Investing in Conservation: Cost-effective adaptive management in the Colorado River Basin
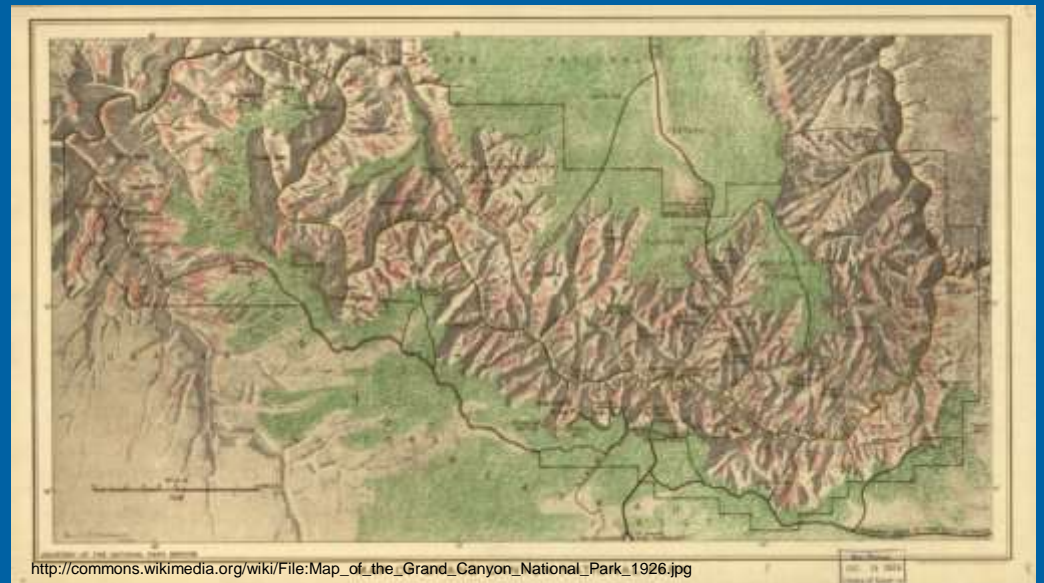
Lucas Bair

Economist

Grand Canyon Monitoring and Research Center

Presentation Outline

- **Overview**
  - **Adaptive management**
  - **Economics of adaptive management**
- **Grand Canyon Monitoring and Research Center example**
  - **Humpback chub**
- **Conclusion**

http://commons.wikimedia.org/wiki/File:Map_of_the_Grand_Canyon_National_Park_1926.jpg

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Adaptive Management

- **Monitoring and research of managed systems**
  - **Passive**
  - **Active**
- **Reducible uncertainty**
  - **Biological**
  - **Physical**
- **Irreducible uncertainty**
  - **Hydrologic**

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science for a changing world
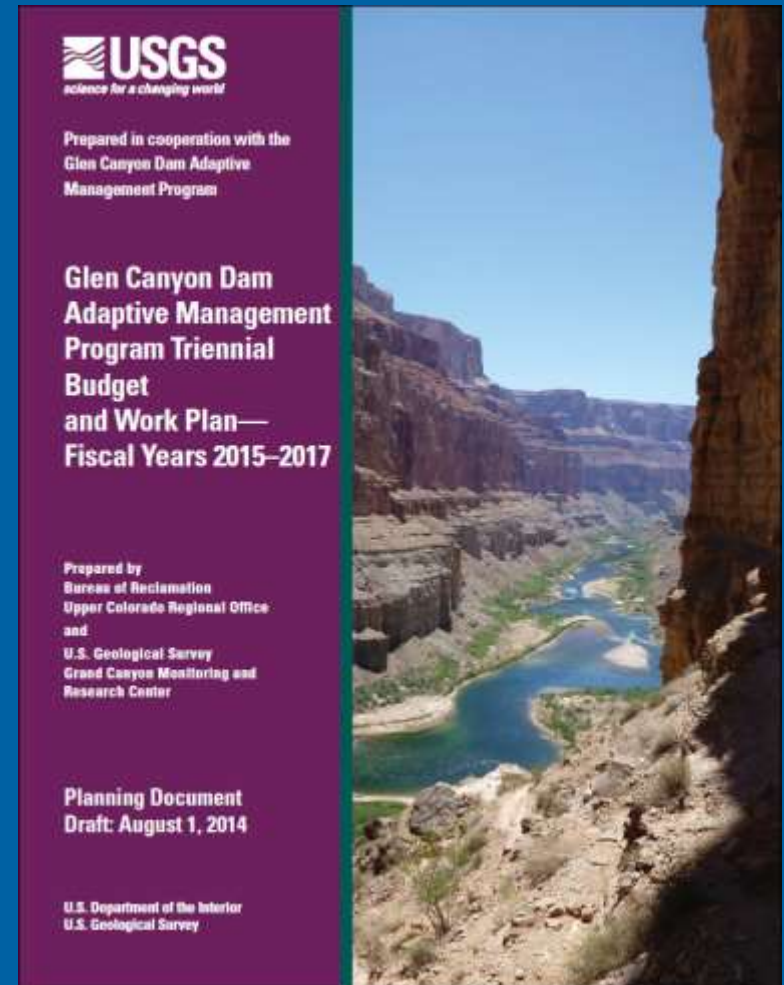
Prepared in cooperation with the
Glen Canyon Dam Adaptive
Management Program

**Glen Canyon Dam
Adaptive Management
Program Triennial
Budget
and Work Plan—
Fiscal Years 2015–2017**

Prepared by
Bureau of Reclamation
Upper Colorado Regional Office
and
U.S. Geological Survey
Grand Canyon Monitoring and
Research Center

**Planning Document
Draft: August 1, 2014**

U.S. Department of the Interior
U.S. Geological Survey

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Economics of Resource Management

- **Value associated with resource outcomes**
- **Management actions and associated costs**
- **Net value of outcome (benefit – cost)**

S. Thybony
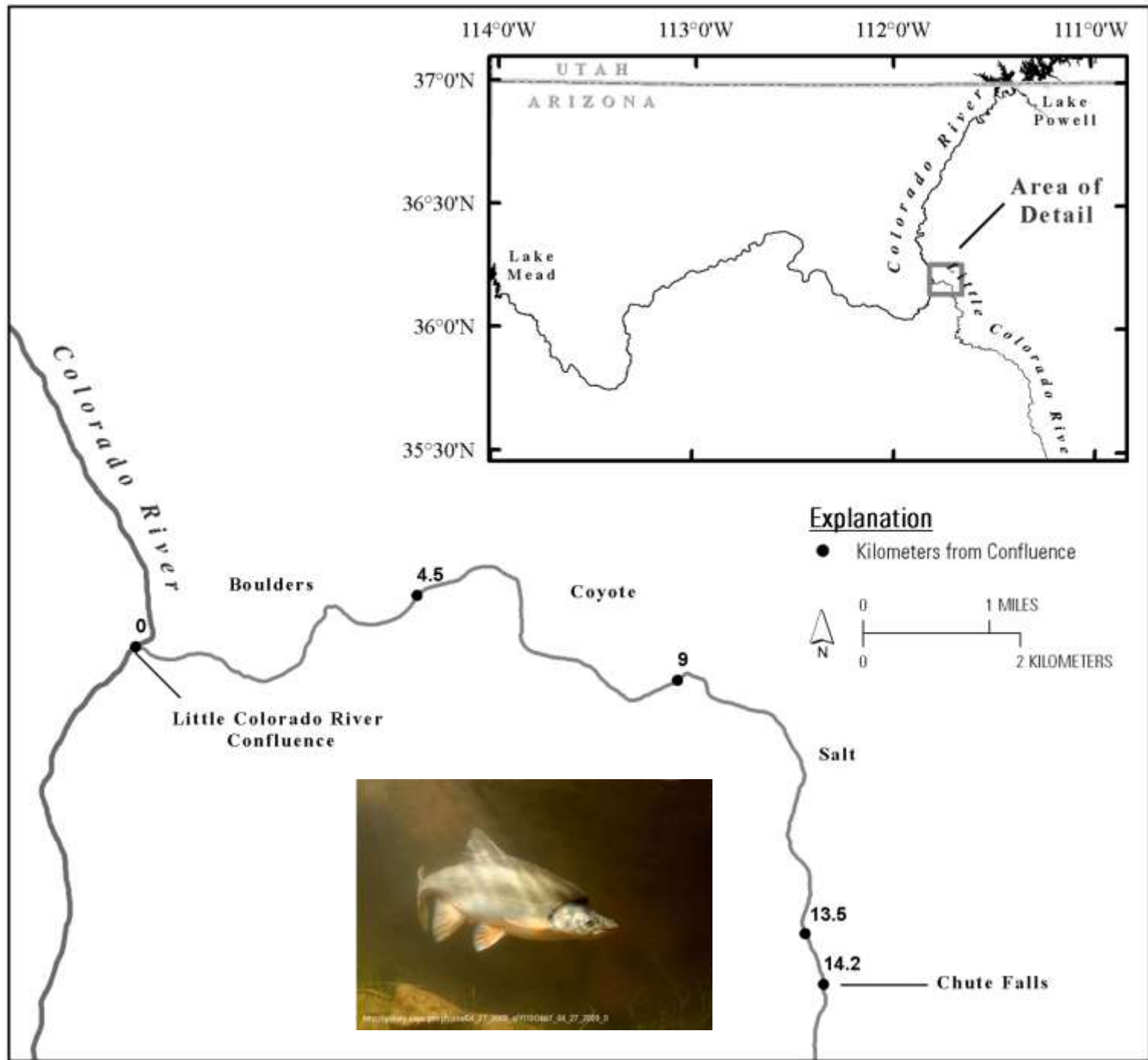
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Economics of Adaptive Management

- **Hypotheses about resource outcomes**
- **Expected net value of outcomes**
- **Updating hypotheses**
  - **Value of information**
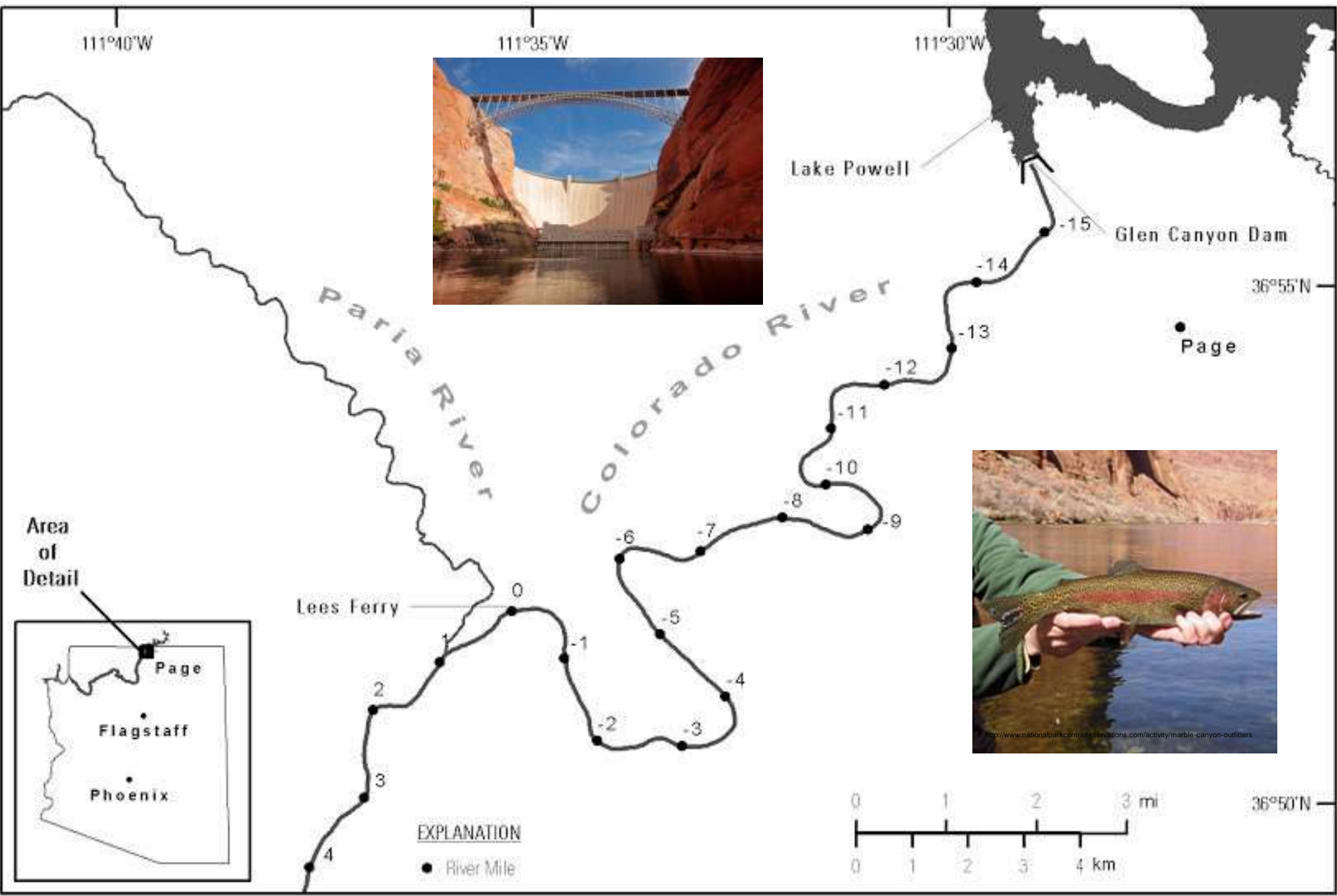 - **Opportunity cost of information**

http://www.nps.gov/grca/naturescience/hfe.htm

http://www.gcmrc.gov/research_areas/humpback_chub/humpback_chub_default.aspx

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Grand Canyon Monitoring and Research Center

Explanation

● Kilometers from Confluence

111°40'W   111°35'W   111°30'W

Paria River

Colorado River

Lake Powell

-15   Glen Canyon Dam

-14

36°55'N

-13

-12

Page

-11

-10

-8   -9

-6   -7

0
Lees Ferry

-5

1   -1

-4

2

-2   -3

3   36°50'N

4

Area of Detail

Page
Flagstaff
Phoenix

EXPLANATION
● River Mile

0   1   2   3 mi

0   1   2   3   4 km

http://www.nationalparkcentralreservations.com/activity/marble-canyon-outfitters

Humpback Chub (*Gila cypha*)*

- **Hypotheses of humpback chub outcomes**
  - **Healthy population (species recovery)**
  - **Unhealthy population**
- **Resource outcomes (economic benefits)**
  - **Healthy humpback chub ($20 annually)**
  - **Unhealthy humpback chub ($0 annually)**
- **Management Actions (economic costs)**
  - **Temperature control ($2 annualized)**
  - **Predation control ($0.50 annually)**
  - **Combination of temperature and predation control**

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*hypothetical example

Investment in Conservation*

Management Strategies (control)	Hypotheses			Expected Value
	Temperature (Weight 33%)	Predation (Weight 33%)	Combination (Weight 33%)	
Temperature	$18.00	-$2.00	-$2.00	**$4.67**
Predation	-$0.50	$19.50	-$0.50	**$6.17**
Combination	$17.50	$17.50	$17.50	**$17.50**

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*hypothetical example

Investment in Conservation and the Value of Information*

Management Strategies (control)	Hypotheses			
	Temperature (Weight 33%)	Predation (Weight 33%)	Combination (Weight 33%)	**Expected Value**
Temperature	$18.00	-$2.00	-$2.00	**$4.67**
Predation	-$0.50	$19.50	-$0.50	**$6.17**
Combination	$17.50	$17.50	$17.50	**$17.50**
Value of Information	**$0.50**	**$2.00**	**$0.00**	**$0.83**

*hypothetical example

Integrating Economic, Political and Social Goals*

- **Economic passive use value**
- **Endangered Species Act**
- **Stakeholder goals and objectives**

*hypothetical example

Population Modeling

- **Rainbow trout population dynamics**
  - **Rainbow trout recruitment**
    - **Function of flow**
  - **Rainbow trout movement**
    - **Function of recruitment**
- **Humpback chub population dynamics**
 - **Temperature and RBT at the Little Colorado River**

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Hydrologic Uncertainty

- **Lake Powell**
  - **Temperature**
  - **Flow**
- **Paria River**
  - **Sediment**
- **Little Colorado River**
- **Nonnative species**
  - **Lake Mead**

http://upload.wikimedia.org/wikipedia/commons/2/2e/Lake_Powell_Map.jpg

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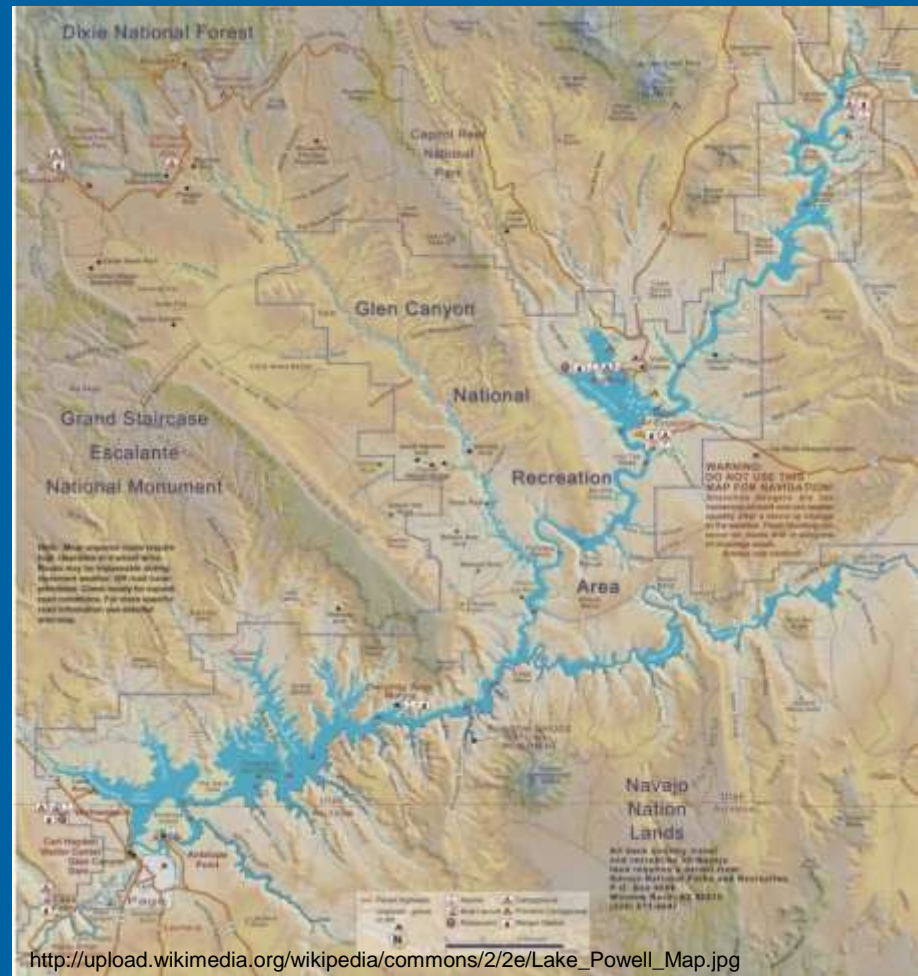
Bioeconomic Model

- **Cost-effectiveness analysis**
  - **Rainbow trout management**
  - **Appropriate effort considering management and cost perspectives**
  - **Spatial and temporal problem**
- **Humpback chub recovery**
  - **Population threshold**
- **Irreducible uncertainty**
  - **Scenario planning**
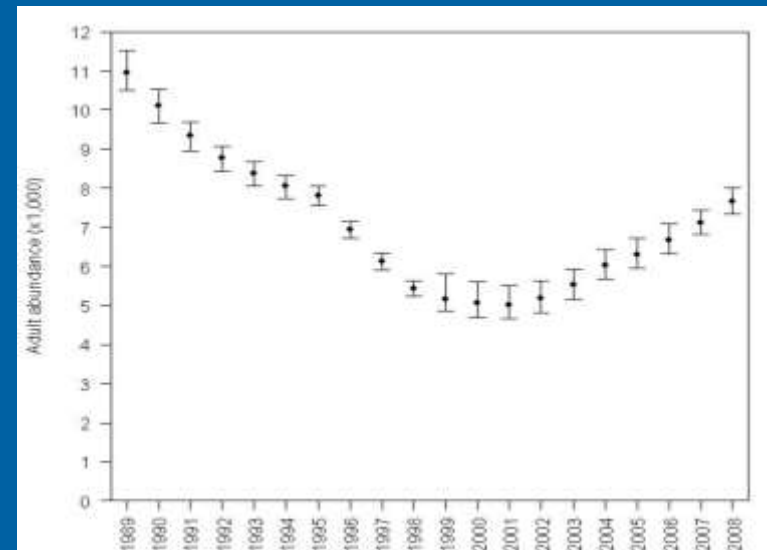
Conclusion

- **Traditional approaches to economic analysis are deficient in the face of significant uncertainty**

- **The expected value of management actions and the value of information are important elements of an adaptive management program**

- **Decision analysis framework should be guided by institutional context, availability of predictive models and level of uncertainty**

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Questions?