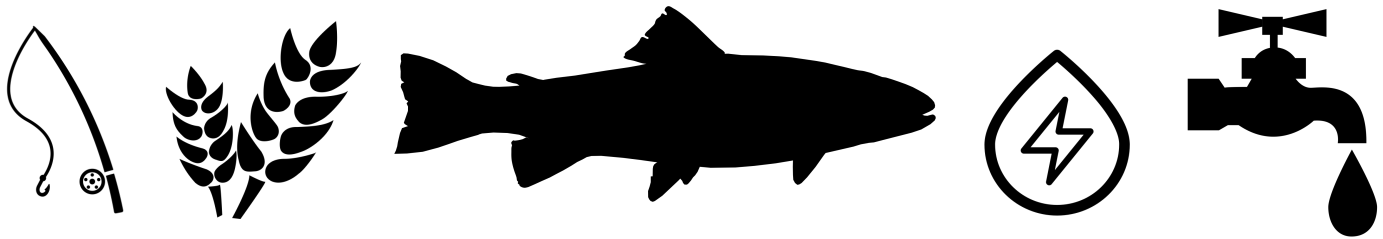
Linking ecohydrology and social systems to support multi-stakeholder management of the lower Henry's Fork river

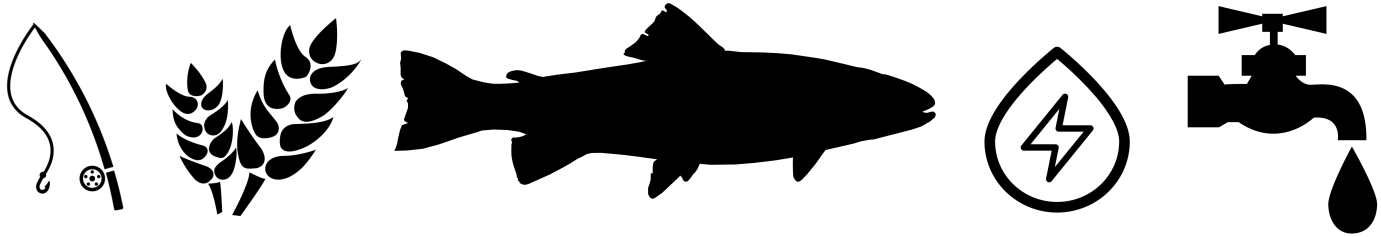
Christina Morrisett, Ph.D. Student

Henry's Fork Watershed Council Meeting || April 9, 2019

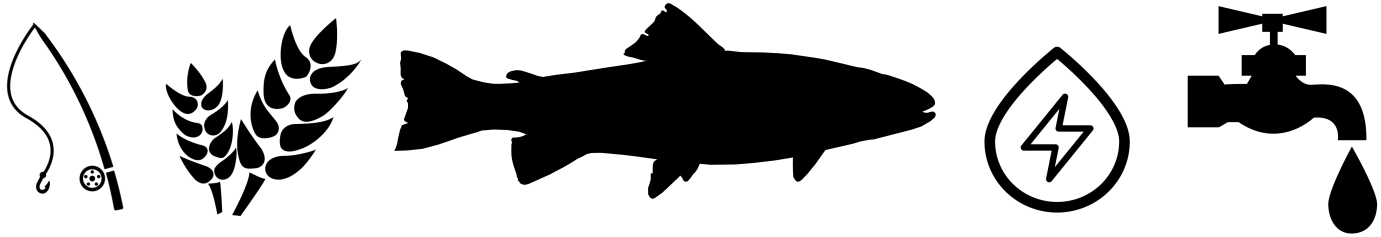
NSF Grant No. 1633756



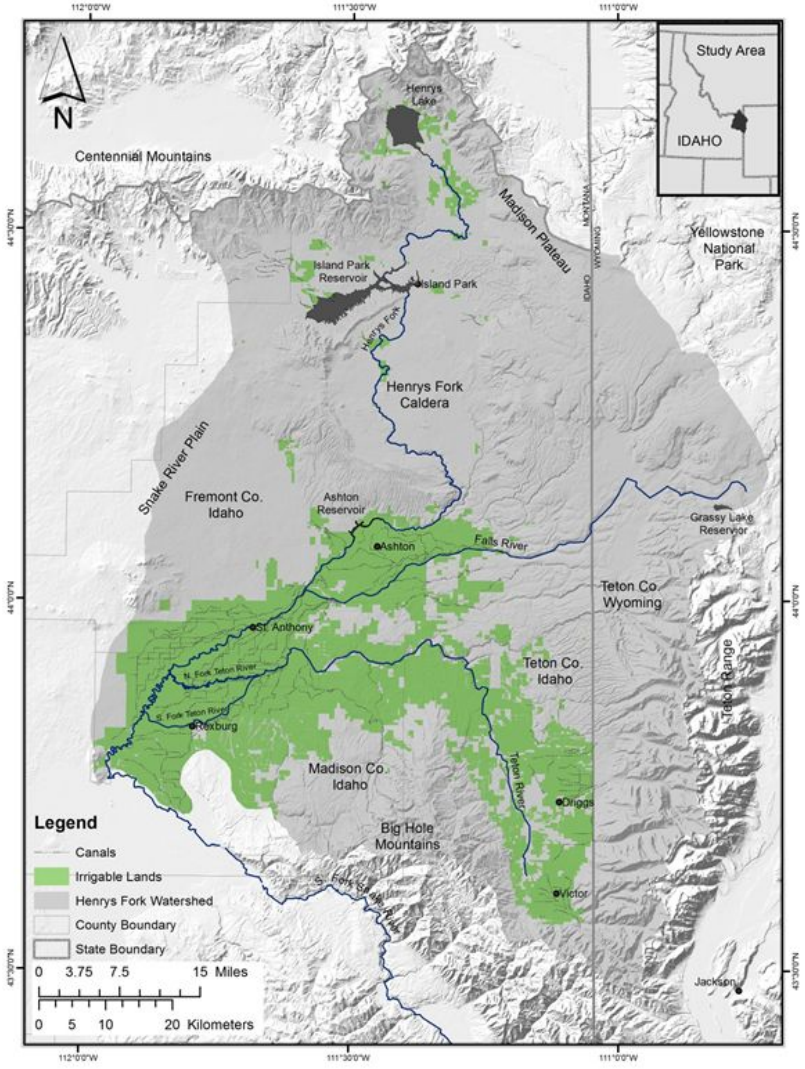
Water availability is less predictable

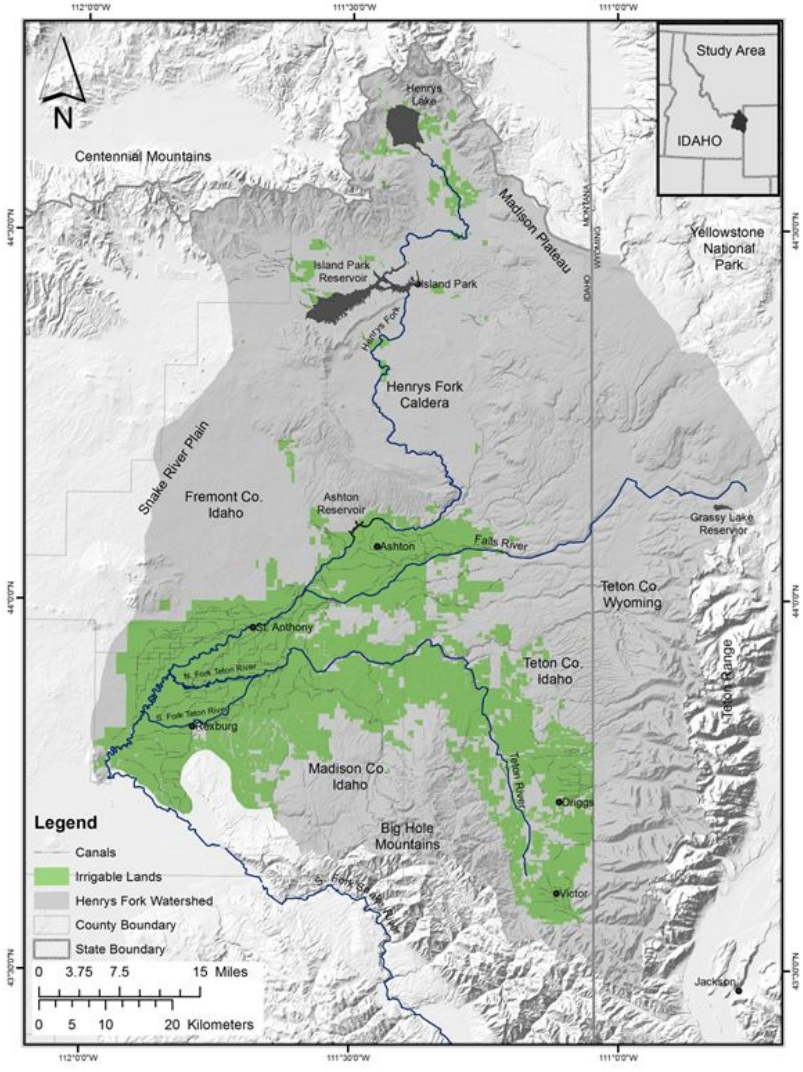


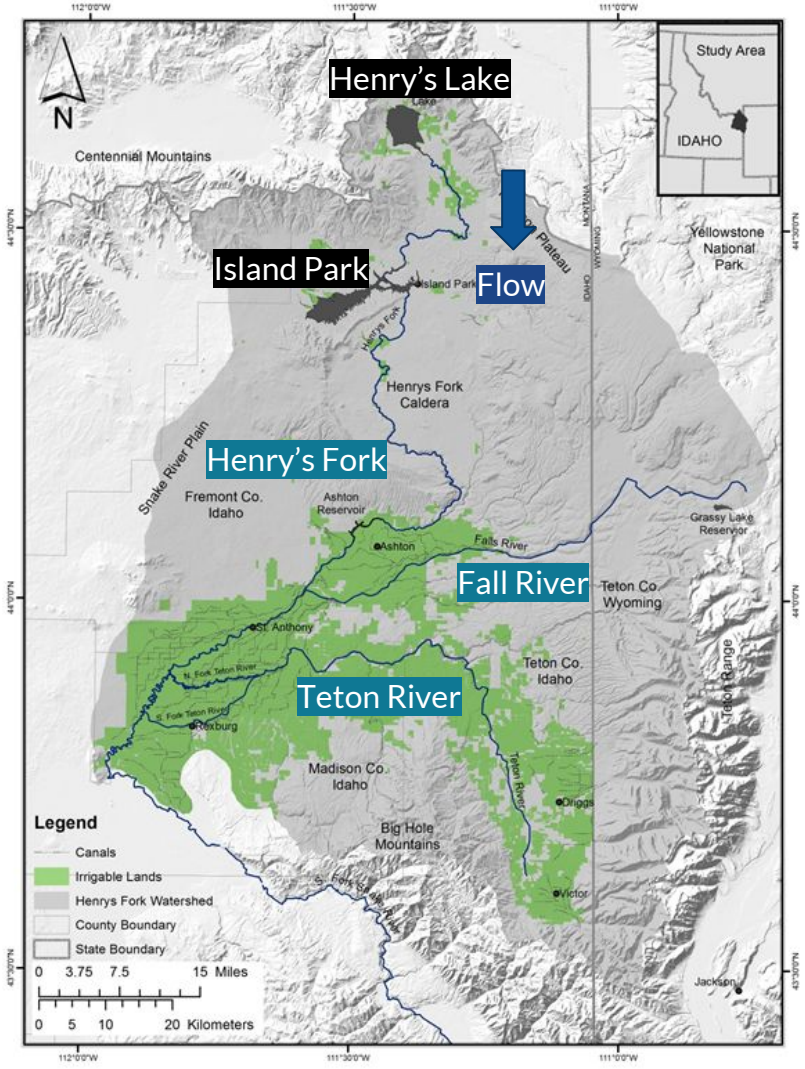
Water availability is less predictable

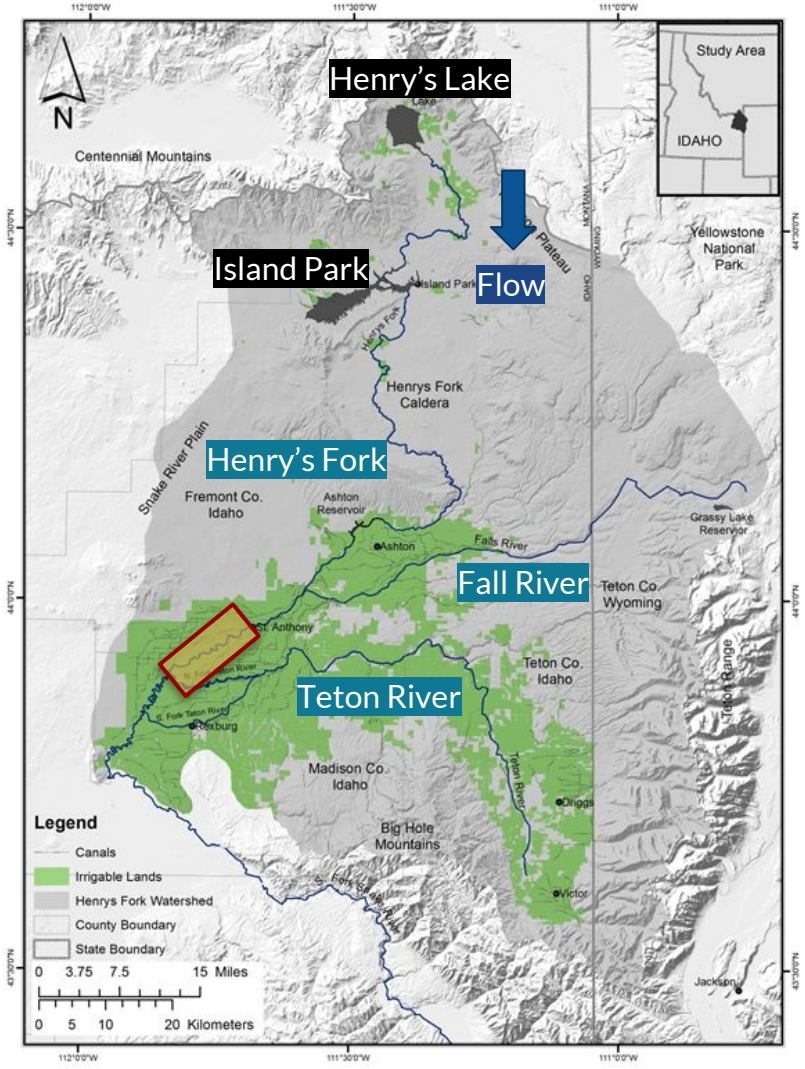


How can we adapt our water management strategies?

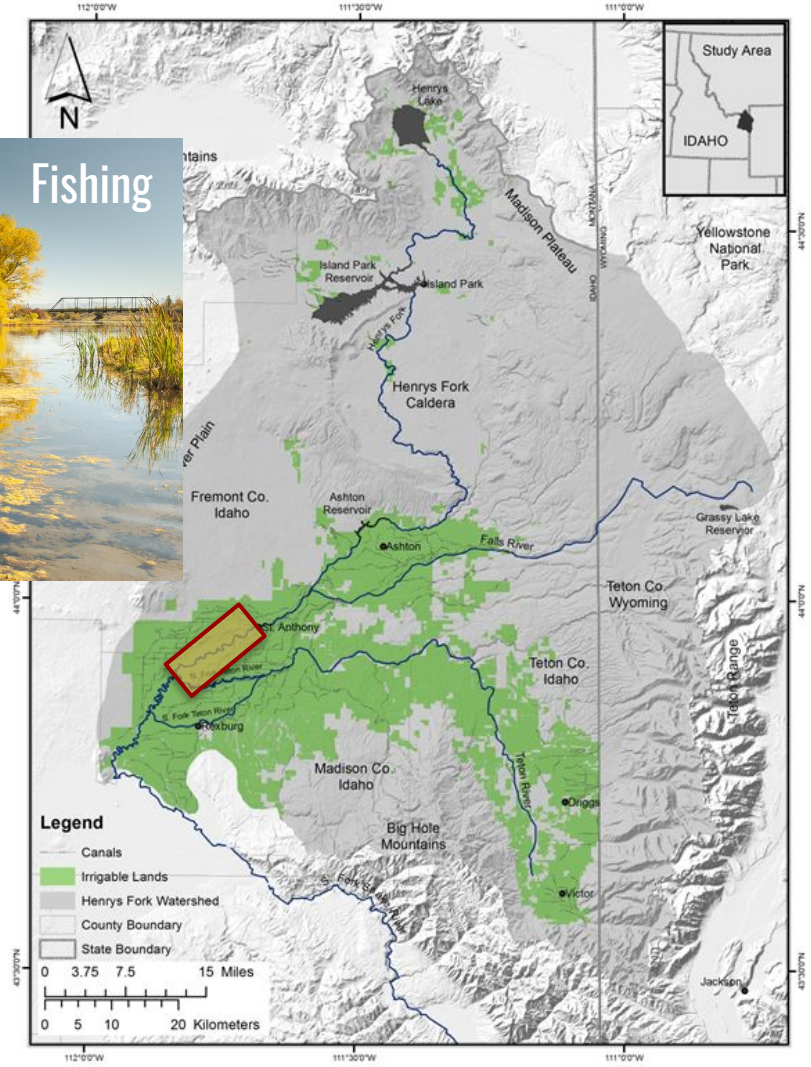

N
Study Area
IDAHO
Henrys Lake
Centennial Mountains
Madison Plateau
Yellowstone National Park
Island Park Reservoir
Island Park
Henrys Fork
Henrys Fork Caldera
Snake River Plain
Fremont Co. Idaho
Ashton Reservoir
Ashton
Falls River
Grassy Lake Reservoir
Teton Co. Wyoming
St. Anthony
N. Fork Teton River
S. Fork Teton River
Rexburg
Teton Co. Idaho
Teton Range
Madison Co. Idaho
Teton River
Driggs
Big Hole Mountains
Victor
Jackson
Legend
Canals
Irrigable Lands
Henrys Fork Watershed
County Boundary
State Boundary
0 3.75 7.5 15 Miles
0 5 10 20 Kilometers
112°0'0"W
111°30'0"W
111°0'0"W
44°30'0"N
44°0'0"N
43°30'0"N


112°0'0"W
111°30'0"W
111°0'0"W
44°30'0"N
44°0'0"N
43°30'0"N
N
Study Area
IDAHO
Centennial Mountains
Henrys Lake
Madison Plateau
Yellowstone National Park
Island Park Reservoir
Island Park
Henrys Fork
Henrys Fork Caldera
Snake River Plain
Fremont Co. Idaho
Ashton Reservoir
Ashton
Falls River
Grassy Lake Reservoir
Teton Co. Wyoming
St. Anthony
N. Fork Teton River
S. Fork Teton River
Rexburg
Teton Co. Idaho
Teton Range
Madison Co. Idaho
Teton River
Driggs
Big Hole Mountains
Victor
Jackson
Legend
Canals
Irrigable Lands
Henrys Fork Watershed
County Boundary
State Boundary
0 3.75 7.5 15 Miles
0 5 10 20 Kilometers


Henry's Lake
Island Park
Flow
Henry's Fork
Fall River
Teton River
Centennial Mountains
Henrys Fork Caldera
Snake River Plain
Fremont Co. Idaho
Ashton Reservoir
Ashton
Falls River
St. Anthony
N. Fork Teton River
S. Fork Teton River
Rexburg
Madison Co. Idaho
Big Hole Mountains
Teton River
Driggs
Victor
Teton Co. Idaho
Teton Co. Wyoming
Teton Range
Yellowstone National Park
Grassy Lake Reservoir
Jackson
Study Area
IDAHO
N
Legend
Canals
Irrigable Lands
Henrys Fork Watershed
County Boundary
State Boundary
0 3.75 7.5 15 Miles
0 5 10 20 Kilometers

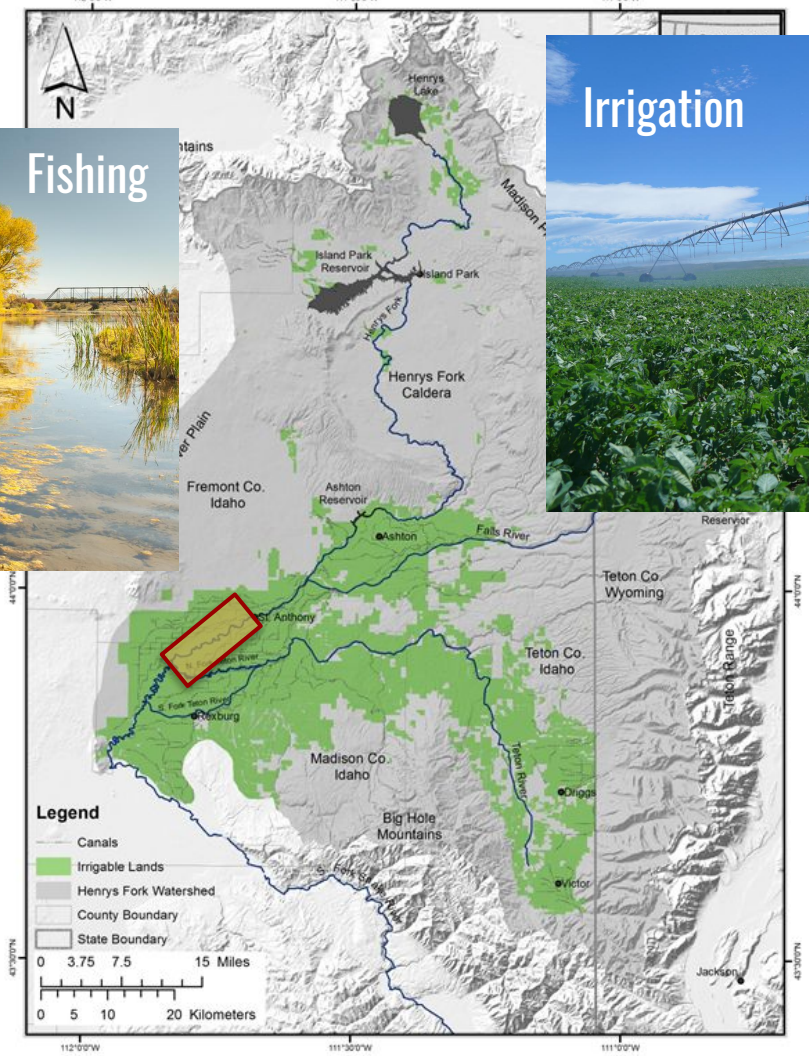

Henry's Lake
Island Park
Flow
Henry's Fork
Fall River
Teton River
Centennial Mountains
Henrys Fork Caldera
Snake River Plain
Fremont Co. Idaho
Ashton Reservoir
Ashton
Falls River
Grassy Lake Reservoir
Teton Co. Wyoming
St. Anthony
Teton Co. Idaho
Rexburg
Madison Co. Idaho
Big Hole Mountains
Driggs
Victor
Jackson
Yellowstone National Park
Teton Range
Study Area
IDAHO
N
Legend
Canals
Irrigable Lands
Henrys Fork Watershed
County Boundary
State Boundary
0 3.75 7.5 15 Miles
0 5 10 20 Kilometers


Fishing


Study Area
IDAHO
N
Henrys Lake
Madison Plateau
Yellowstone National Park
Island Park Reservoir
Island Park
Henrys Fork
Henrys Fork Caldera
Fremont Co. Idaho
Ashton Reservoir
Ashton
Falls River
Grassy Lake Reservoir
Teton Co. Wyoming
St. Anthony
Teton Co. Idaho
Teton Range
Rexburg
Madison Co. Idaho
Teton River
Driggs
Big Hole Mountains
Victor
Jackson
Legend
Canals
Irrigable Lands
Henrys Fork Watershed
County Boundary
State Boundary
0 3.75 7.5 15 Miles
0 5 10 20 Kilometers


Fishing


Irrigation

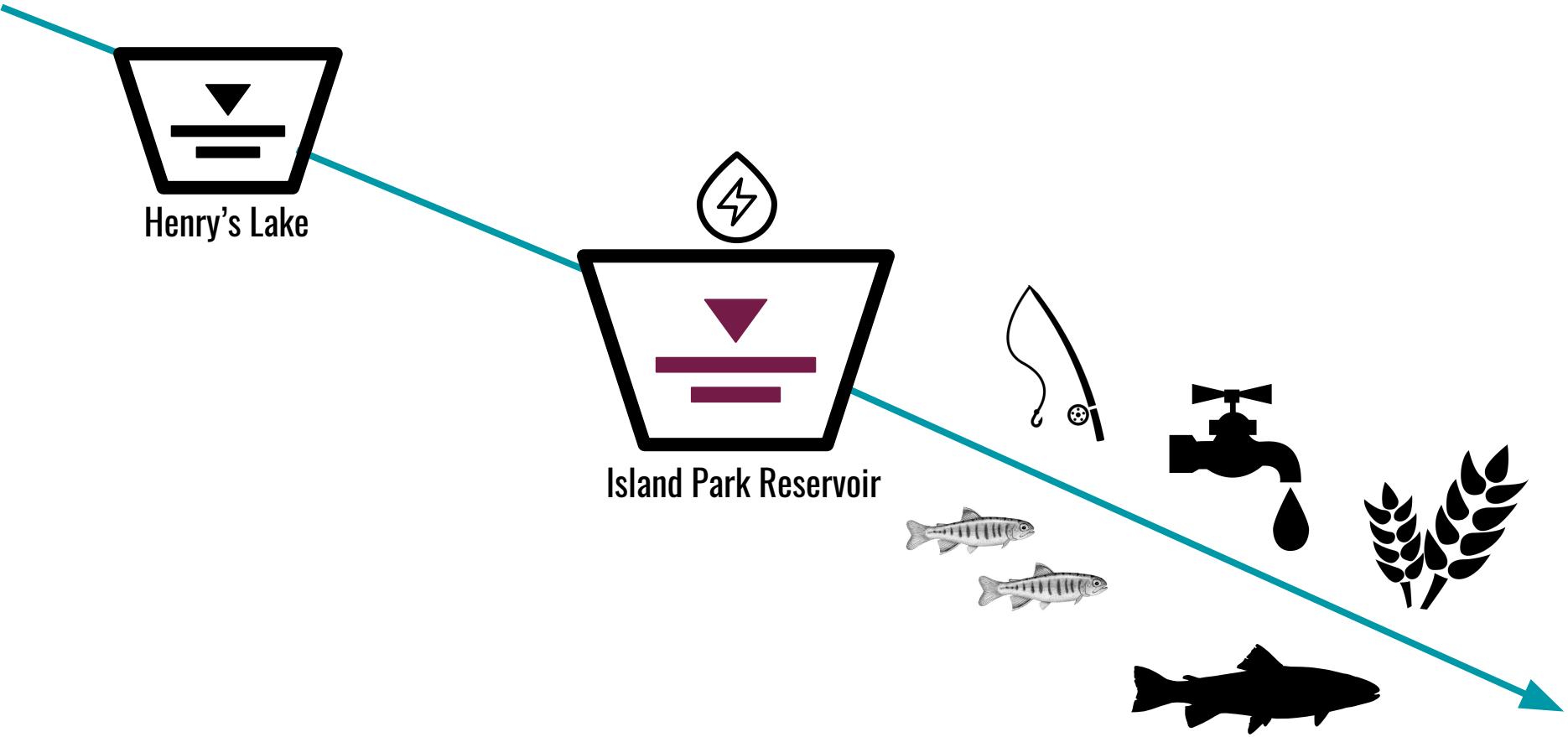

N
Henrys Lake
Island Park Reservoir
Island Park
Henrys Fork
Henrys Fork Caldera
Fremont Co. Idaho
Ashton Reservoir
Ashton
Falls River
Reservoir
Teton Co. Wyoming
St. Anthony
Teton Co. Idaho
Rexburg
Madison Co. Idaho
Teton Range
Teton River
Driggs
Big Hole Mountains
Victor
Jackson
Legend
Canals
Irrigable Lands
Henrys Fork Watershed
County Boundary
State Boundary
0 3.75 7.5 15 Miles
0 5 10 20 Kilometers

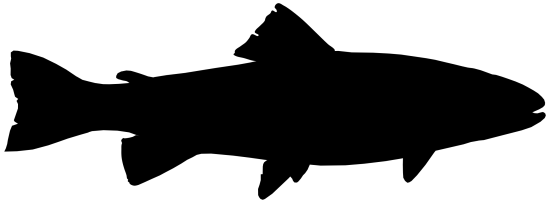

Fishing


Irrigation


Groundwater

N
Henrys Lake
Island Park Reservoir
Island Park
Henrys Fork
Henrys Fork Caldera
Fremont Co.
Idaho
Ashton Reservoir
Ashton
Falls River
Reservoir
St. Anthony
Rexburg
Madison Co.
Idaho
Legend
Canals
Irrigable Lands
Henrys Fork Watershed
County Boundary
State Boundary
0 3.75 7.5 15 Miles
0 5 10 20 Kilometers


Henry's Lake
Island Park Reservoir

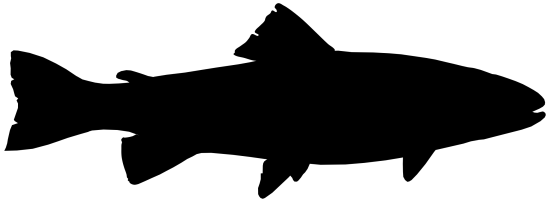


How much water do TROUT need?

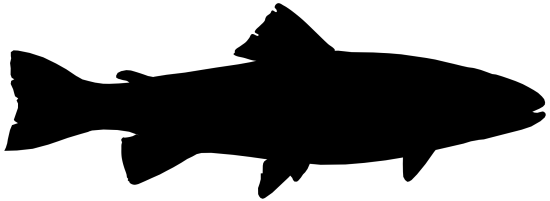
What role does GROUNDWATER play?

How can we OPTIMIZE for multiple stakeholders?

How can we ADAPT?

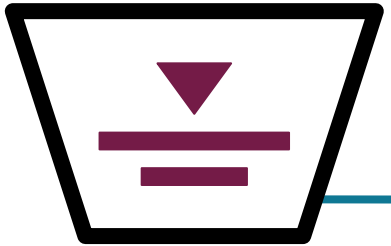


How much water do TROUT need?

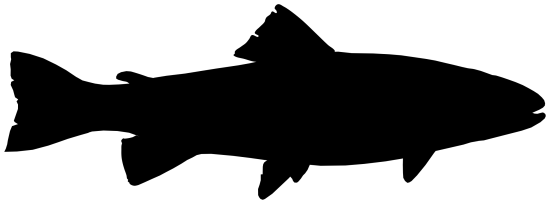


How much water do TROUT need?

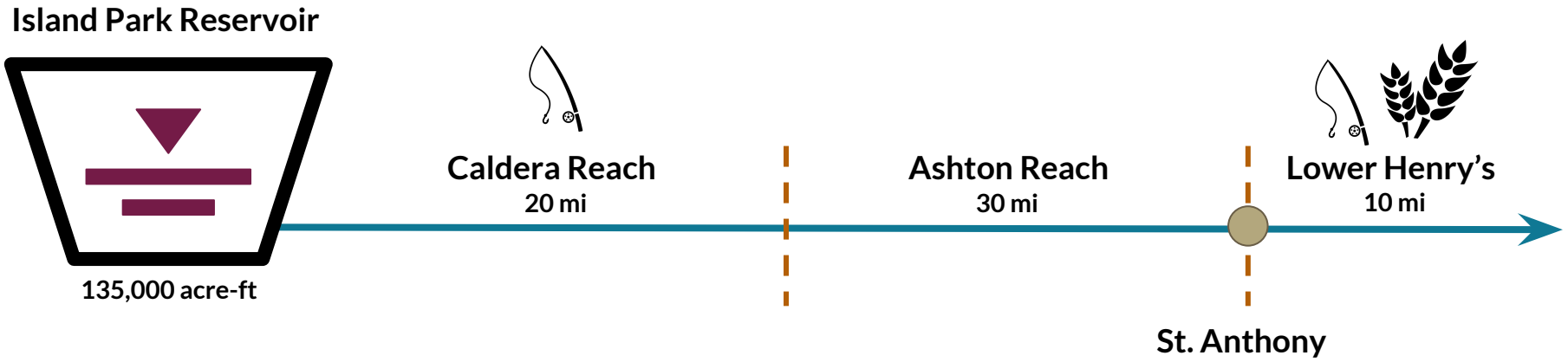
Island Park Reservoir

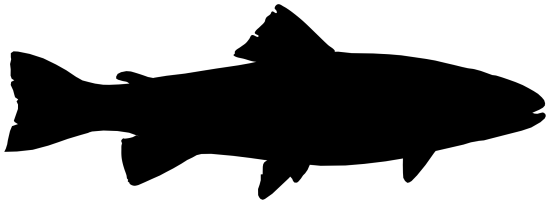


135,000 acre-ft

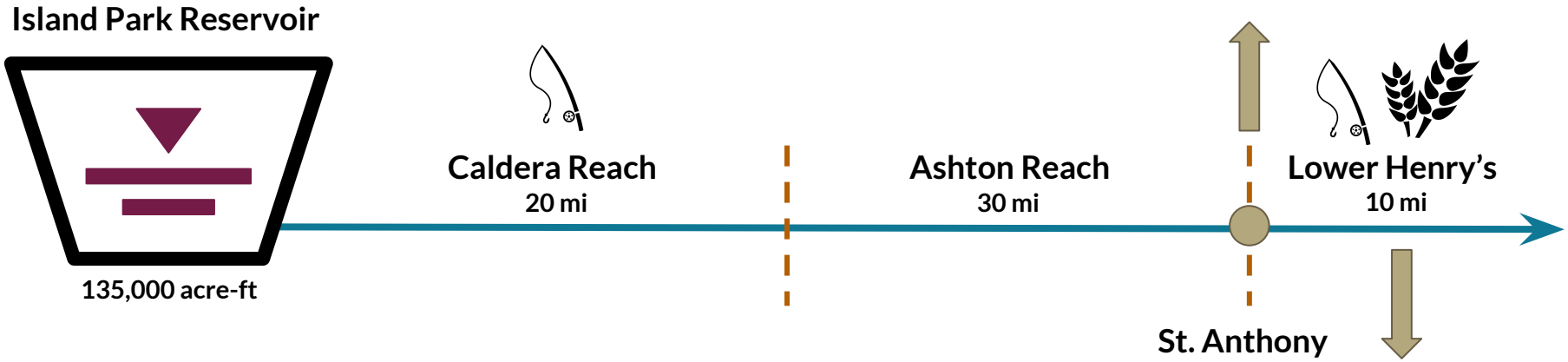


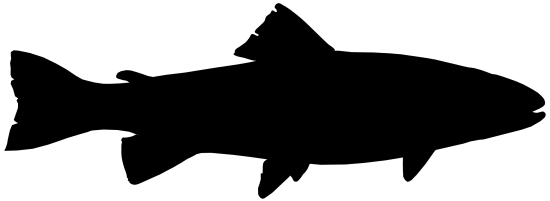
How much water do TROUT need?



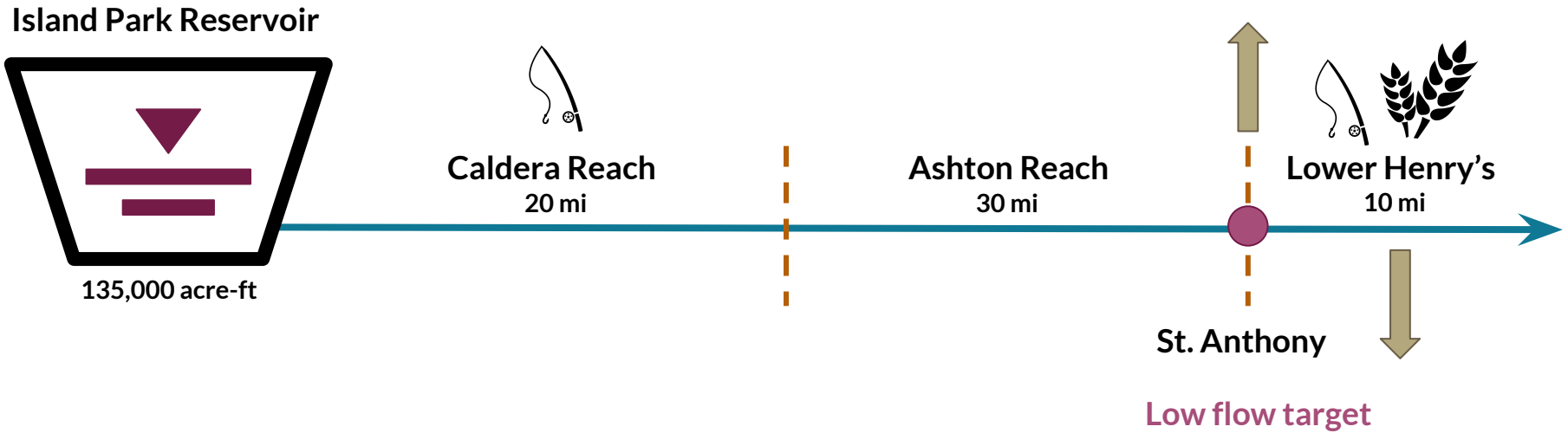


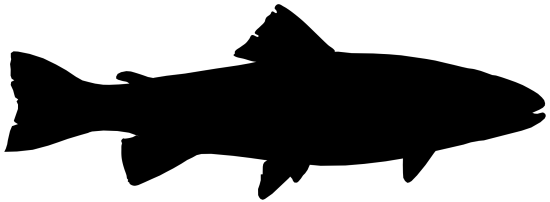
How much water do TROUT need?



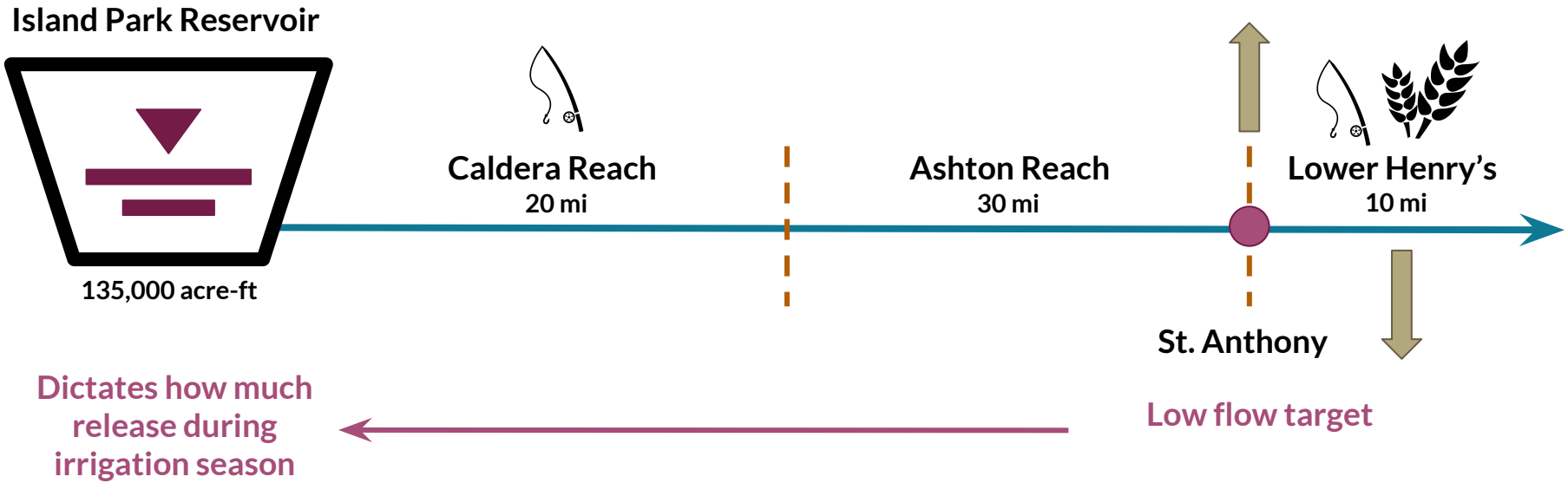


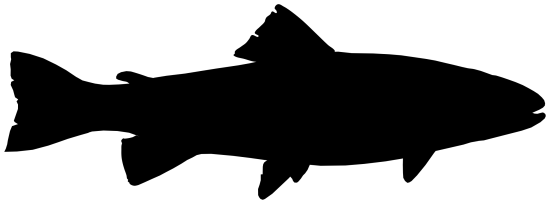
How much water do TROUT need?



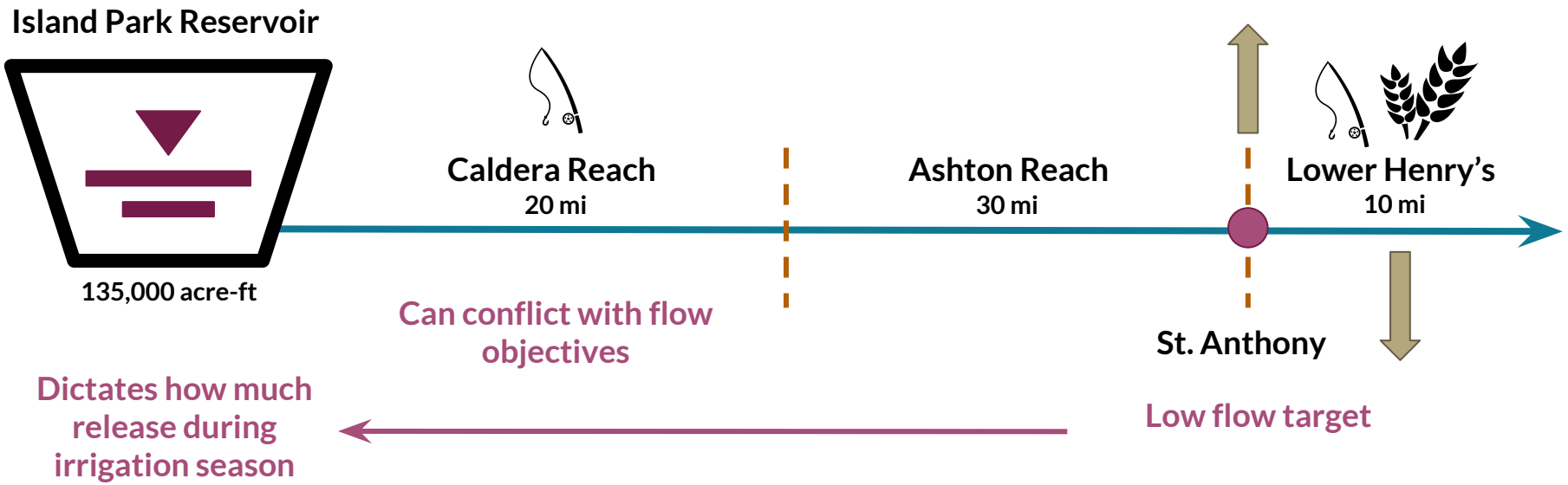


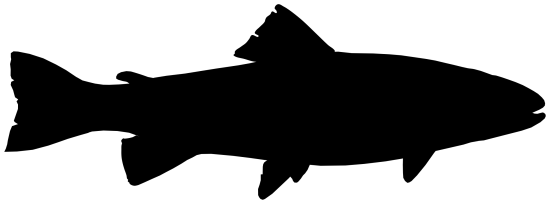
How much water do TROUT need?





How much water do TROUT need?





How much water do TROUT need?

Island Park Reservoir

135,000 acre-ft

Caldera Reach
20 mi

Ashton Reach
30 mi

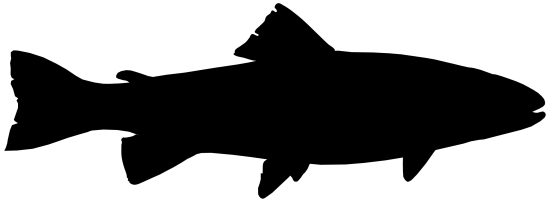
Lower Henry's
10 mi

St. Anthony

Can conflict with flow objectives

Low flow target

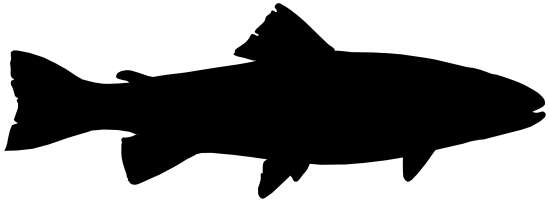
Dictates how much release during irrigation season



How much water do TROUT need?

Objectives:

- Identify streamflow and water temperature attributes that may limit trout habitat
- Inform low flow target for lower Henry's Fork



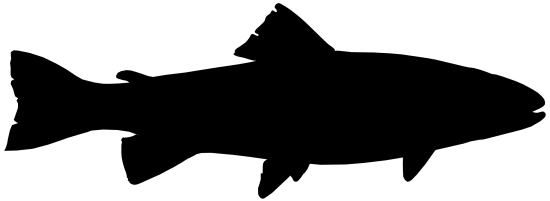
How much water do TROUT need?

Objectives:

- Identify streamflow and water temperature attributes that may limit trout habitat
- Inform low flow target for lower Henry's Fork

Approach:

- Hydraulic habitat surveys at different streamflows during irrigation season

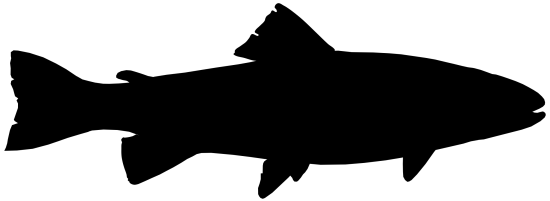


How much water do TROUT need?

St. Anthony

Parker

North Fork
Teton River



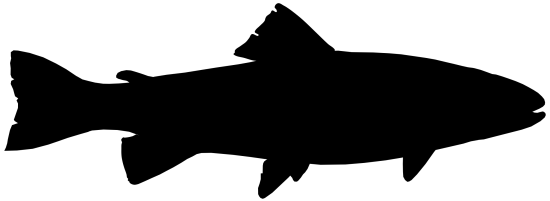
How much water do TROUT need?

Acoustic
Doppler
Current
Profiler

St. Anthony

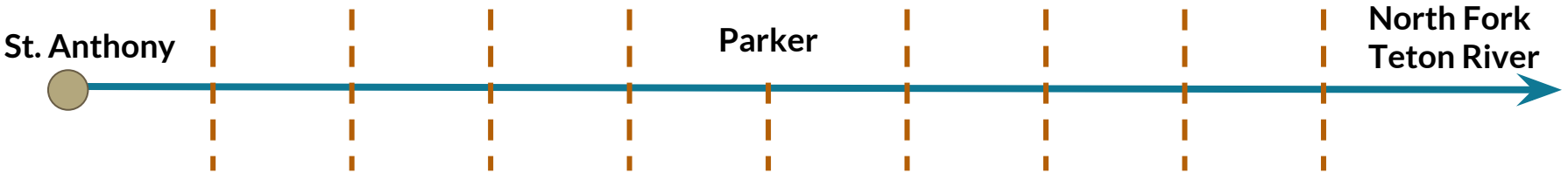
Parker

North Fork
Teton River

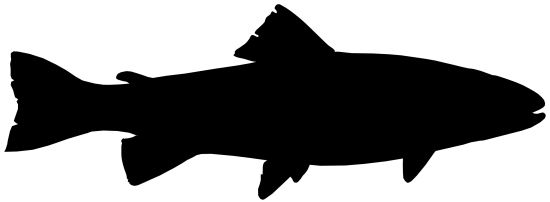


How much water do TROUT need?

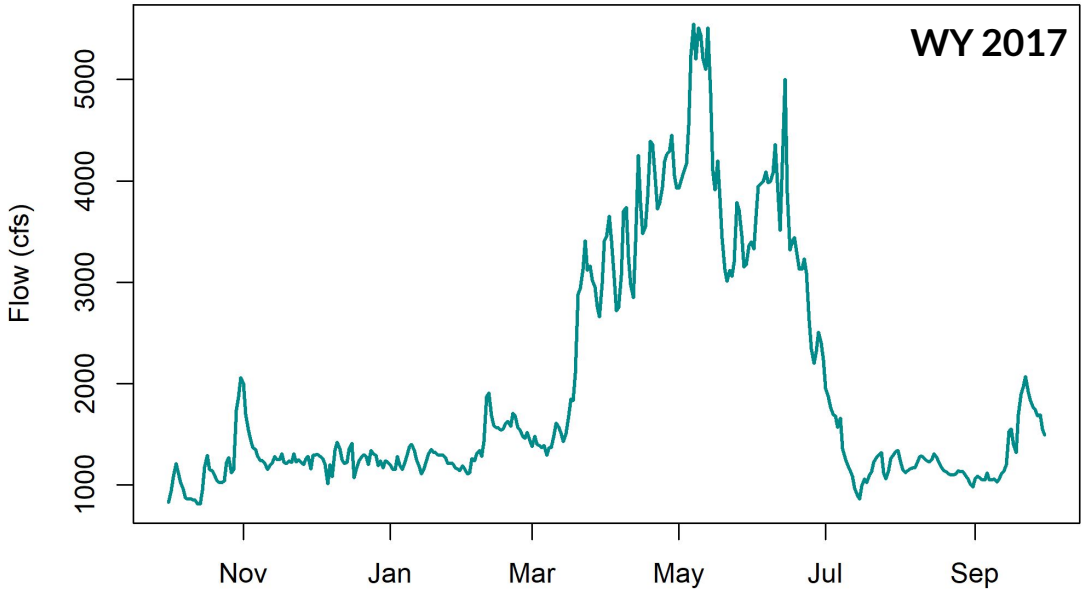
Acoustic
Doppler
Current
Profiler

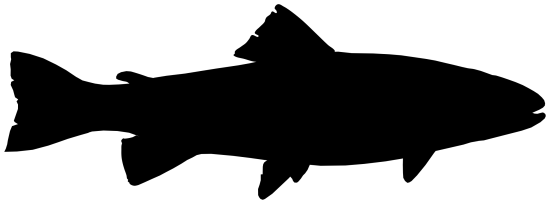


Collect hydraulic habitat data at different streamflows during irrigation season

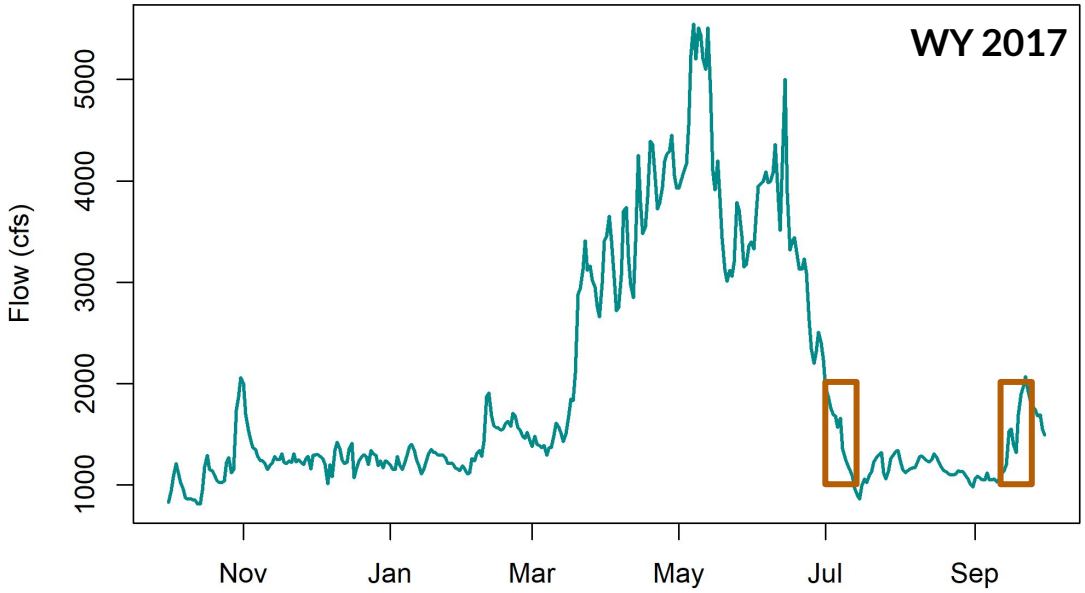


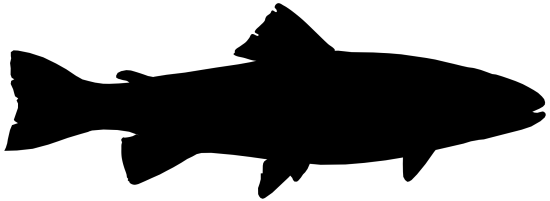
How much water do TROUT need?



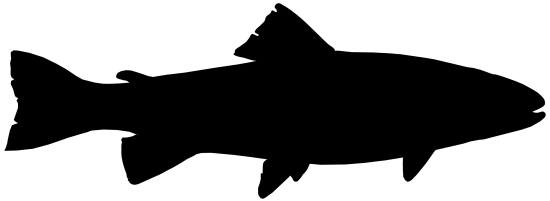


How much water do TROUT need?

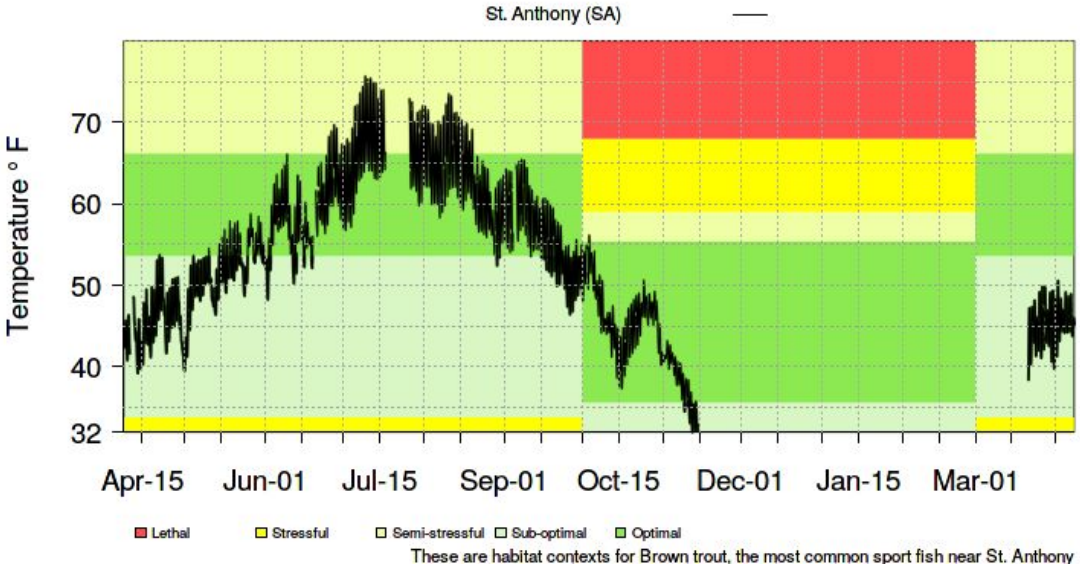


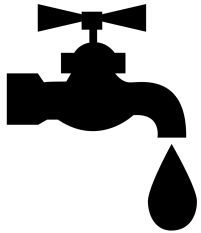


How much water do TROUT need?

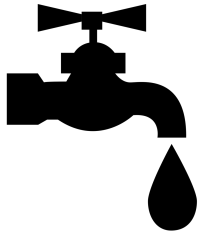


How much water do TROUT need?

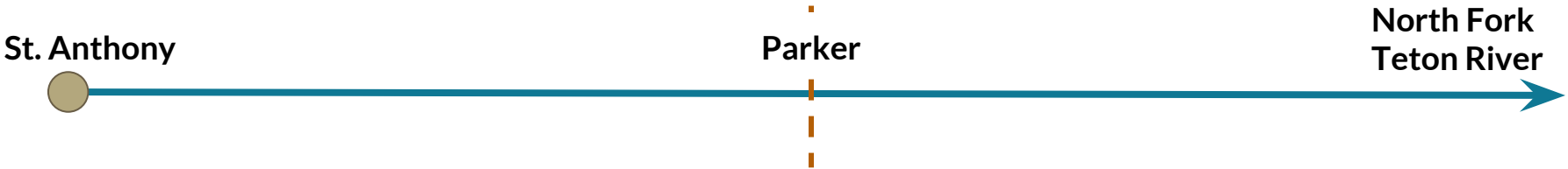


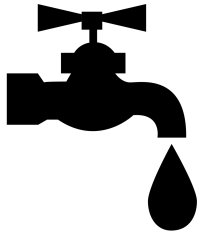


What role does GROUNDWATER play?

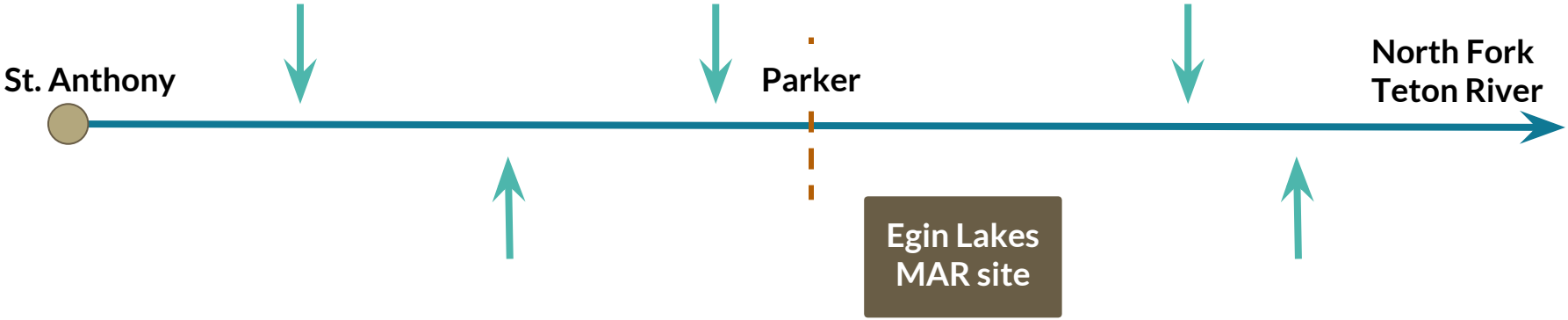


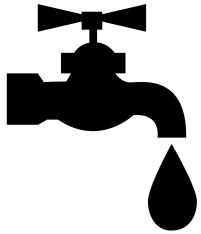
What role does GROUNDWATER play?



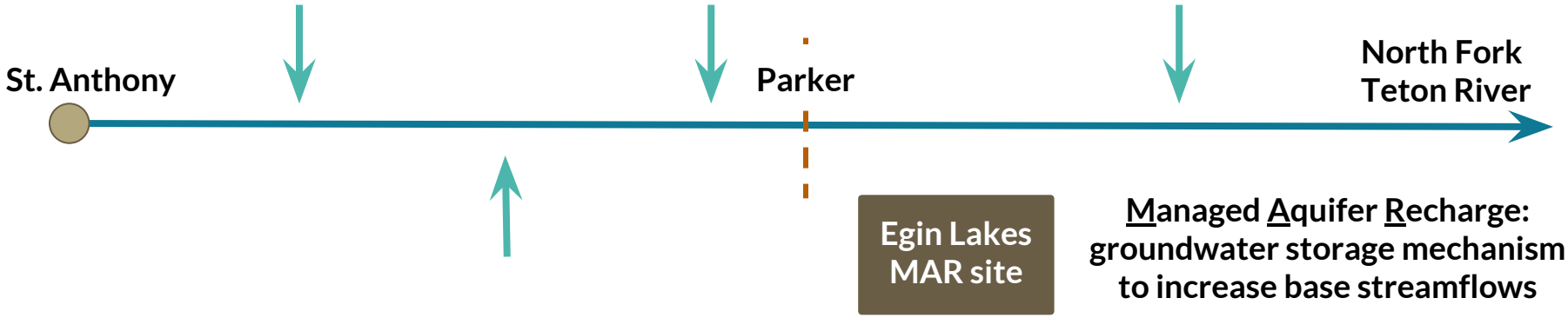


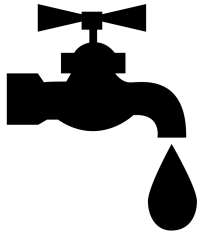
What role does GROUNDWATER play?





What role does GROUNDWATER play?





What role does GROUNDWATER play?

When shallow aquifer level drops, base streamflows drop

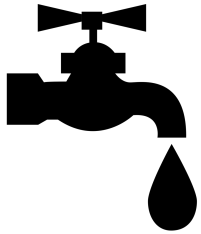
St. Anthony

Parker

North Fork Teton River

Egin Lakes MAR site

Managed Aquifer Recharge: groundwater storage mechanism to increase base streamflows



What role does GROUNDWATER play?

When shallow aquifer level drops, base streamflows drop

St. Anthony

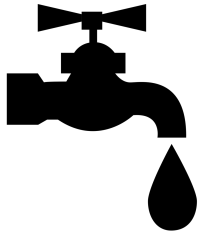
Parker

North Fork Teton River

When streamflow drops, river temperature rises

Egin Lakes MAR site

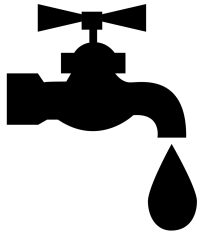
Managed Aquifer Recharge: groundwater storage mechanism to increase base streamflows



What role does GROUNDWATER play?

Objectives:

- Quantify MAR contributions to stream habitat
- Identify optimal MAR strategy
- Inform low flow target for lower Henry's Fork



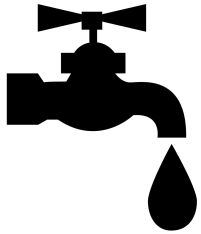
What role does GROUNDWATER play?

Objectives:

- Quantify MAR contributions to stream habitat
- Identify optimal MAR strategy
- Inform low flow target for lower Henry's Fork

Approach:

- Downscale ESPAM2.1
  - Deploy piezometers
  - Install streamflow gage
  - Weekly temporal scale
- Deploy temperature sensors



What role does GROUNDWATER play?

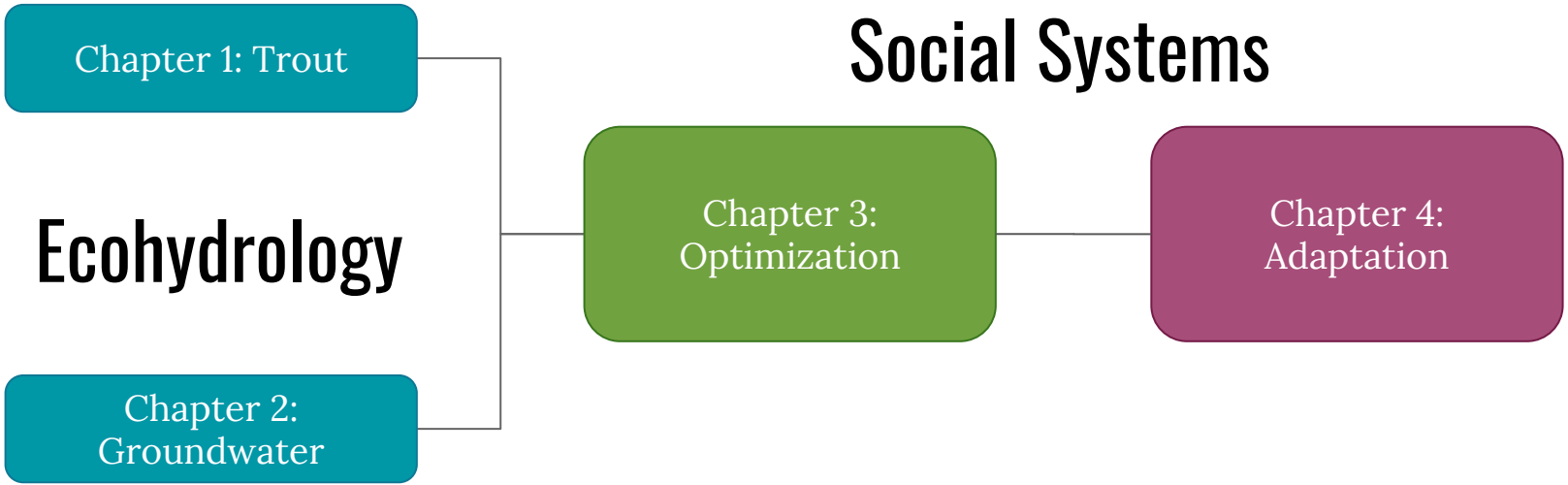
Objectives:

- Quantify MAR contributions to stream habitat
- Identify optimal MAR strategy
- Inform low flow target for lower Henry's Fork

Approach:

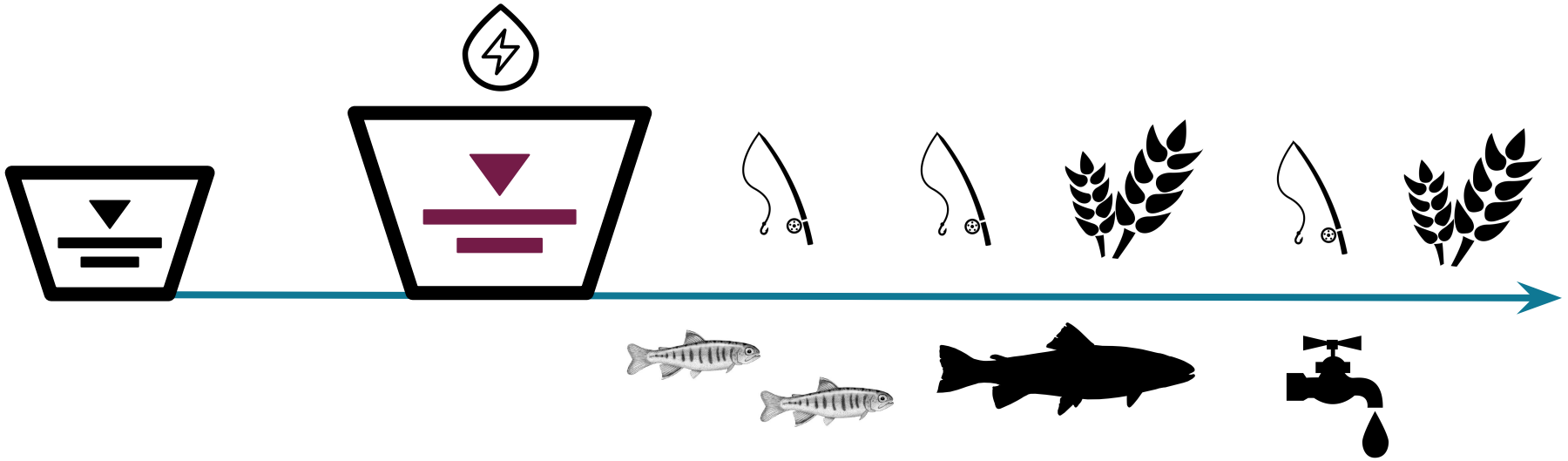
- Downscale ESPAM2.1
  - Deploy piezometers
  - Install streamflow gage
  - Weekly temporal scale
- Deploy temperature sensors

***NOVEL RESEARCH**

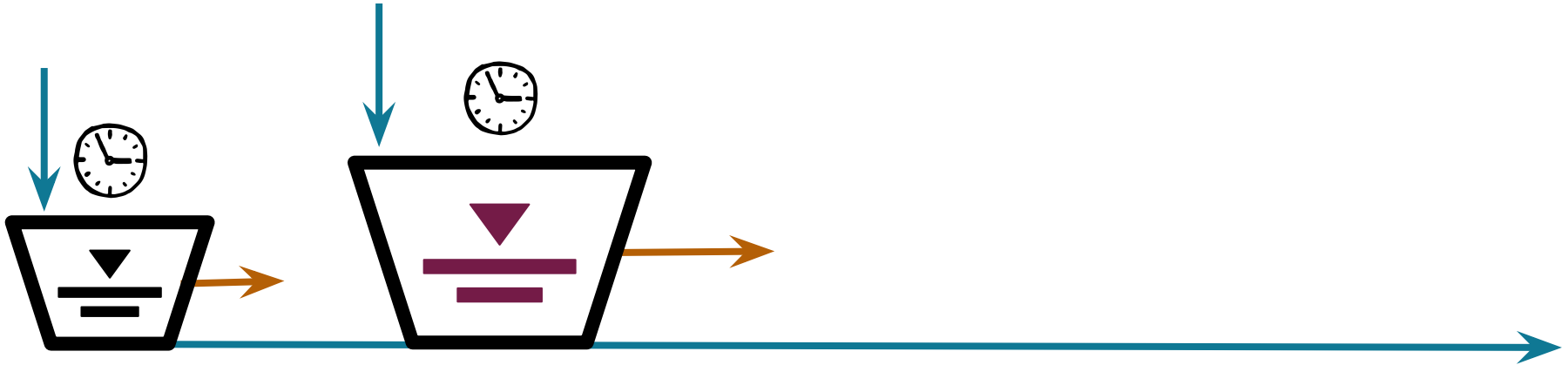

Chapter 1: Trout
Ecohydrology
Chapter 2: Groundwater
Social Systems
Chapter 3: Optimization
Chapter 4: Adaptation

How can we OPTIMIZE for multiple stakeholders?

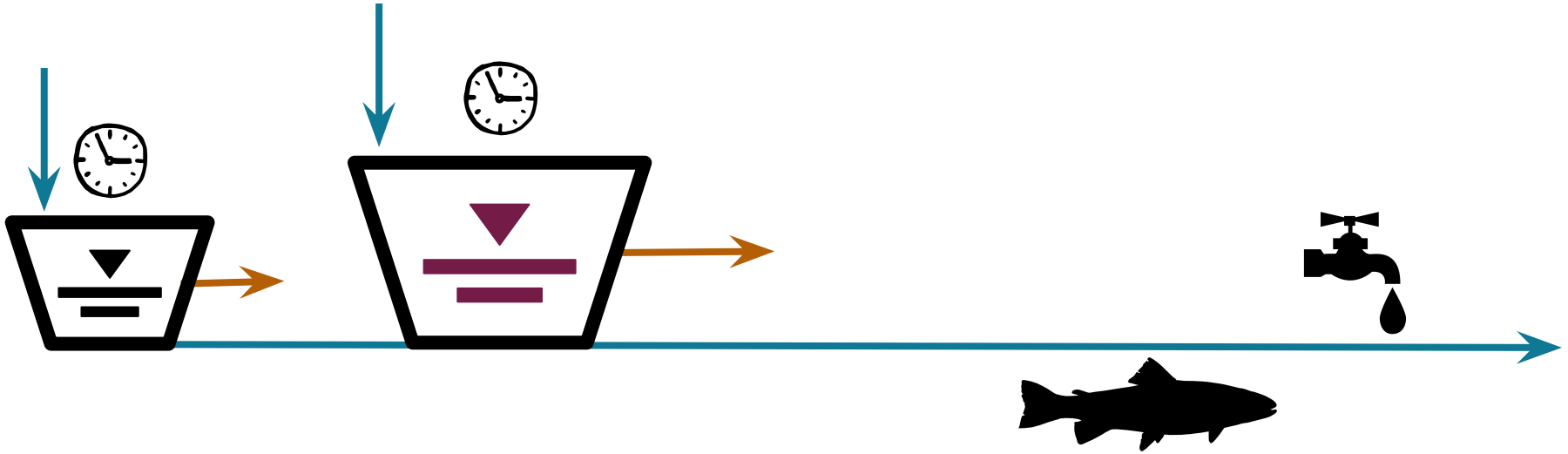
How can we OPTIMIZE for multiple stakeholders?



How can we OPTIMIZE for multiple stakeholders?



How can we OPTIMIZE for multiple stakeholders?



How can we OPTIMIZE for multiple stakeholders?

Objectives:

- In collaboration with DMPC, develop a multiple reservoir optimization model to:
  - identify delivery strategies
  - quantify trade-offs

How can we OPTIMIZE for multiple stakeholders?

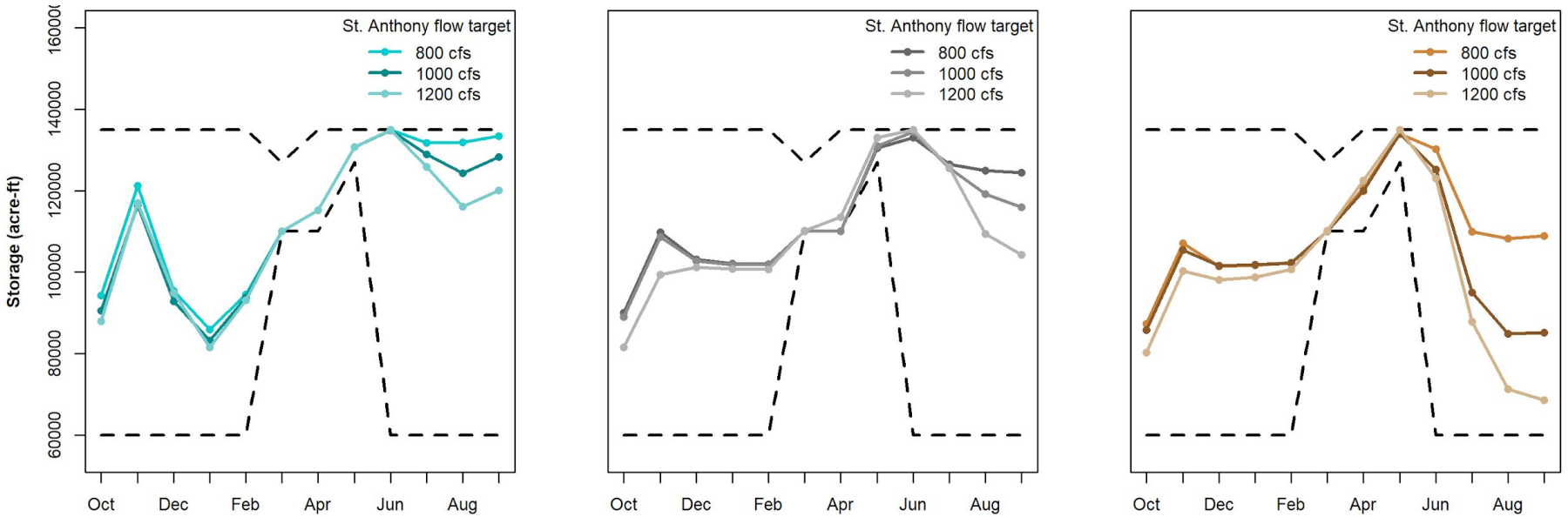
Objectives:

- In collaboration with DMPC, develop a multiple reservoir optimization model to:
  - identify delivery strategies
  - quantify trade-offs

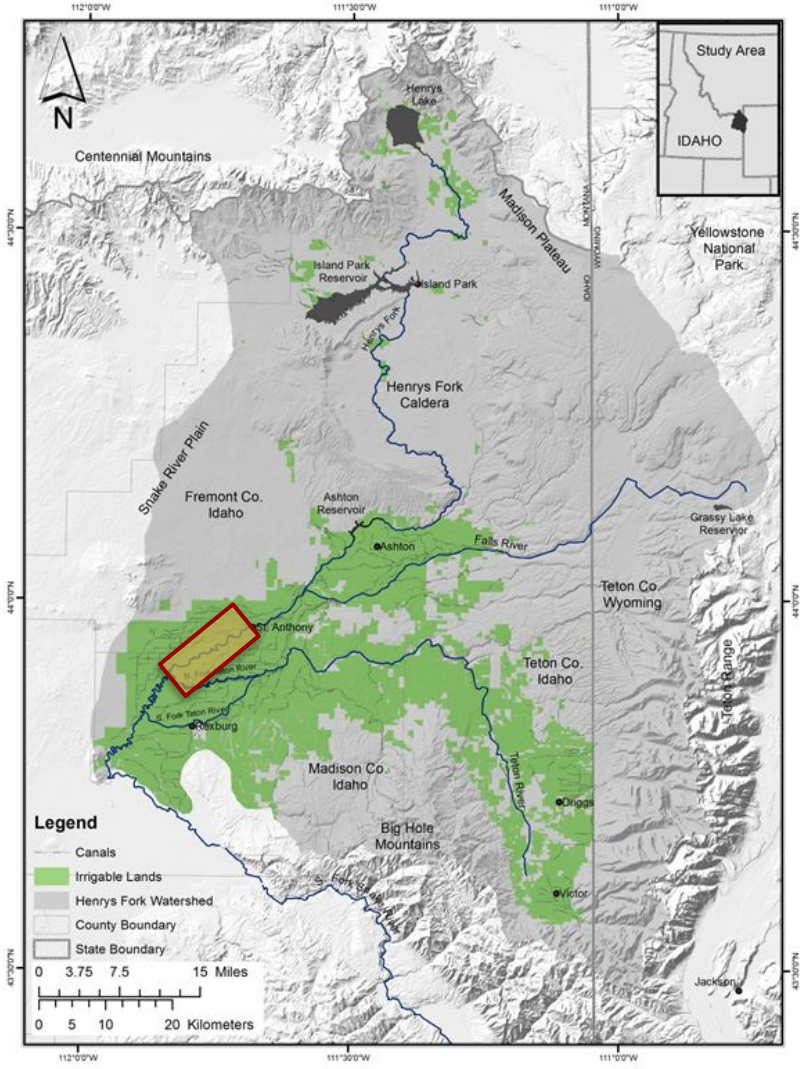
Approach:

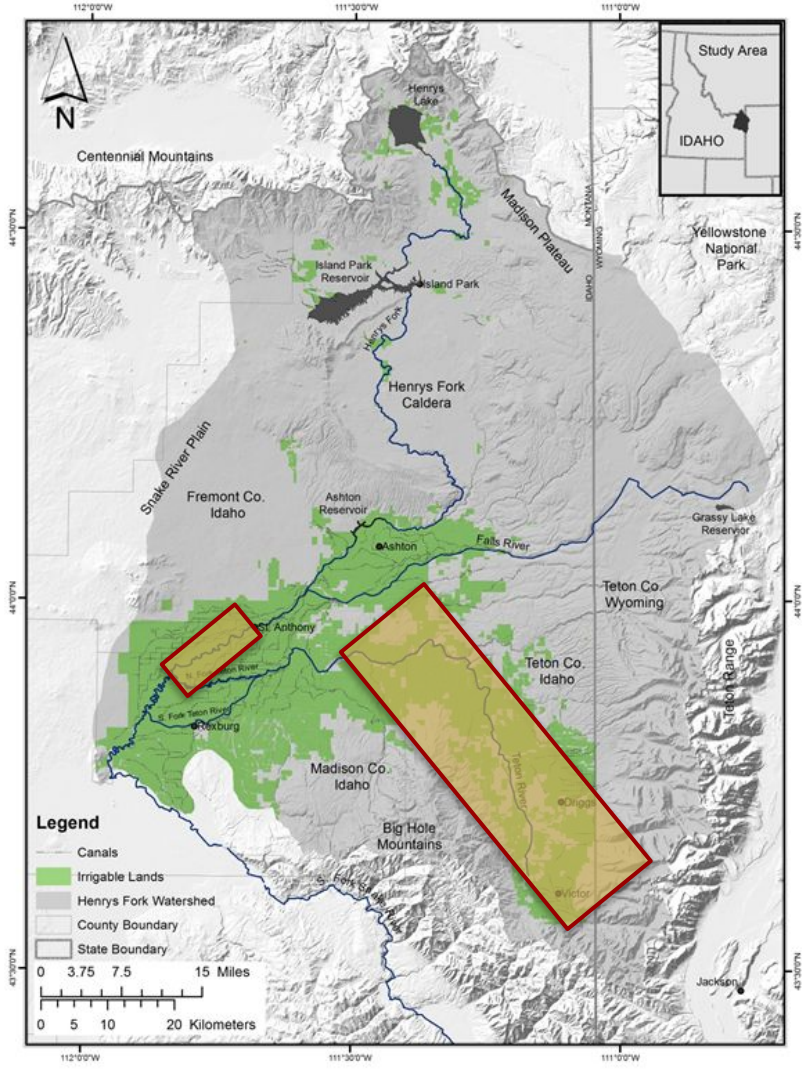
- Select:
  - Objectives and constraints
  - Open-source solver
  - Solution approach
- Daily time-scale

How can we OPTIMIZE for multiple stakeholders?



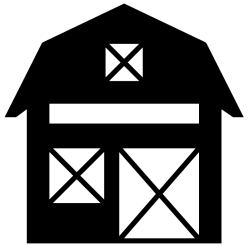
How can we ADAPT?

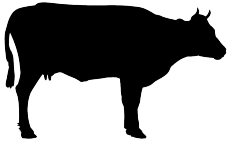

N
Study Area
IDAHO
Henrys Lake
Centennial Mountains
Madison Plateau
Yellowstone National Park
Island Park Reservoir
Island Park
Henrys Fork
Henrys Fork Caldera
Snake River Plain
Fremont Co. Idaho
Ashton Reservoir
Ashton
Falls River
Grassy Lake Reservoir
Teton Co. Wyoming
St. Anthony
Teton Co. Idaho
Teton Range
Rexburg
Madison Co. Idaho
Teton River
Driggs
Big Hole Mountains
Victor
Jackson
Legend
Canals
Irrigable Lands
Henrys Fork Watershed
County Boundary
State Boundary
0 3.75 7.5 15 Miles
0 5 10 20 Kilometers


N
Study Area
IDAHO
Henrys Lake
Centennial Mountains
Madison Plateau
Yellowstone National Park
Island Park Reservoir
Island Park
Henrys Fork
Henrys Fork Caldera
Snake River Plain
Fremont Co. Idaho
Ashton Reservoir
Ashton
Falls River
Grassy Lake Reservoir
Teton Co. Wyoming
St. Anthony
Teton Co. Idaho
Teton Range
Rexburg
Madison Co. Idaho
Driggs
Big Hole Mountains
Victor
Jackson
Legend
Canals
Irrigable Lands
Henrys Fork Watershed
County Boundary
State Boundary
0 3.75 7.5 15 Miles
0 5 10 20 Kilometers
112°0'0"W
111°30'0"W
111°0'0"W
44°30'0"N
44°0'0"N
43°30'0"N

How can we ADAPT?

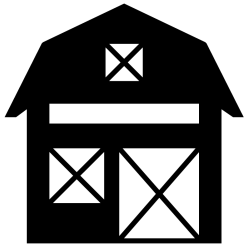
How can we ADAPT?

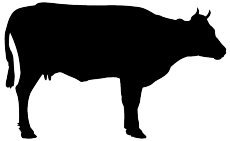




Use cover crop + grazing rotation to improve soil health

How can we ADAPT?



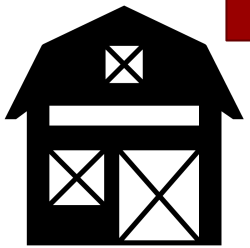


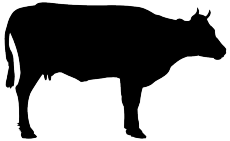
Improved soil health can decrease irrigation demand

Use cover crop + grazing rotation to improve soil health

How can we ADAPT?

But is this a viable strategy for farmers and ranchers?



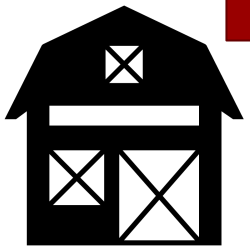


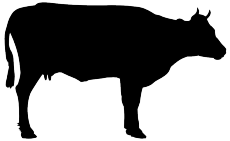
Improved soil health can decrease irrigation demand

Use cover crop + grazing rotation to improve soil health

How can we ADAPT?

But is this a viable strategy for farmers and ranchers?





Improved soil health can decrease irrigation demand

Use cover crop + grazing rotation to improve soil health

How can we ADAPT?

Objectives:

- Investigate the adaptive capacity of Teton Valley farmers/ranchers to reduce their irrigation demand
- Identify the barriers and pathways to strategy adaptation

How can we ADAPT?

Objectives:

- Investigate the adaptive capacity of Teton Valley farmers/ranchers to reduce their irrigation demand
- Identify the barriers and pathways to strategy adaptation

Approach:

- Teton Water Users Association collaboration
- Western Sustainable Agriculture Research and Education grant pre-proposal

How can we ADAPT?

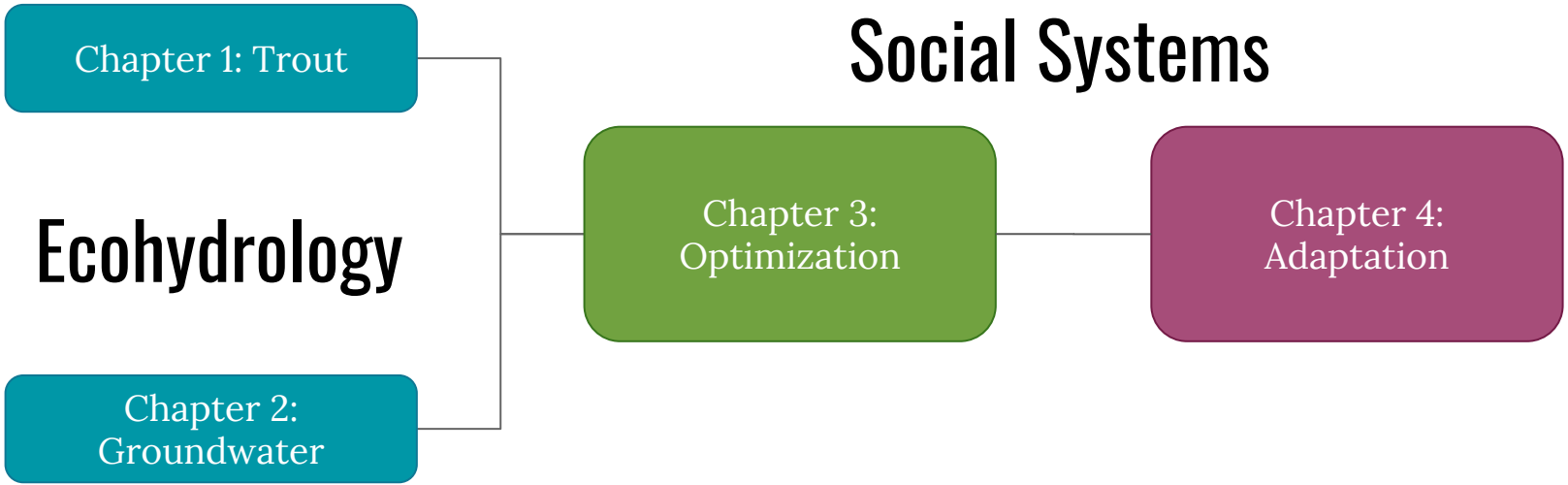
If this works in Teton Valley, can it work elsewhere?

Objectives:

- Investigate the adaptive capacity of Teton Valley farmers/ranchers to reduce their irrigation demand
- Identify the barriers and pathways to strategy adaptation

Approach:

- Teton Water Users Association collaboration
- Western Sustainable Agriculture Research and Education grant pre-proposal


Chapter 1: Trout
Ecohydrology
Chapter 2: Groundwater
Social Systems
Chapter 3: Optimization
Chapter 4: Adaptation

QUESTIONS?

SUGGESTIONS?