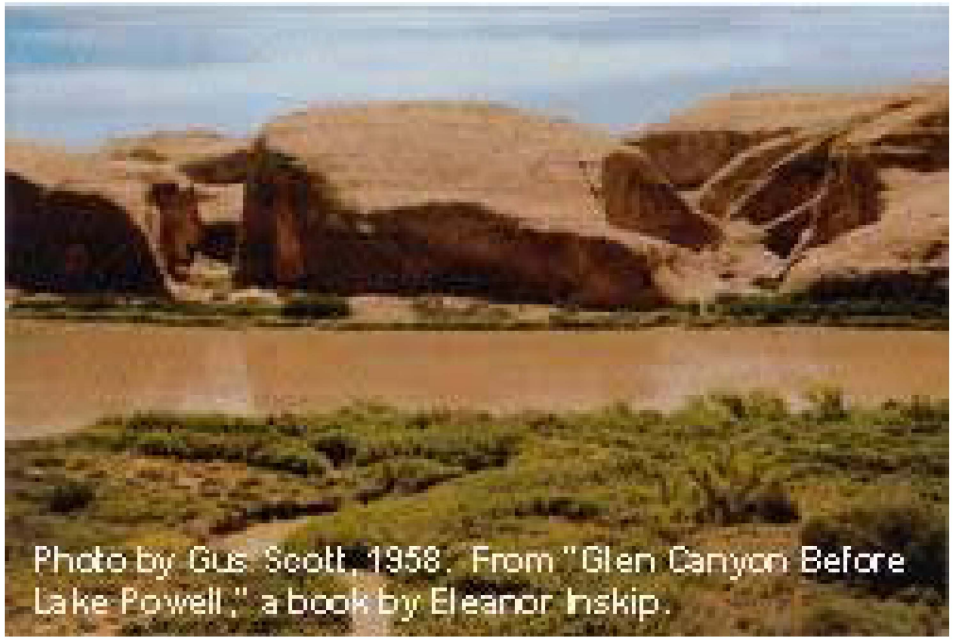
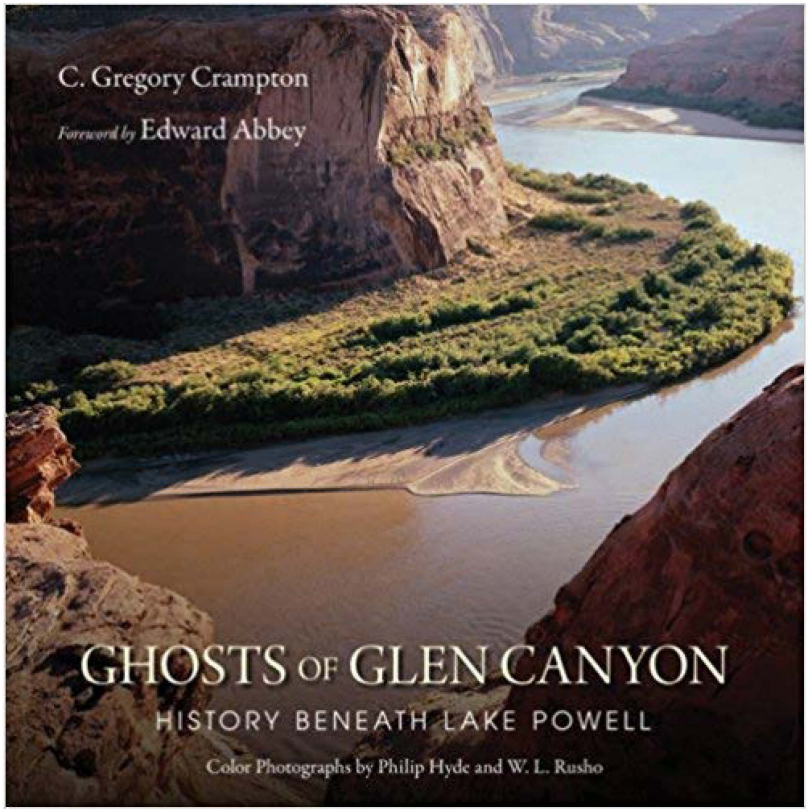


Photo by Gus Scott, 1958. From "Glen Canyon Before Lake Powell," a book by Eleanor Inskip.


C. Gregory Crampton
Foreword by Edward Abbey
GHOSTS OF GLEN CANYON
HISTORY BENEATH LAKE POWELL
Color Photographs by Philip Hyde and W. L. Rusho

# Turbidity shaped the unique endemic fishes

# Even prior to Glen Canyon Dam the Colorado River was impacted by invasive species

But only by species adapted
To live in turbid water!

Fish are physiologically adapted to their environment and anthropogenic changes to those environments have consequences for species survival.

Conservation of imperiled native fishes requires an understanding of the ecological and evolutionary processes that have shaped predator-prey interactions and how those interactions are mediated by specific features of habitat. To be effective, management of native fishes must include elements of maintaining or enhancing features of habitat that reduce predation vulnerability

(Matter and Mannan 2005, How do prey persist, *The Journal of Wildlife Management 69: 1315-1320*).

# Physiology – Morphology - Behavior

# Previous Experiments

- How does turbidity effect the ability of rainbow and brown trout to capture juvenile chub?

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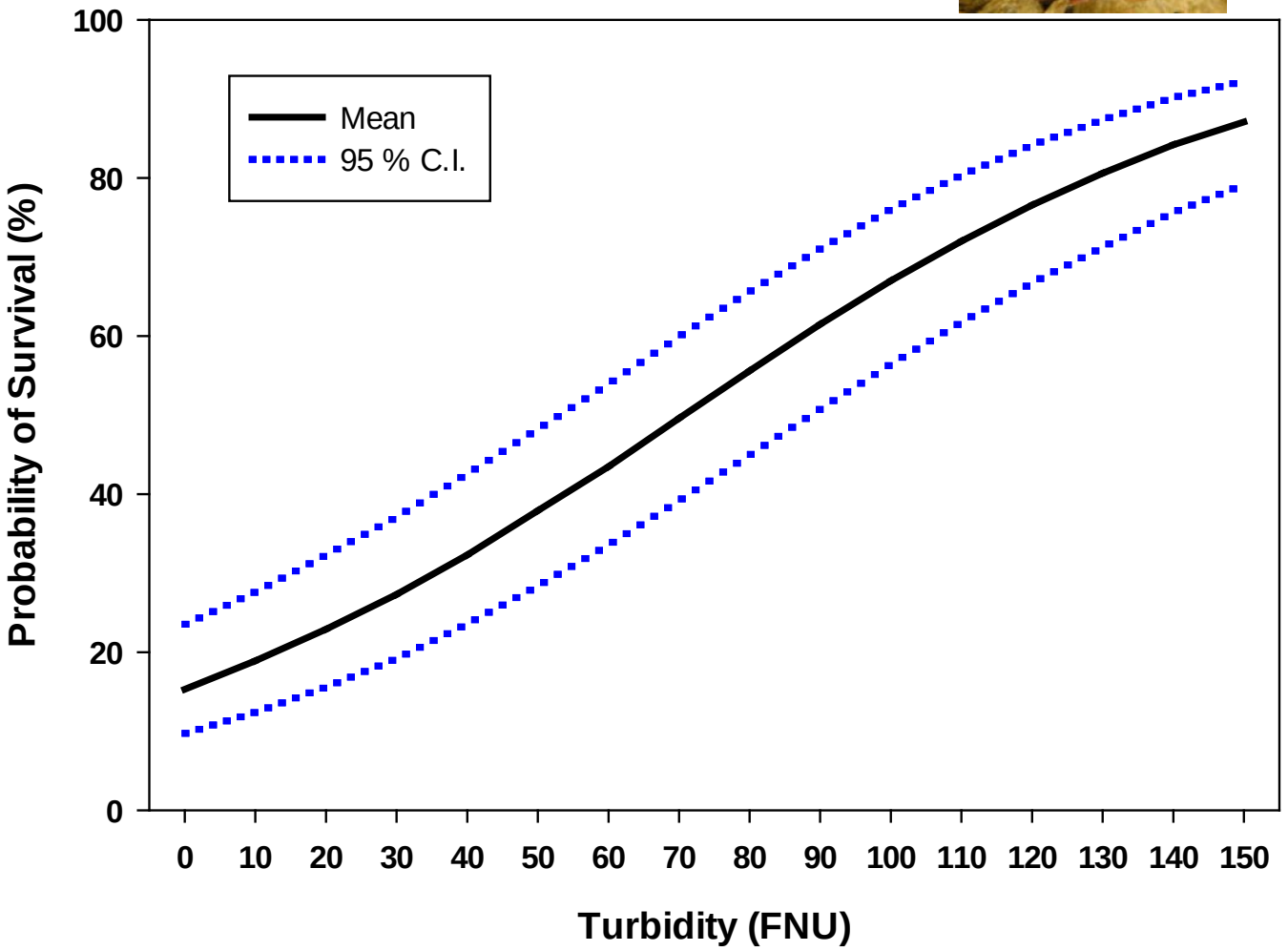
# Rainbow trout




Percent probability of survival for juvenile humpback chub (60 mm TL) exposed to predation by rainbow trout (285 mm TL) as turbidity increases from 0 – 150 FNU at 15° C.

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Ward et al. 2016. Effects of turbidity on predation vulnerability of Juvenile Humpback chub to Rainbow and Brown Trout. *Journal of Fish and Wildlife Management* 7: 1-8

# Rainbow Trout Summary

25 NTU | 50 NTU | 75 NTU | 100 NTU


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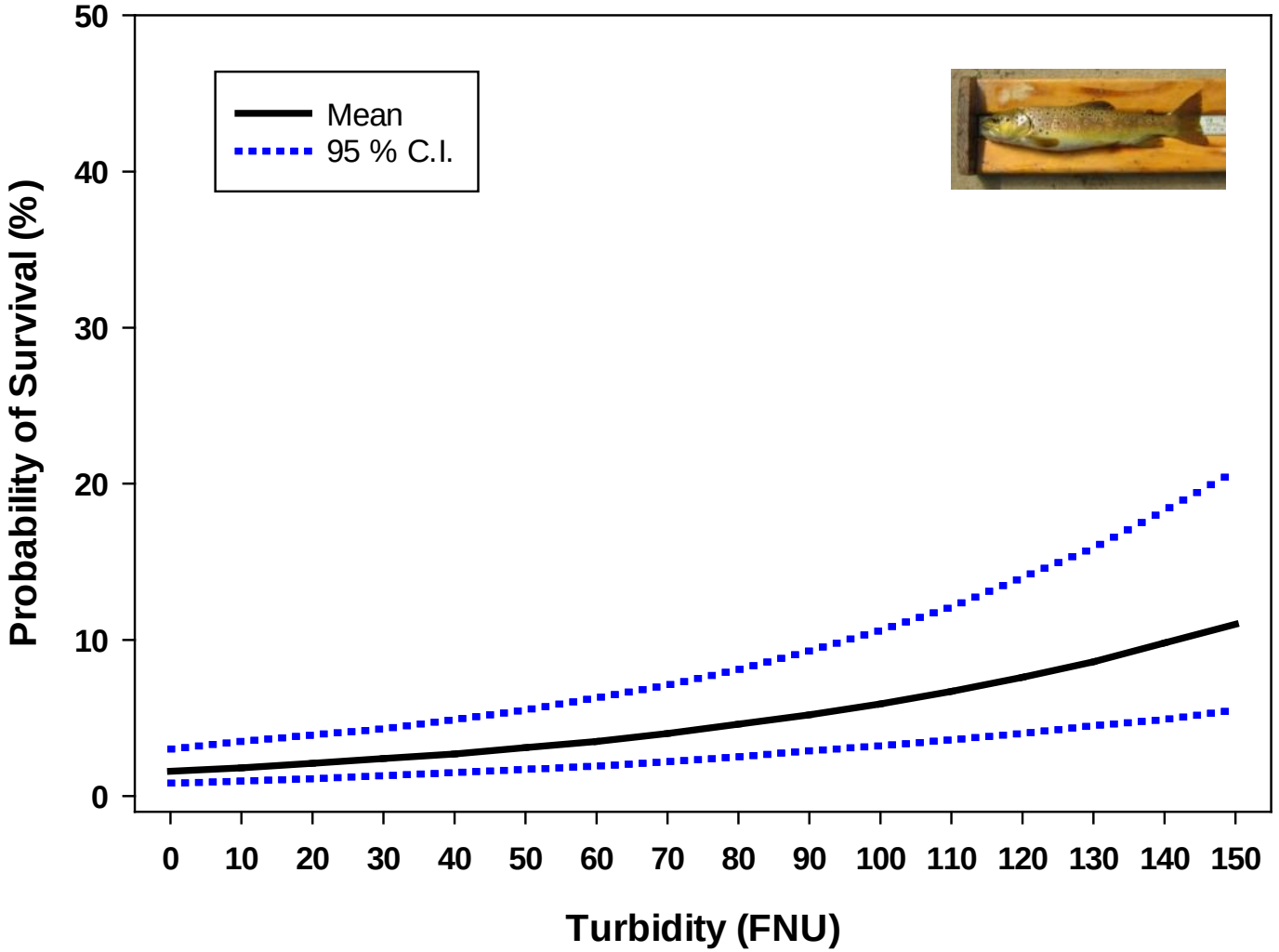
Compared to trials in clear water where survival = 0

(For 60 mm Humpback chub and 285 mm Rainbow Trout)

# Brown trout

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# Brown Trout Summary

25 NTU | 50 NTU | 75 NTU | 100 NTU


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Compared to trials in clear water where survival = 0

(For 60 mm Humpback chub and 285 mm Rainbow Trout)

# This experiment

- How does turbidity effect growth and survival of rainbow trout?

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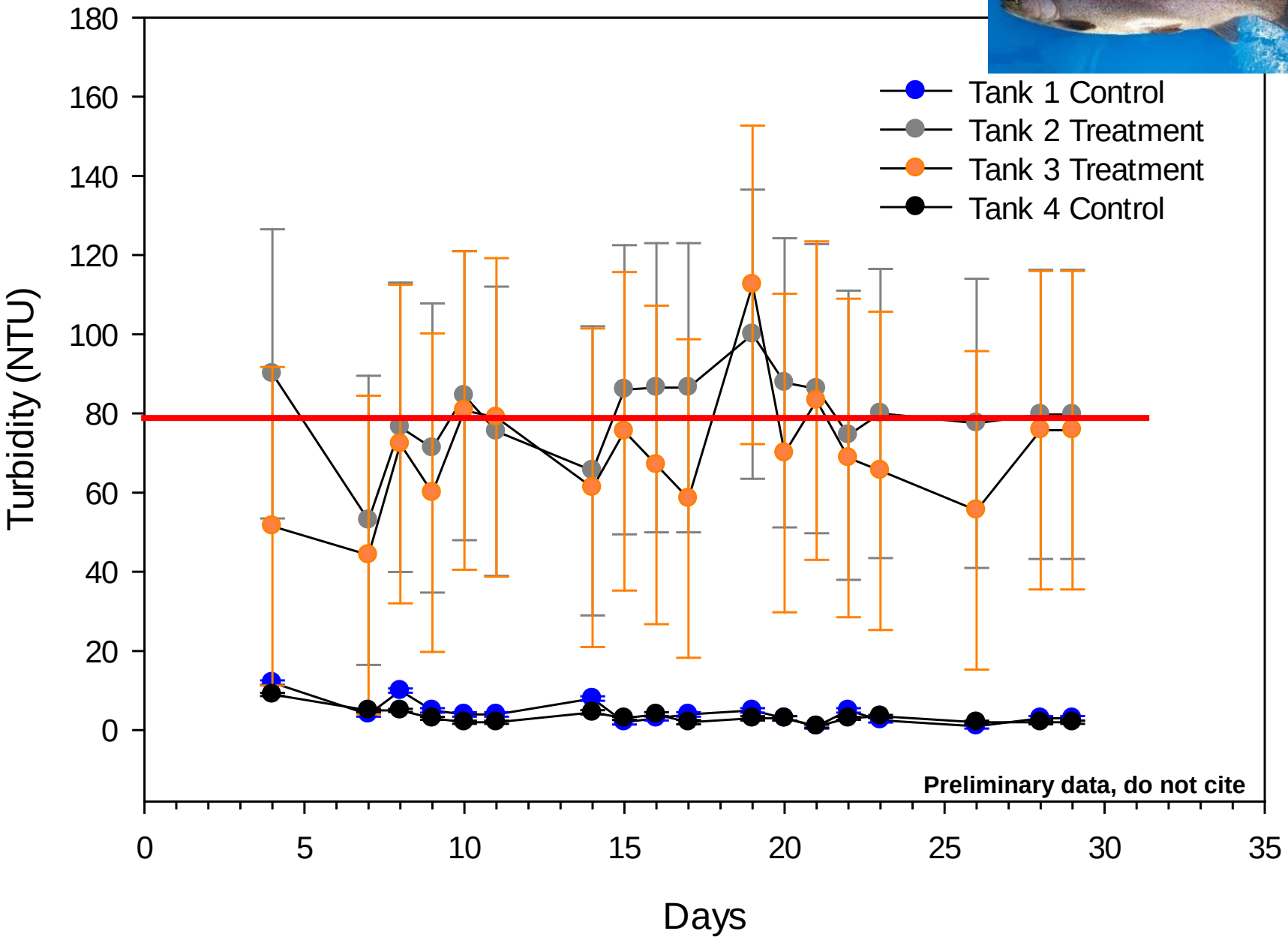
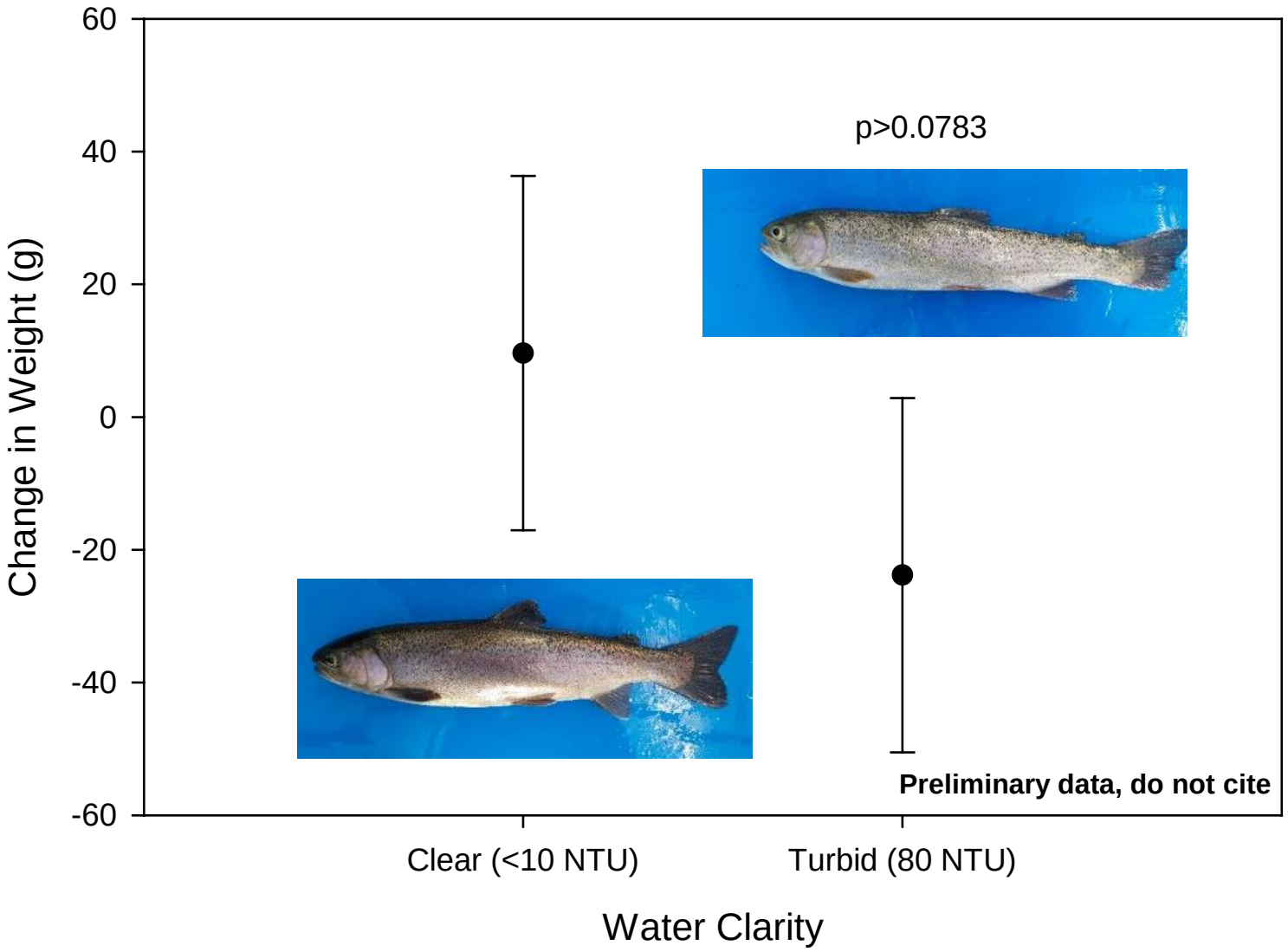
# Methods


# Large Rainbow Trout



# Large Rainbow Trout (329 mm mean TL)




N = 16

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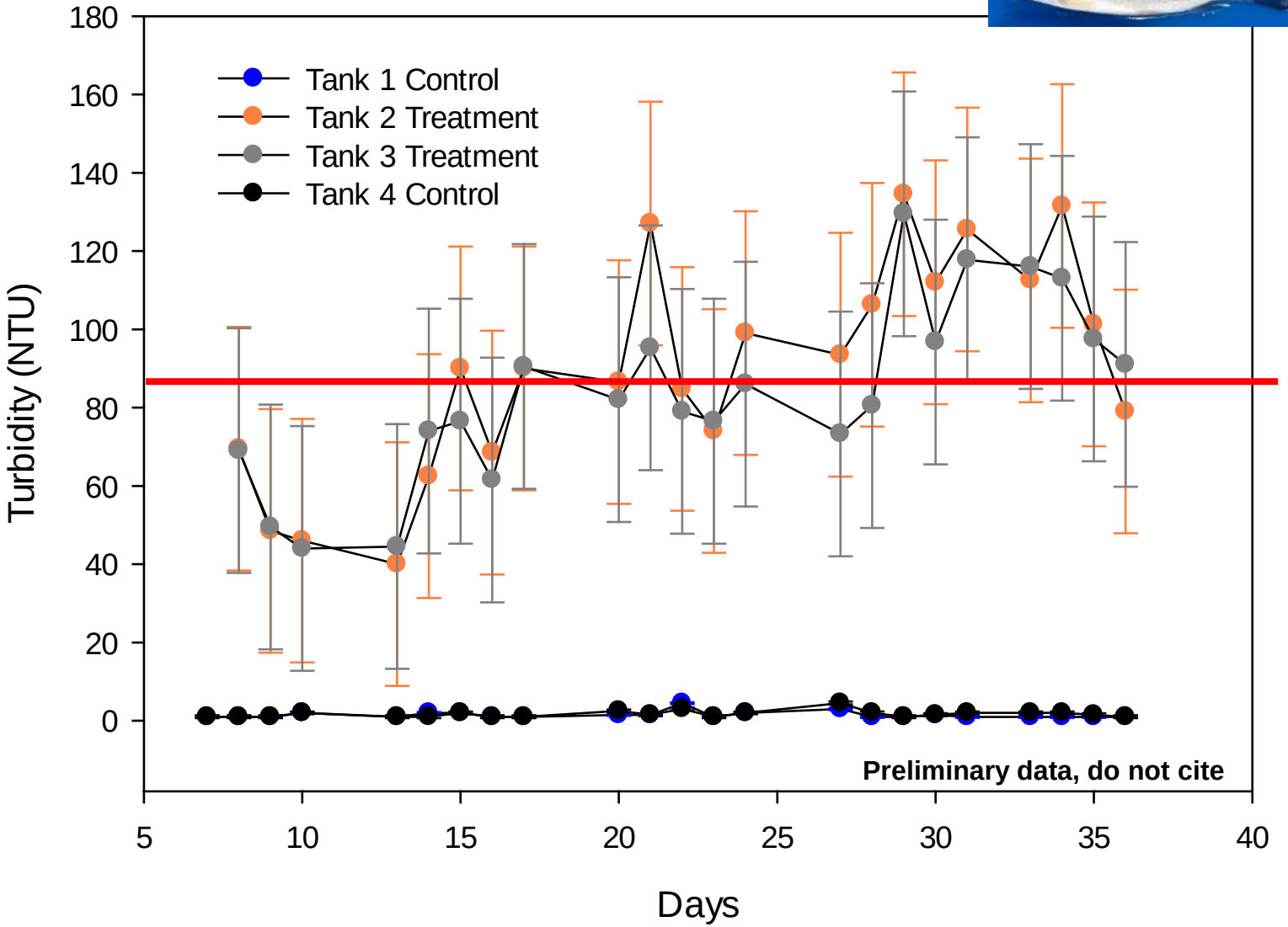
# Small Rainbow Trout

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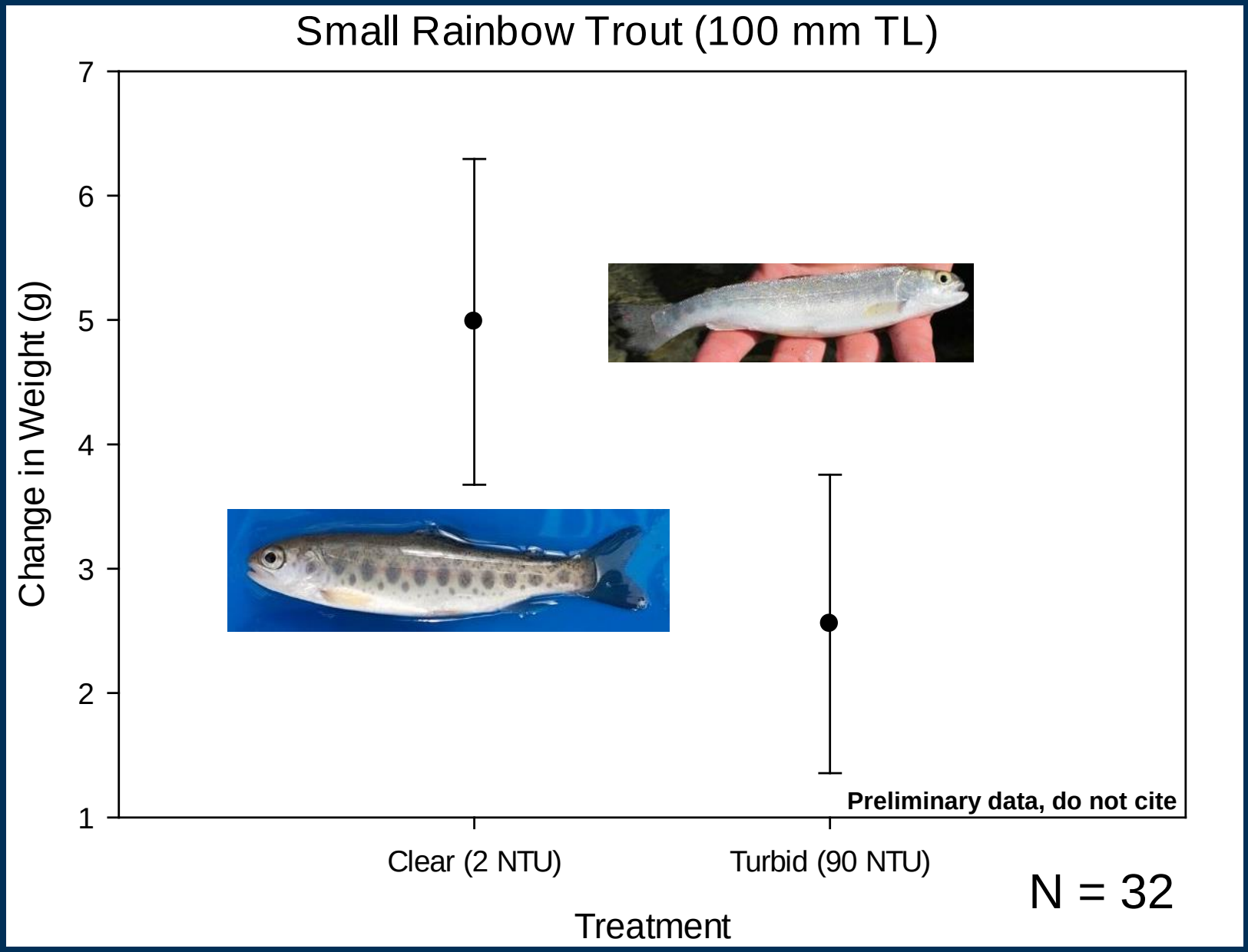
Small Rainbow Trout (100 mm TL)
Change in Weight (g)
7
6
5
4
3
2
1
Preliminary data, do not cite
Clear (2 NTU)
Turbid (90 NTU)
Treatment
N = 32

# So we know extended turbidity causes reduced trout condition –

# What does that mean for management?

- Low condition increases natural mortality
- Lowers reproductive potential
- Makes fish more susceptible to disease

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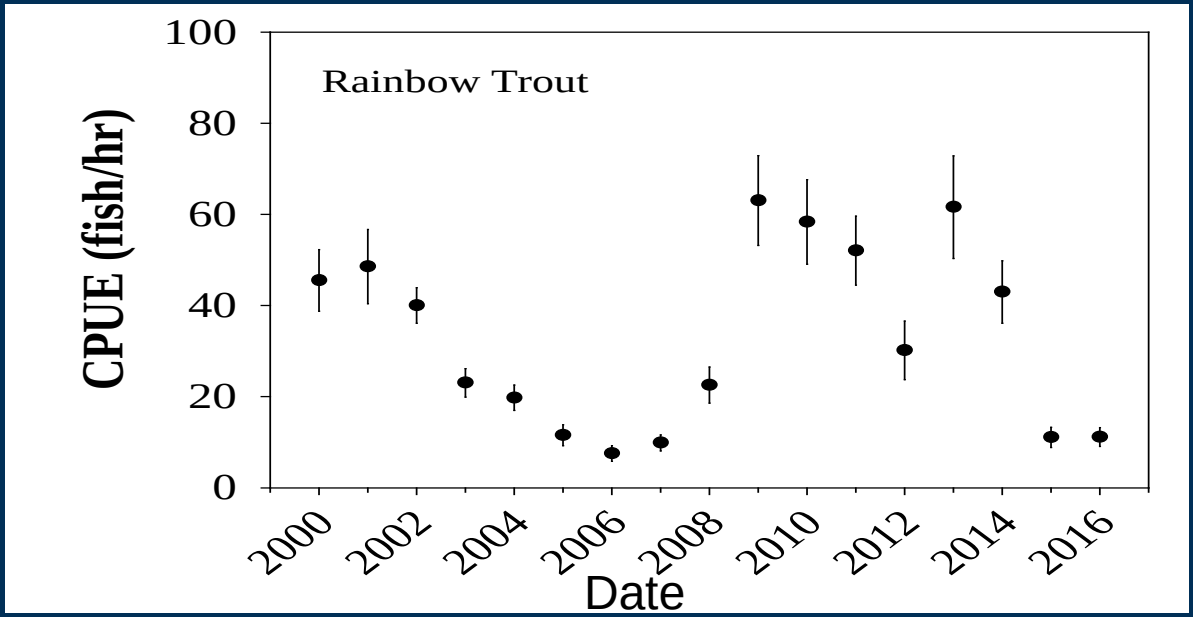
# Can we see a turbidity effect in the field data?




Arizona Game and Fish Long-term Monitoring Data, Electrofishing

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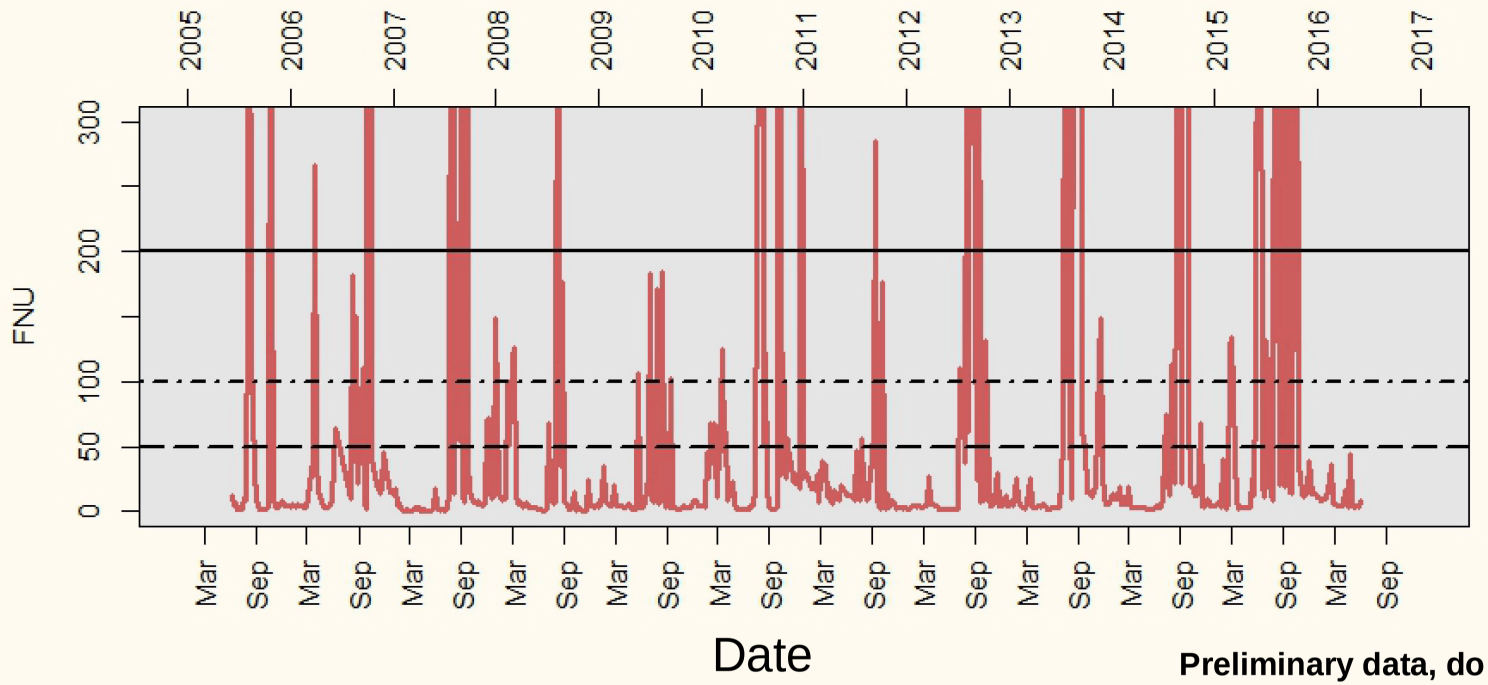
Difficult – need something more proximate – Fish Condition

# Mainstem Colorado River Turbidity, USGS 30-mile gauge

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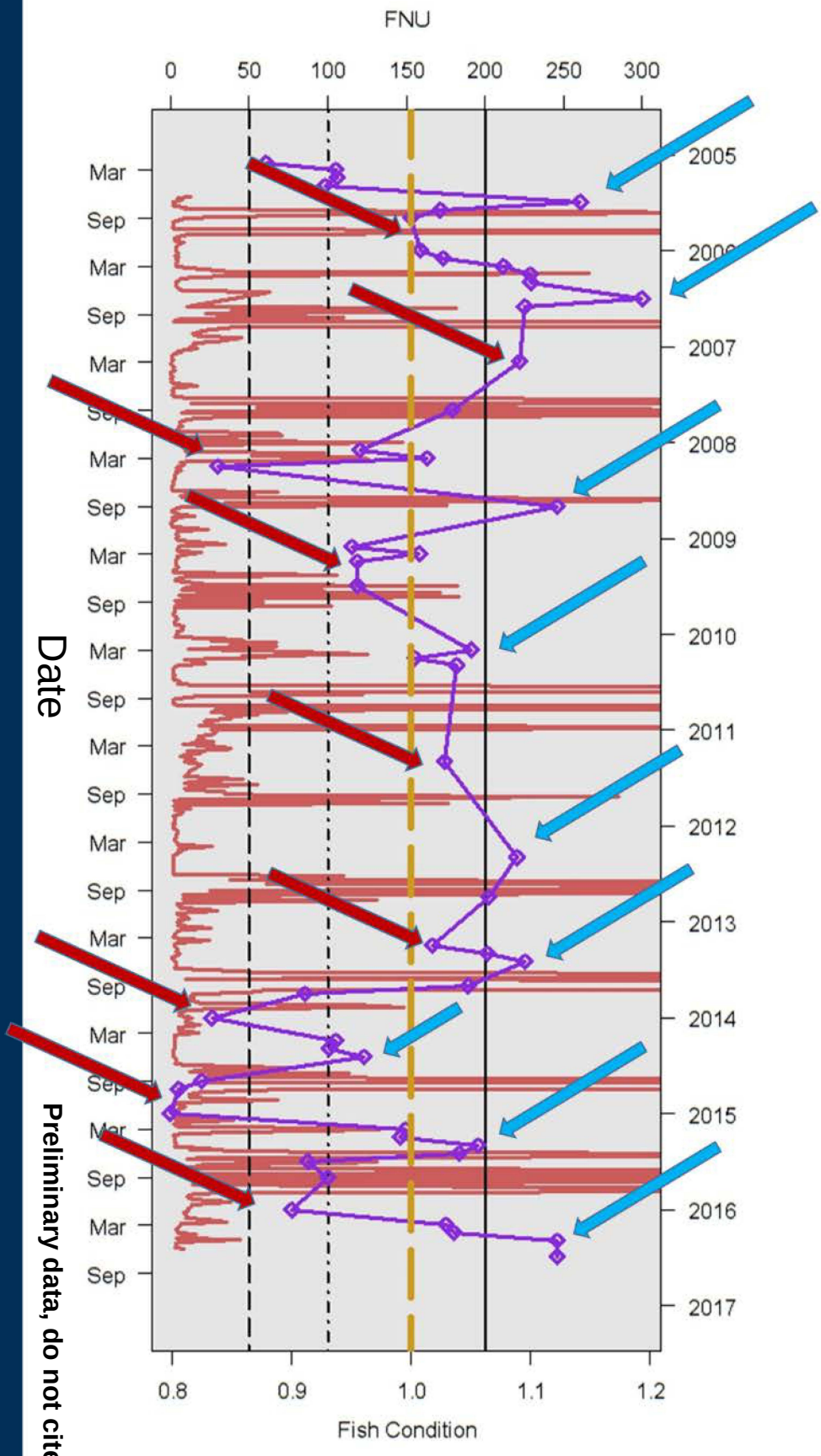
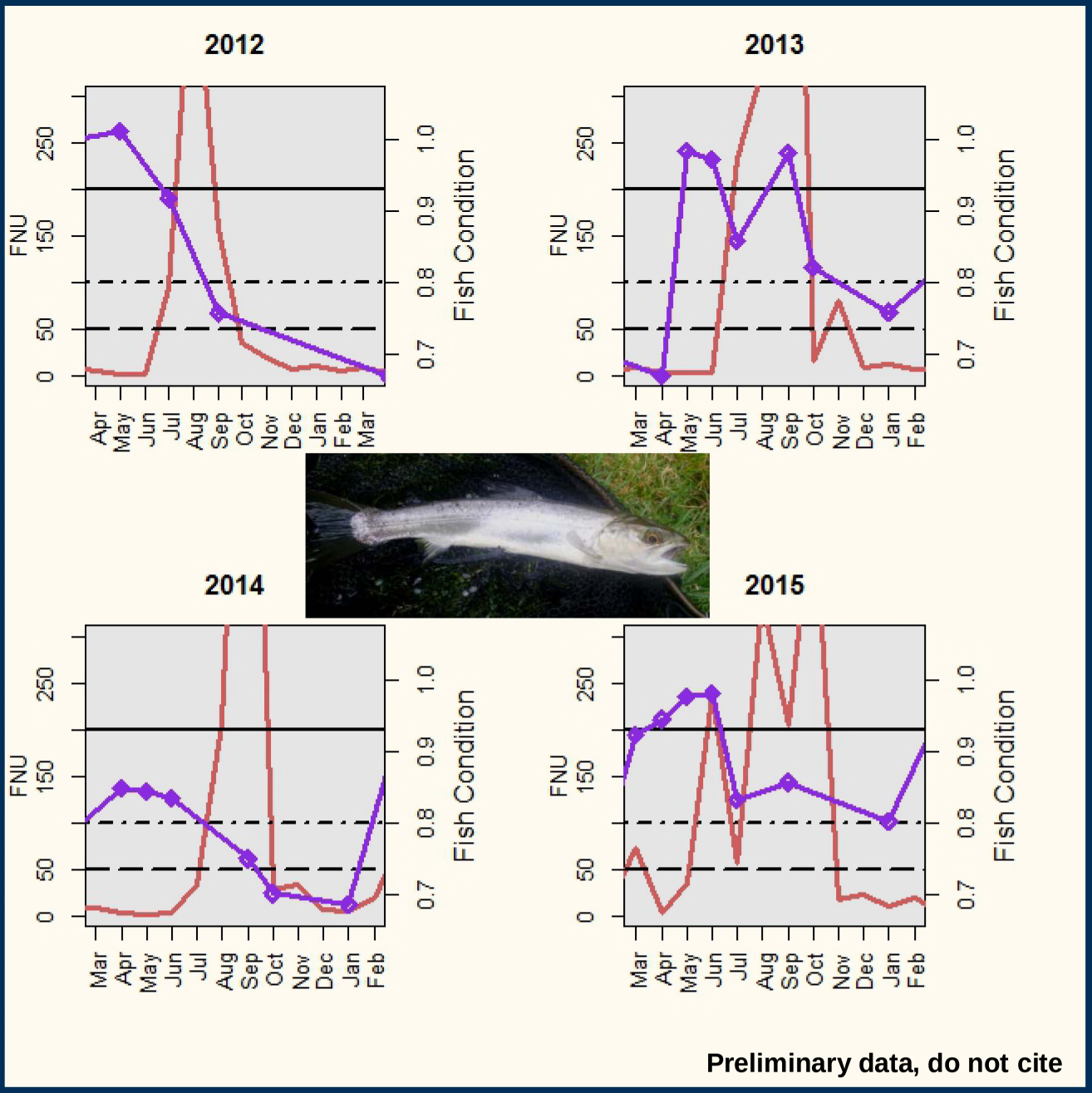

FNU
0
50
100
150
200
250
300
Mar
Sep
2005
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Date
0.8
0.9
1.0
1.1
1.2
Fish Condition
Preliminary data, do not cite

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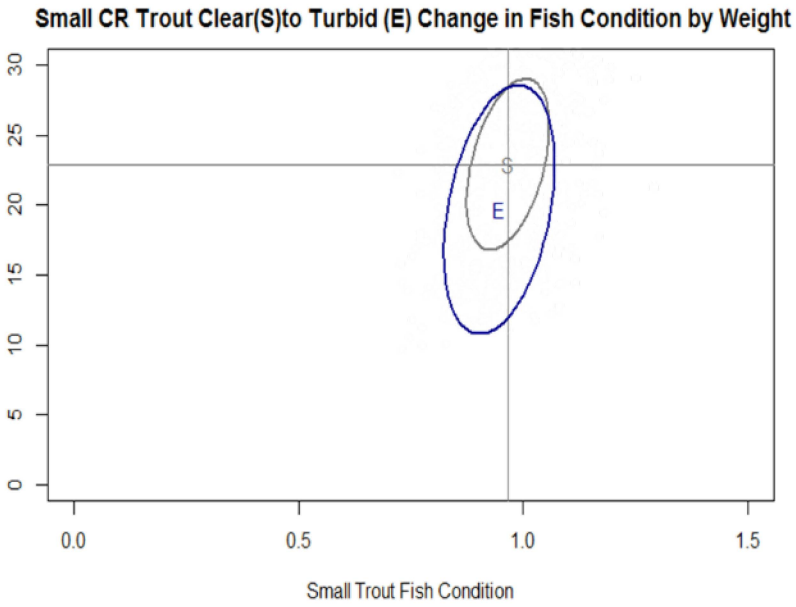
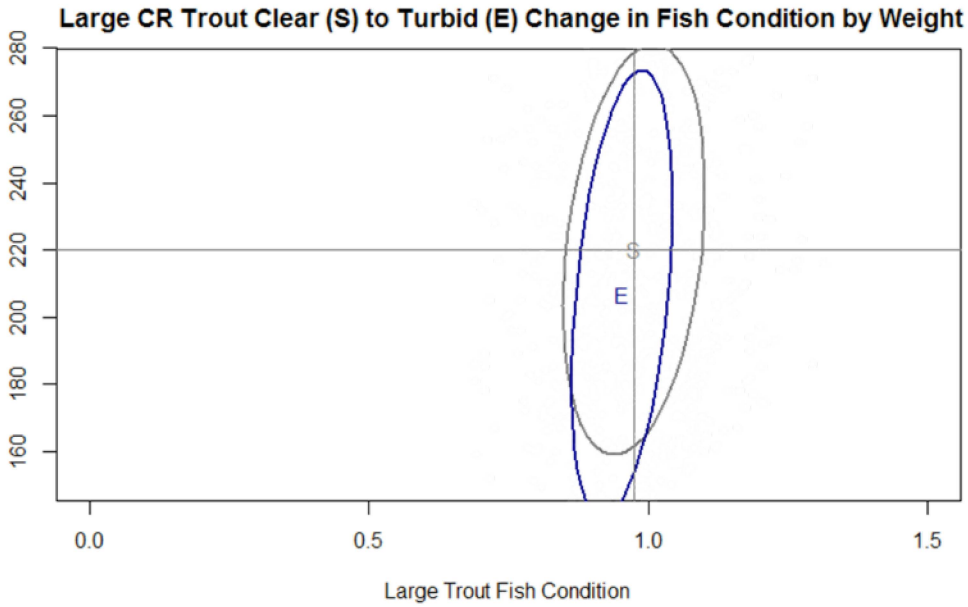
**Preliminary data, do not cite**

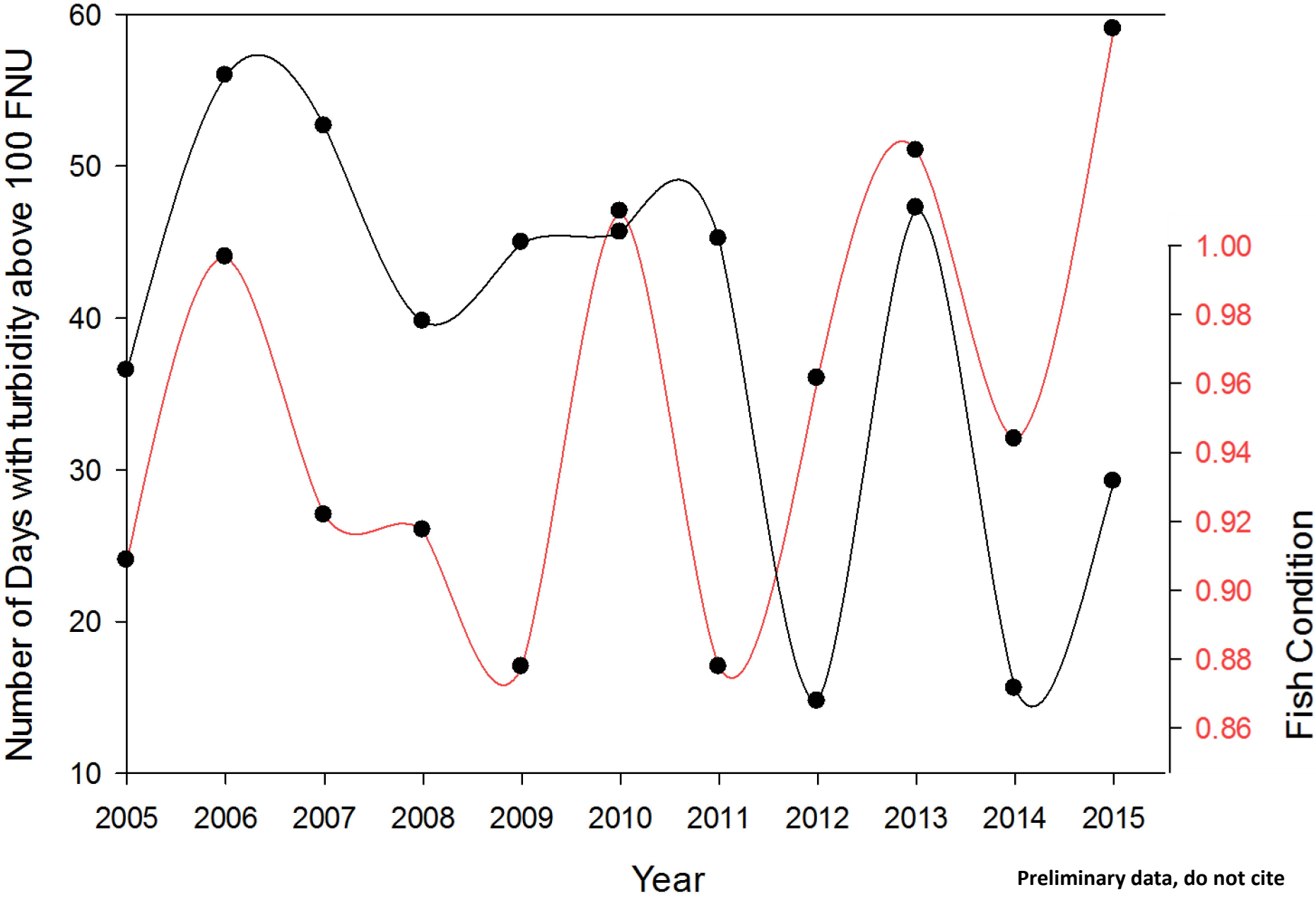
# Rainbow Trout Fish Condition: Weight in the CR



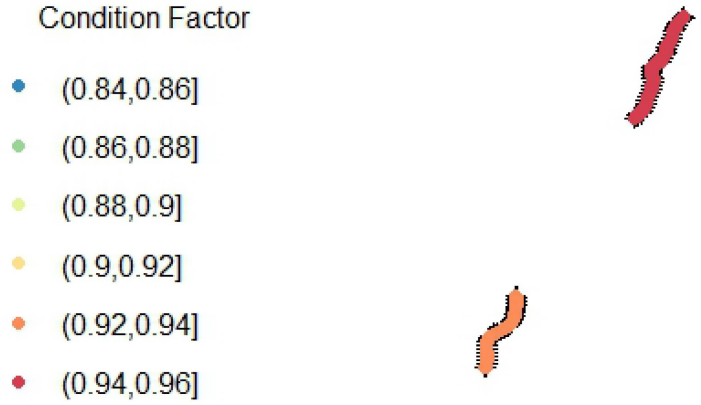

**Preliminary data, do not cite**

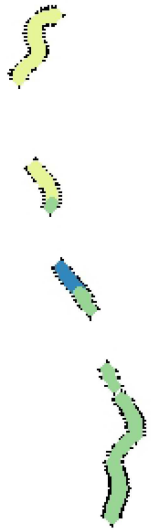
# Yearly Days Above 100 FNU & RBT Condition

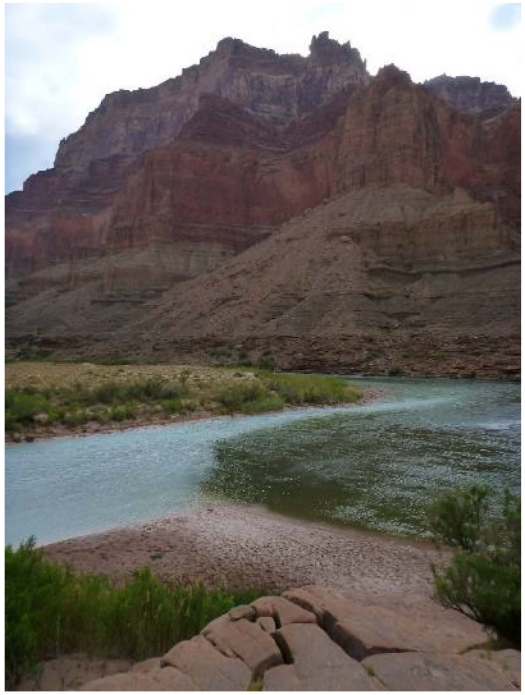



Preliminary data, do not cite

## Spatial Trends in RBT Condition Factor





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# Manipulation of turbidity from the Paria River to benefit downstream native fish (without impacting Lees Ferry Rainbow trout) warrants further evaluation


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# Sediment augmentation was considered as part of 1995 GC Dam EIS

# Randle 2007 Study – Sediment Augmentation

- Target -
  - 500 ppm TSS (500-600 NTU)
  - 1 million tons of sand
  - 8 month period from May – Dec
    - We may only need 1/5$^{th}$ of the silt/Clay and no sand
    - May only need it from April to July

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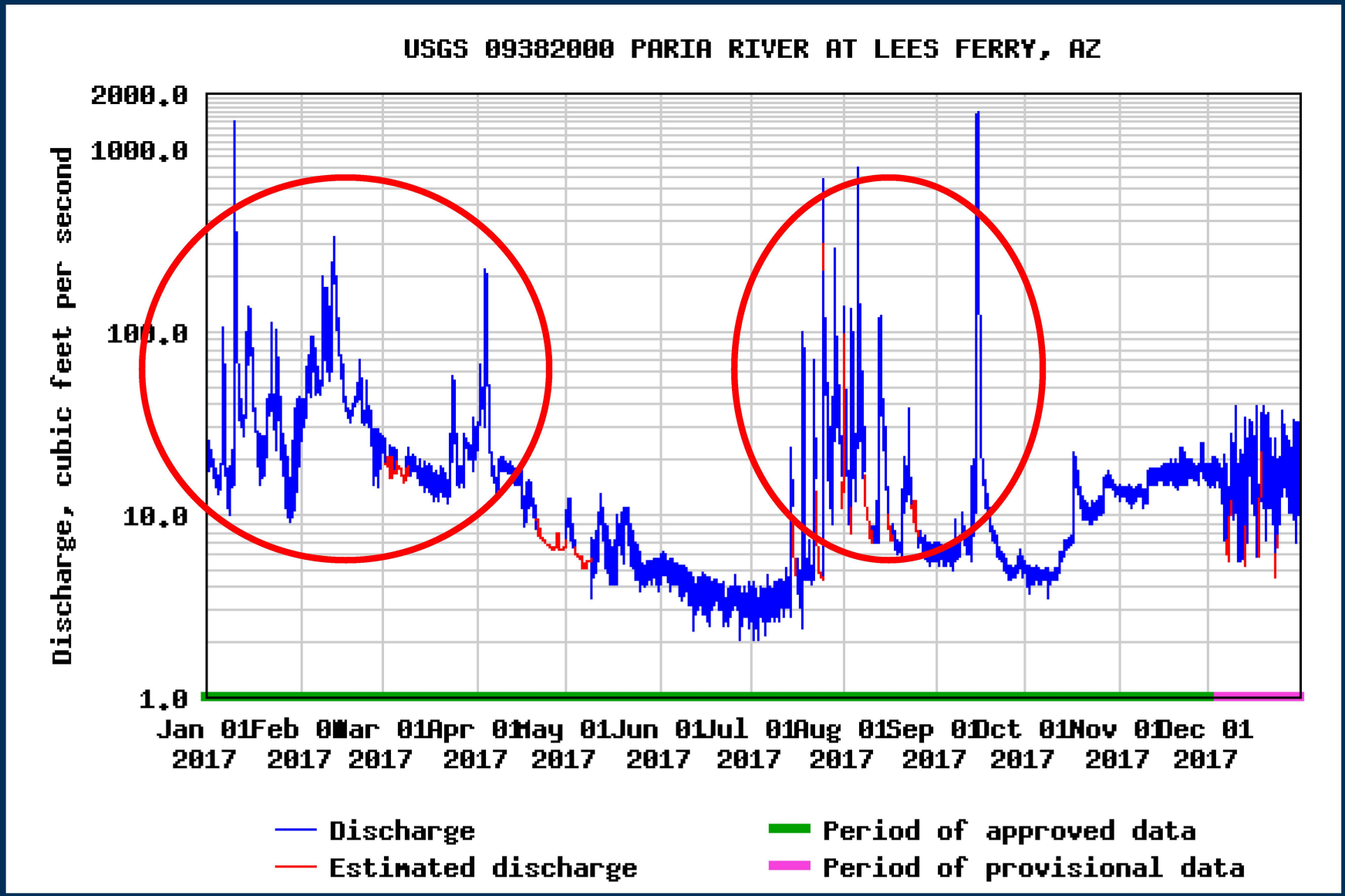


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https://www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09382000

# Conclusion

- Relatively low turbidity (100 FNU) not only impacts predation dynamics but is also likely to negatively impact rainbow trout populations downstream of the Paria.

- Higher turbidities may be necessary to effect predation dynamics of brown trout.

- Laboratory, field data and literature all suggest that rainbow trout populations can be negatively impacted by low level turbidity – but duration is important

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Instead of always reaching for Mechanical Removal

Why not experiment with other methods of
Making the river more conducive to native fish?

Turbidity manipulation ?

Caveat – not my expertise !

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# A Sediment Retention Basin


Sluice gates to allow controlled delivery of turbidity

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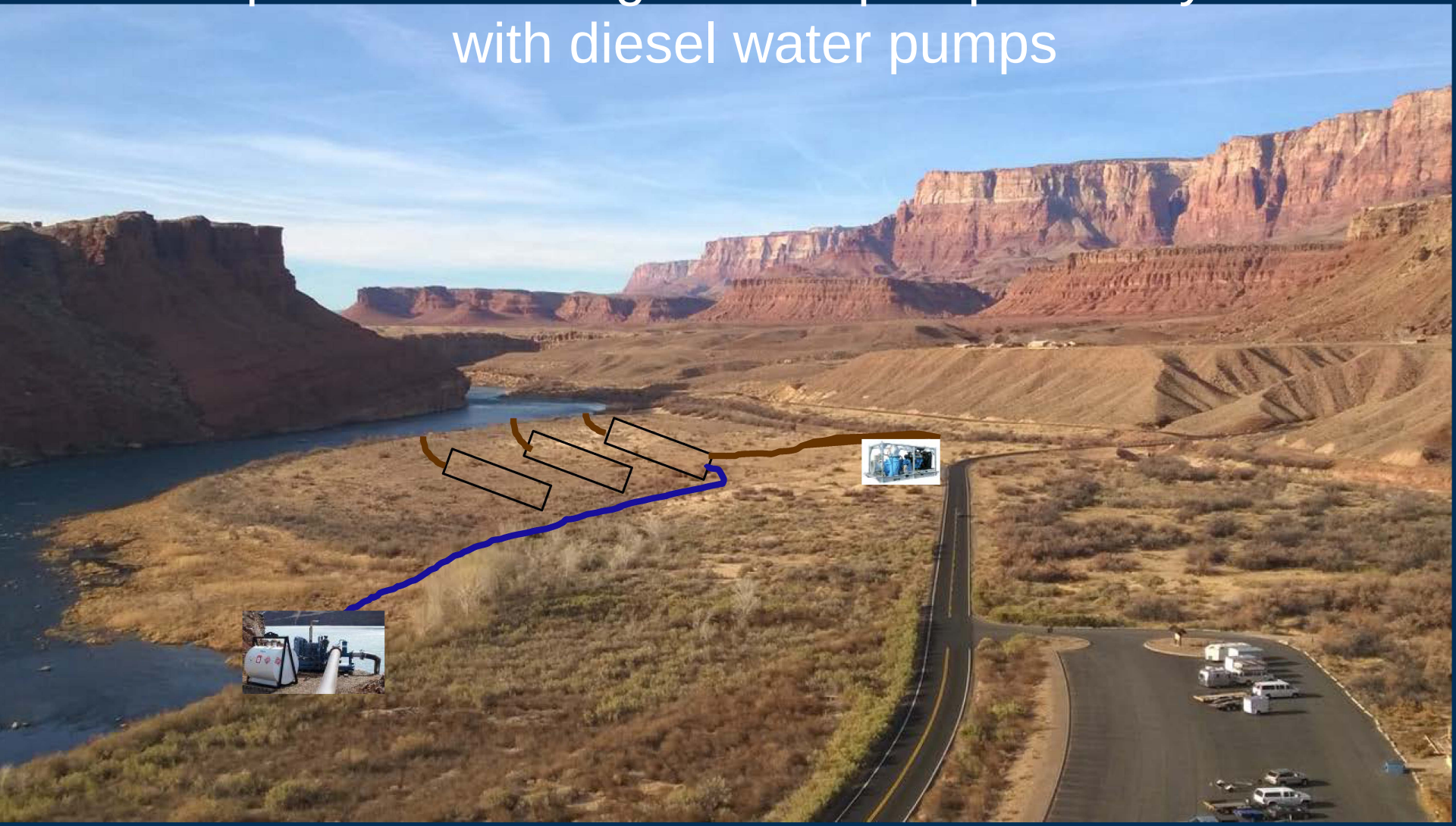
# How about some small scale turbidity manipulation Experiments using a small pump back system with diesel water pumps



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# Example: Sediment Retention Basin


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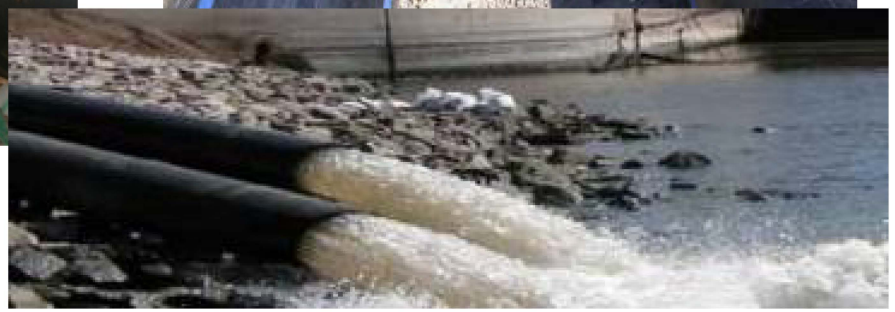
# Rental equipment to experiment ?

# Doesn’t need to look like this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# But if it looked like this – it would be way better for native fish

Colorado River near Moab

# Requested Elements

1. Presentation name:
   **Turbidity as a potential tool to constrain Rainbow Trout populations and reduce predation/competition on juvenile humpback chub**

2. Where this work fits in the work plan?
   Project 9.6 in FY 15-17 workplan

3. How this work relates to GCDAMP goals and needs and the LTEMP EIS?
   Goals to manage both a recreational trout fishery and protect native fish downstream

4. When the project started, where is at now, when will it end?
   FY 15-17 project - completed

5. How was the project funded?
   GCDAMP

6. How will the project results be used for GCDAMP management decisions and actions?
   These results indicate methods to manage turbidity to meet fish objectives may need further investigation

7. What adjustments to the project should be considered based on work to date?
   None – project completed

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