Fixing Broken Ecosystems

Restoring a river after a century of disturbance

The National Context

66,000 dams on rivers in the U.S.
2540 hydropower dams

Dam removals are a national trend

- 200 removed in last 20 years -140 from 1999-2004
- > 60 were scheduled to be removed in 2004
- Only 11-12 hydropower dams
- Mostly small dams but also a few large dams (Edwards)

Source: American Rivers

Why Remove Dams?

- Safety
- Land use changes makes dams obsolete
- Economics of energy production has changed
- Restore ecosystems

Why Fossil Creek?

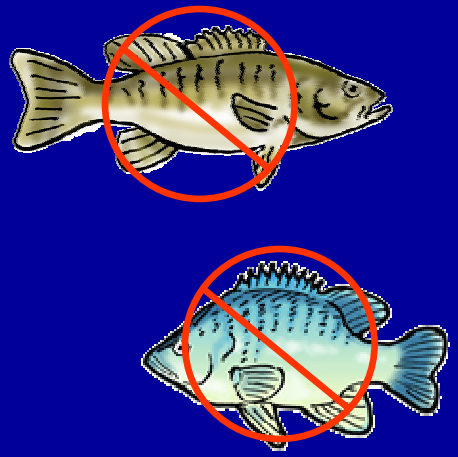
Native Fish
6 species

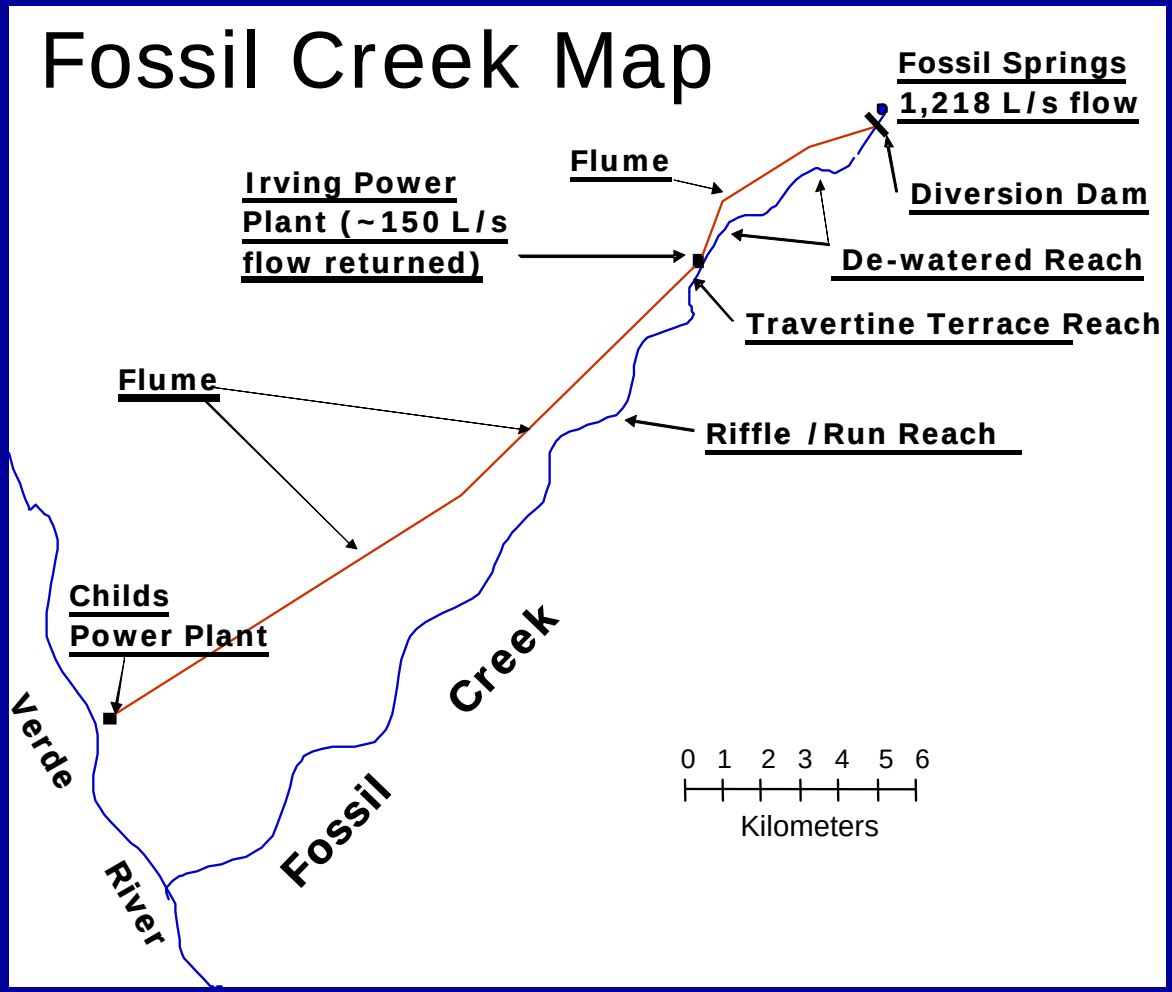
Lowland Leopard Frog

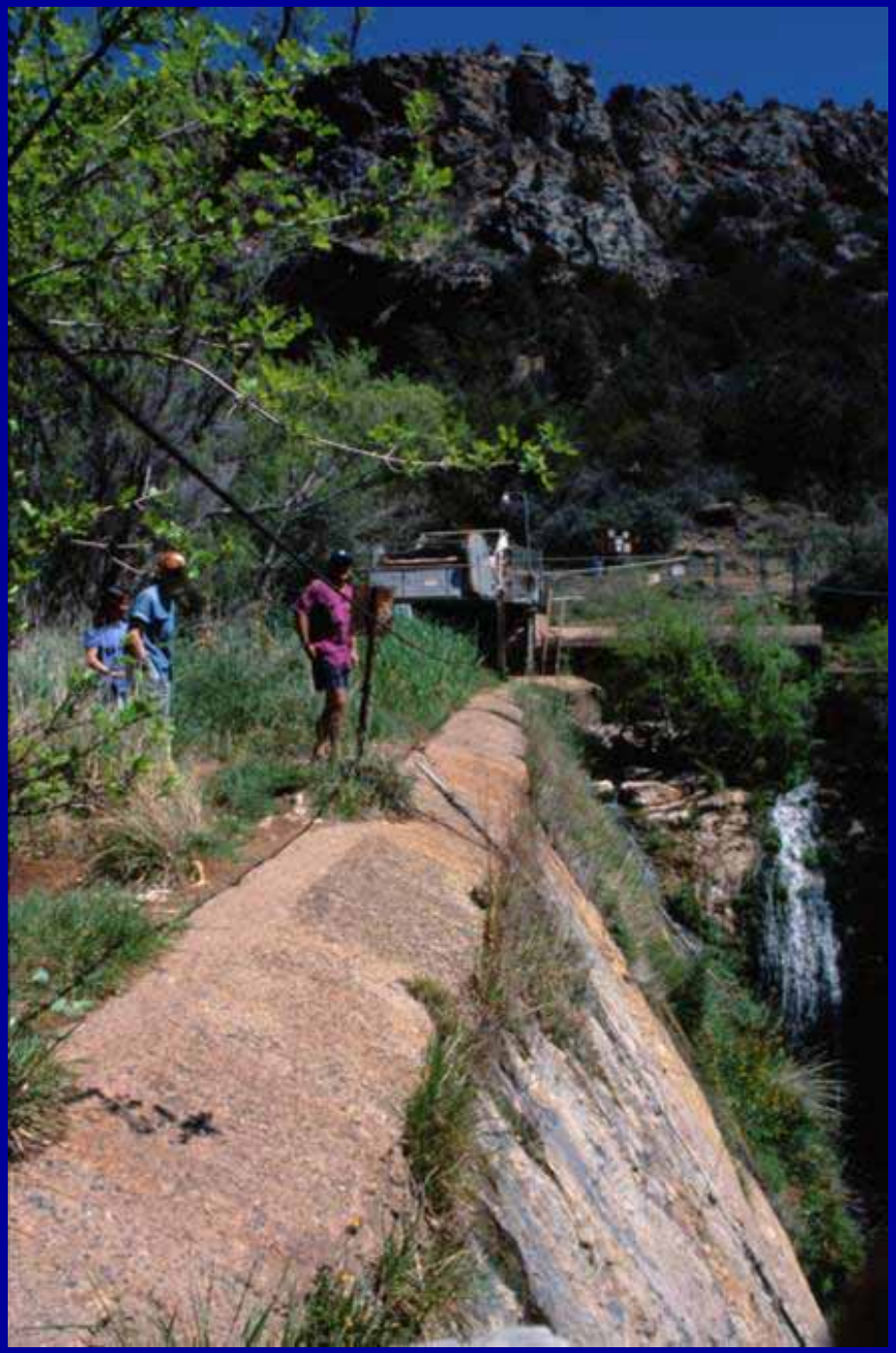
Macroinvertebrates
2 sensitive 1 endemic

Restoring Fossil Creek, Arizona

1) Removal of exotic fish✓
2) Return of full flows by decommissioning century old hydropower dam🕒




Fossil Creek Map
Fossil Springs
1,218 L/s flow
Flume
Diversion Dam
Irving Power
Plant (~150 L/s
flow returned)
De-watered Reach
Travertine Terrace Reach
Flume
Riffle /Run Reach
Childs
Power Plant
Verde
River
Fossil
Creek
0 1 2 3 4 5 6
Kilometers



10 meter
Hydropower Dam
built in 1908

Will be decommissioned
and flow restored
in June, 2005

Will be lowered or
removed after 2007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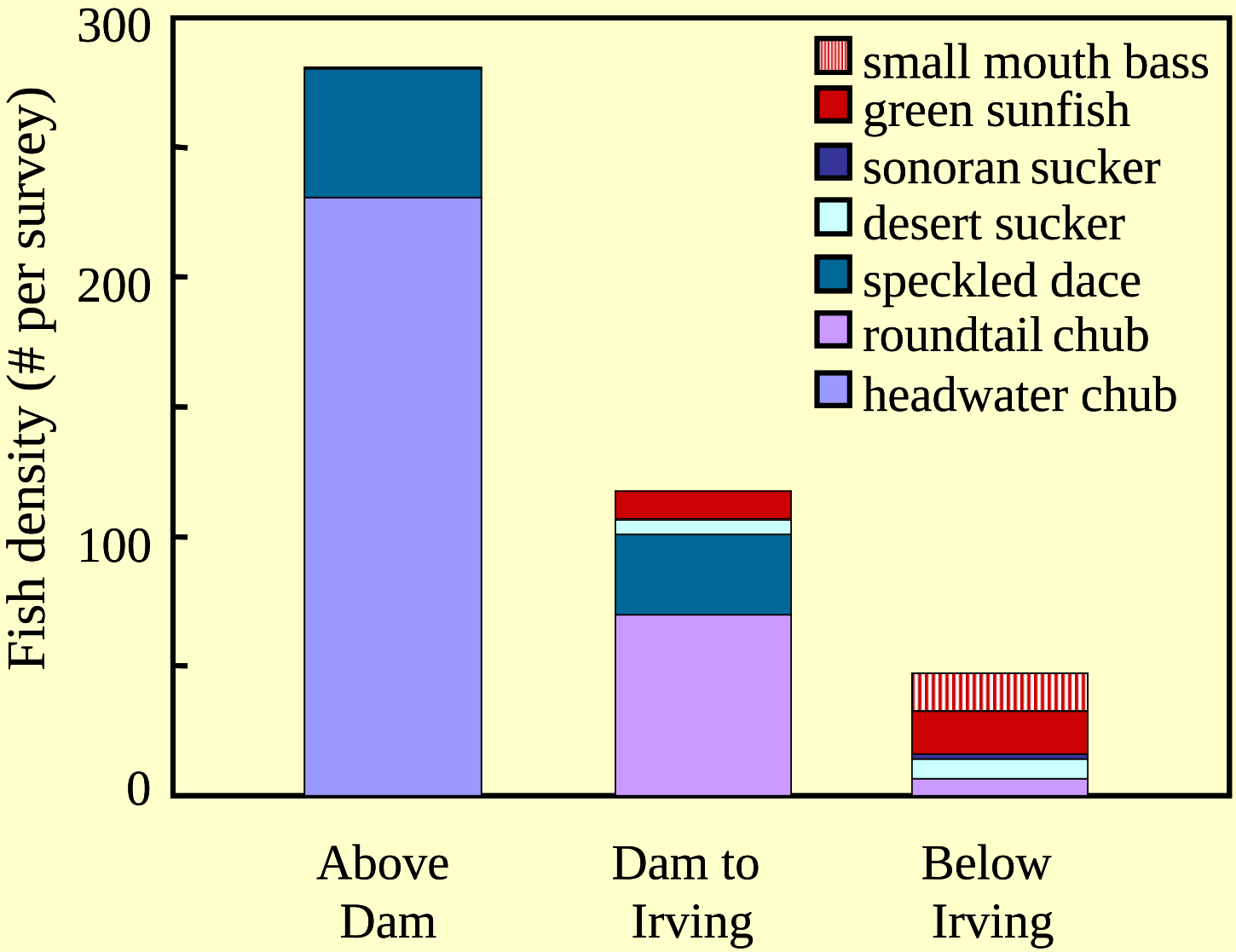
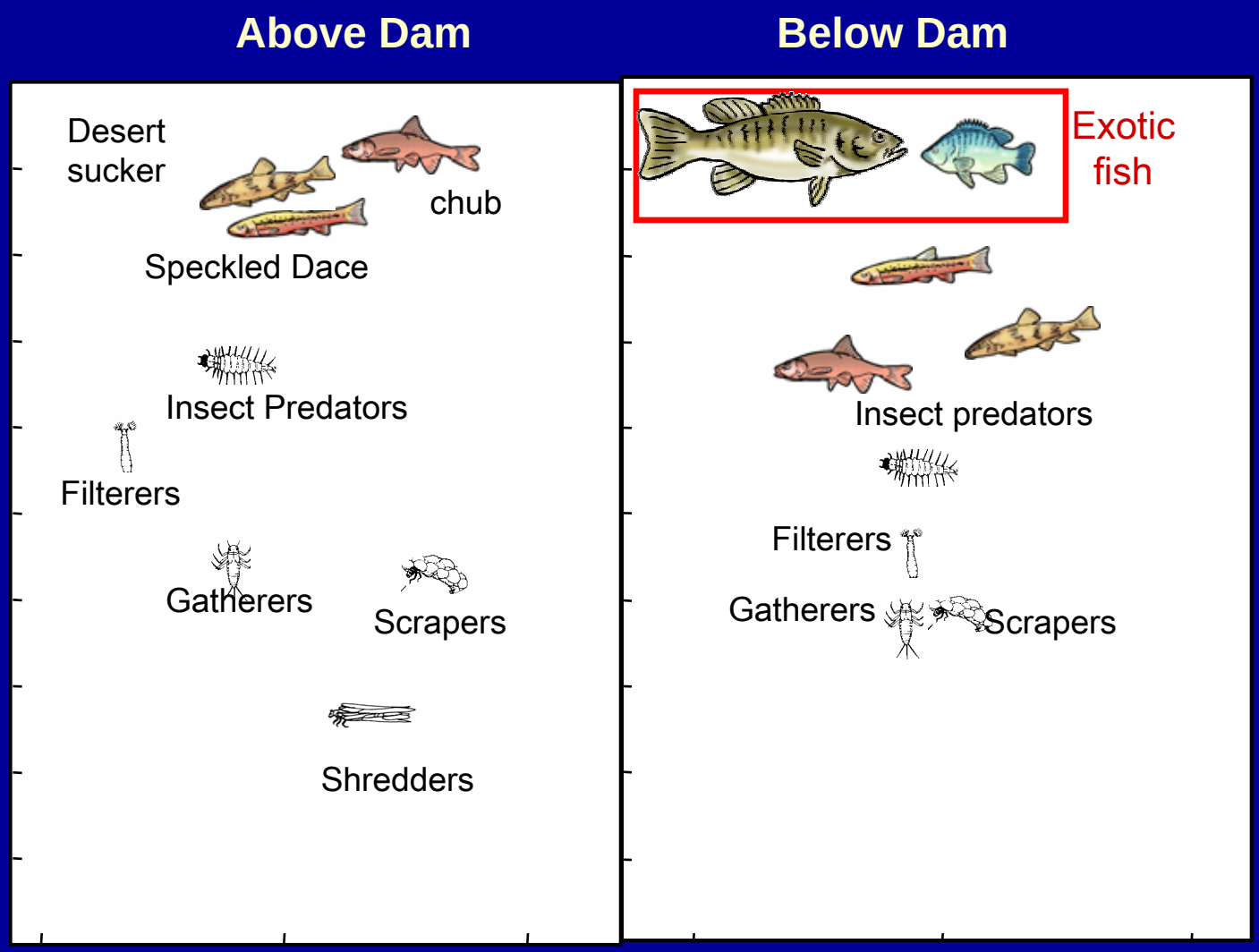
Is the Ecosystem Broken?

Approach

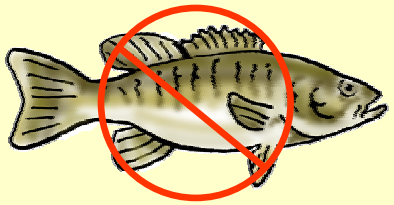
Compare Ecosystems Above and Below the Dam


300
200
100
0
Fish density (# per survey)
small mouth bass
green sunfish
sonoran sucker
desert sucker
speckled dace
roundtail chub
headwater chub
Above Dam
Dam to Irving
Below Irving

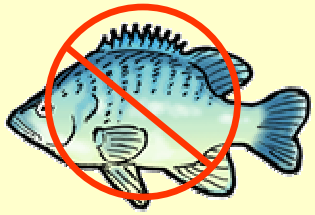
Top of food chain



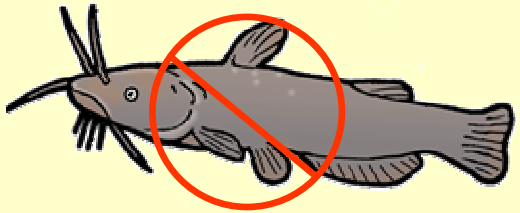
Exotic Fish Were Removed



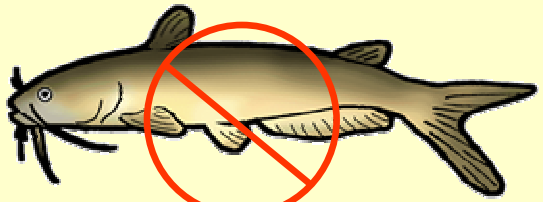
Small Mouth Bass



Green Sunfish



Channel Catfish



Yellow Bullhead Catfish

Crayfish

Fish Restoration: Step 1 collect native fish

1917 native fish salvaged

Rountail chub: 277

Desert sucker: 393

Sonoran sucker: 248

Speckled dace: 986

Longfin dace: 13

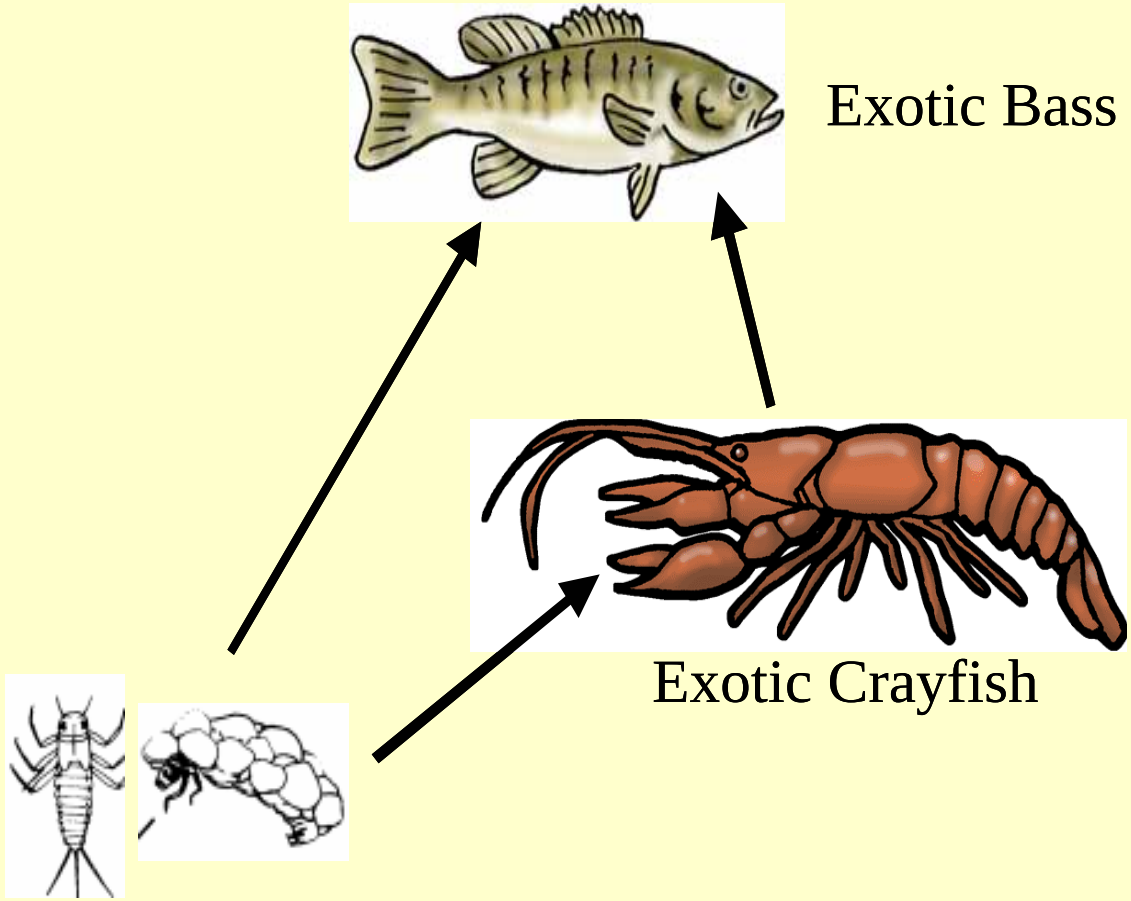
Monitoring insects drifting during chemical treatment showed high mortality rates

Fossil Creek Invertebrates

- 128 species found to date
- Appear to be recovering quickly

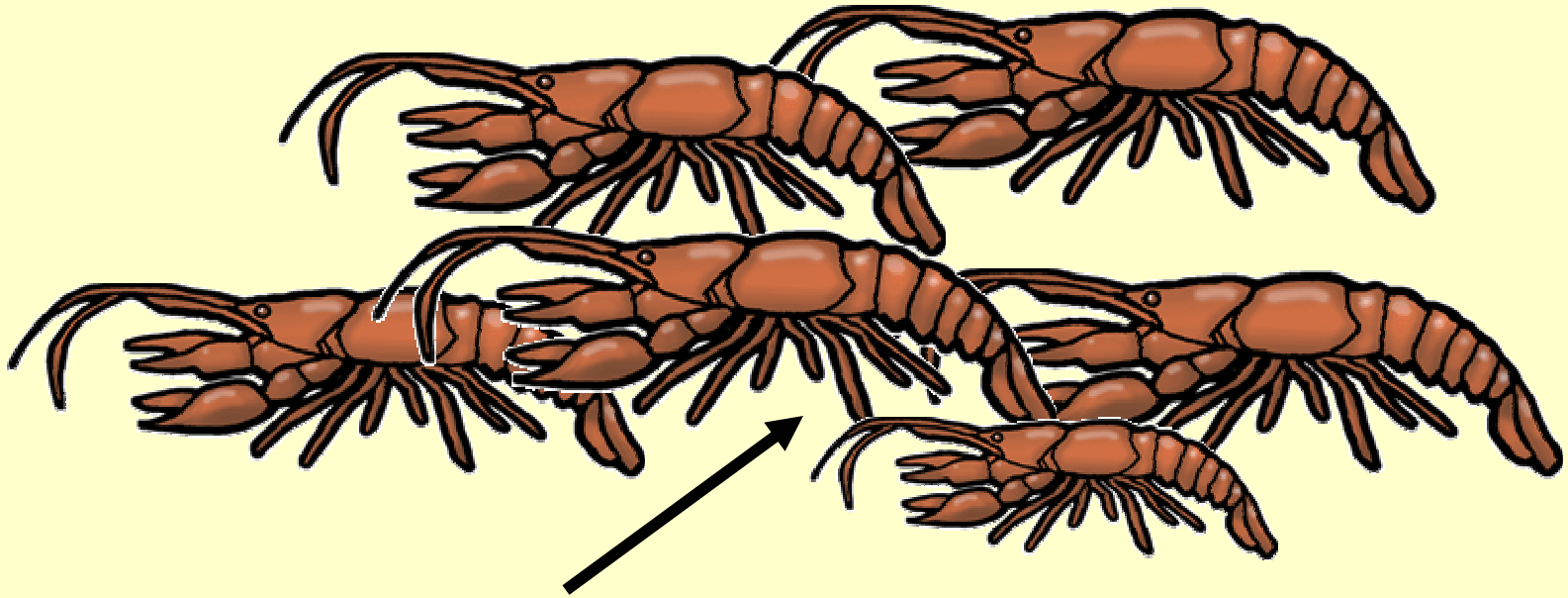
(Slide by Eric C. Dinger)

Will exotic crayfish undermine restoration?

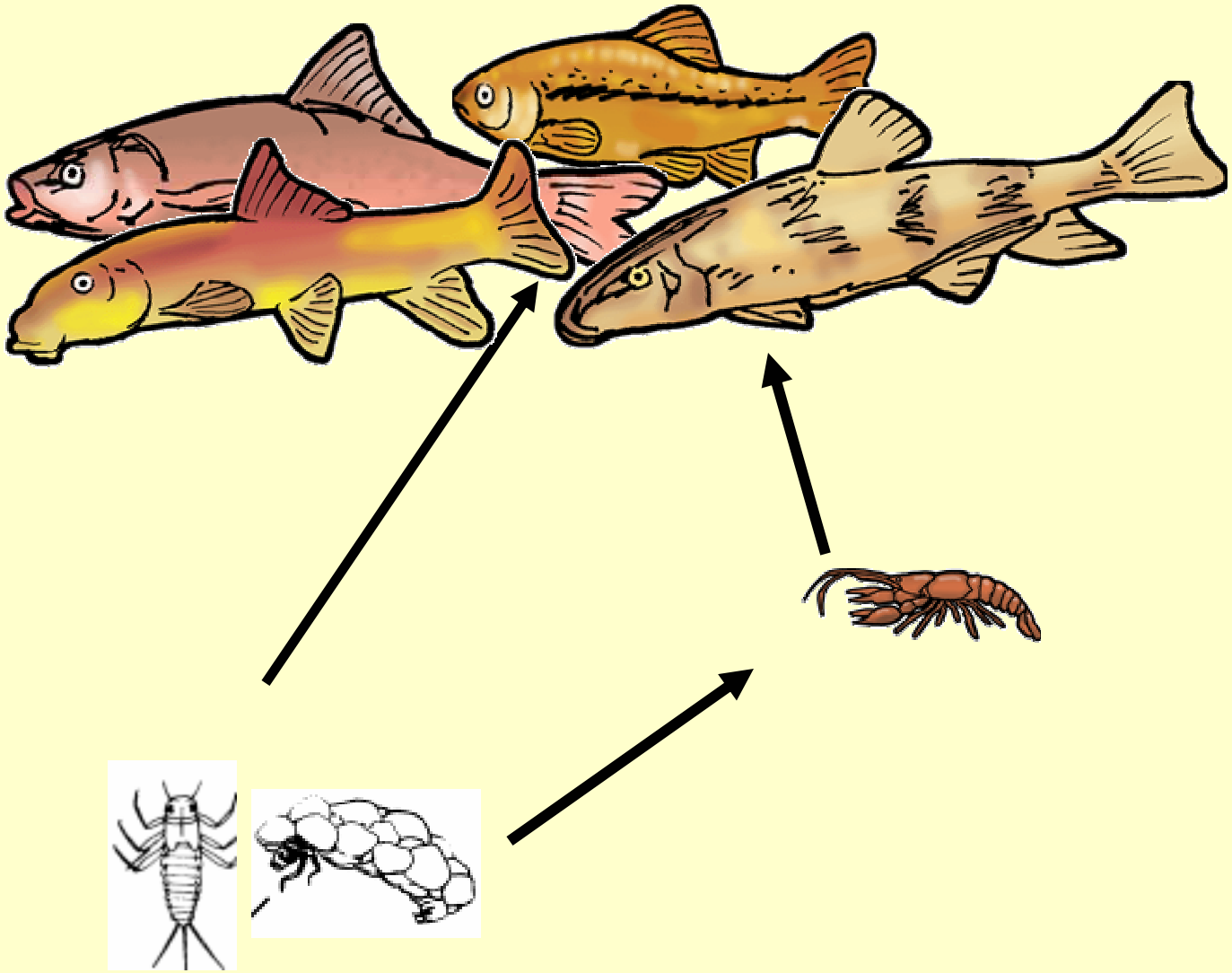


Pessimistic Prediction – crayfish populations explode

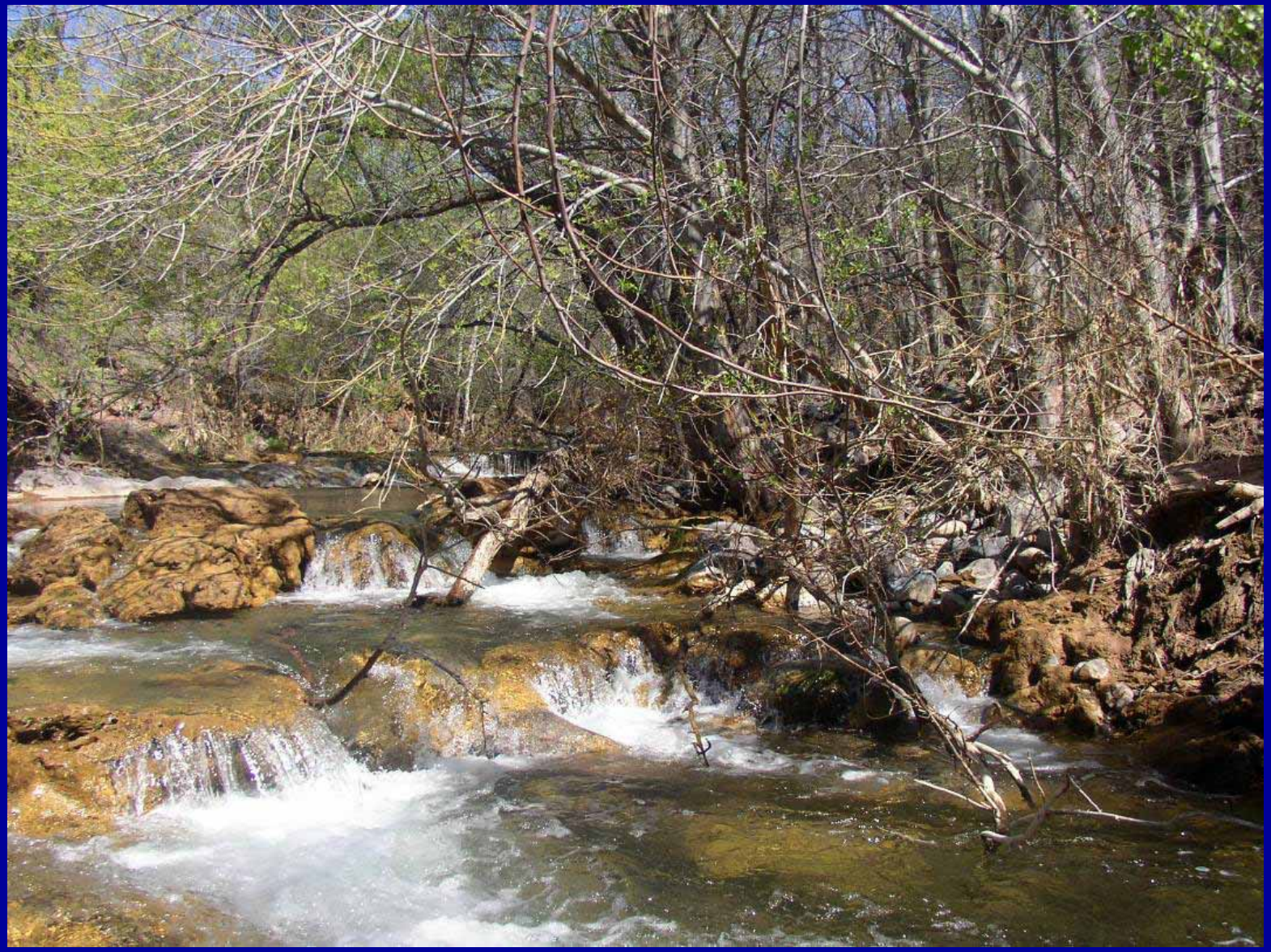
Released from competition and predation



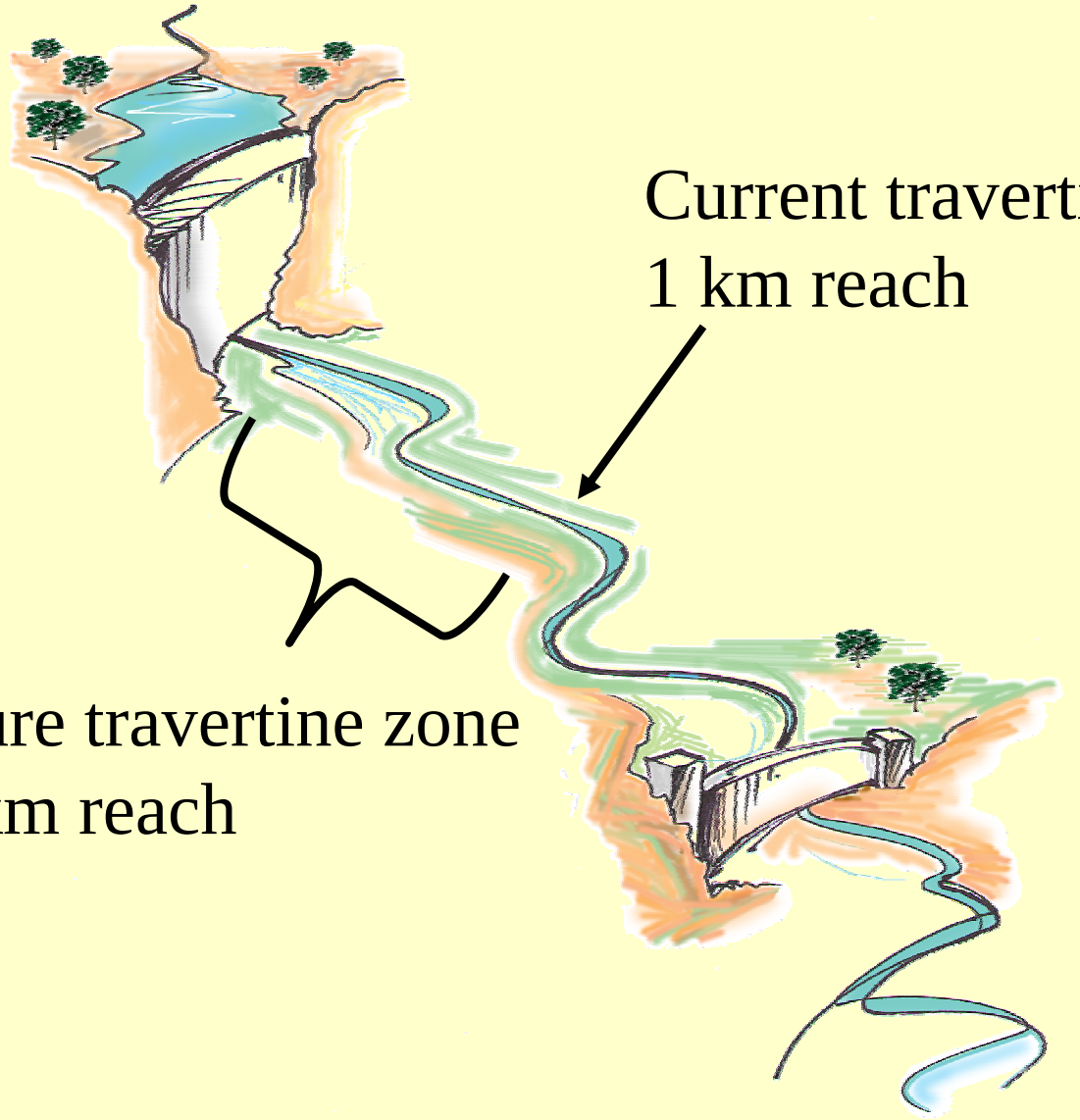
Optimistic Prediction: Native fish thrive and control crayfish



What about the travertine?



Full flows should restore travertine dams

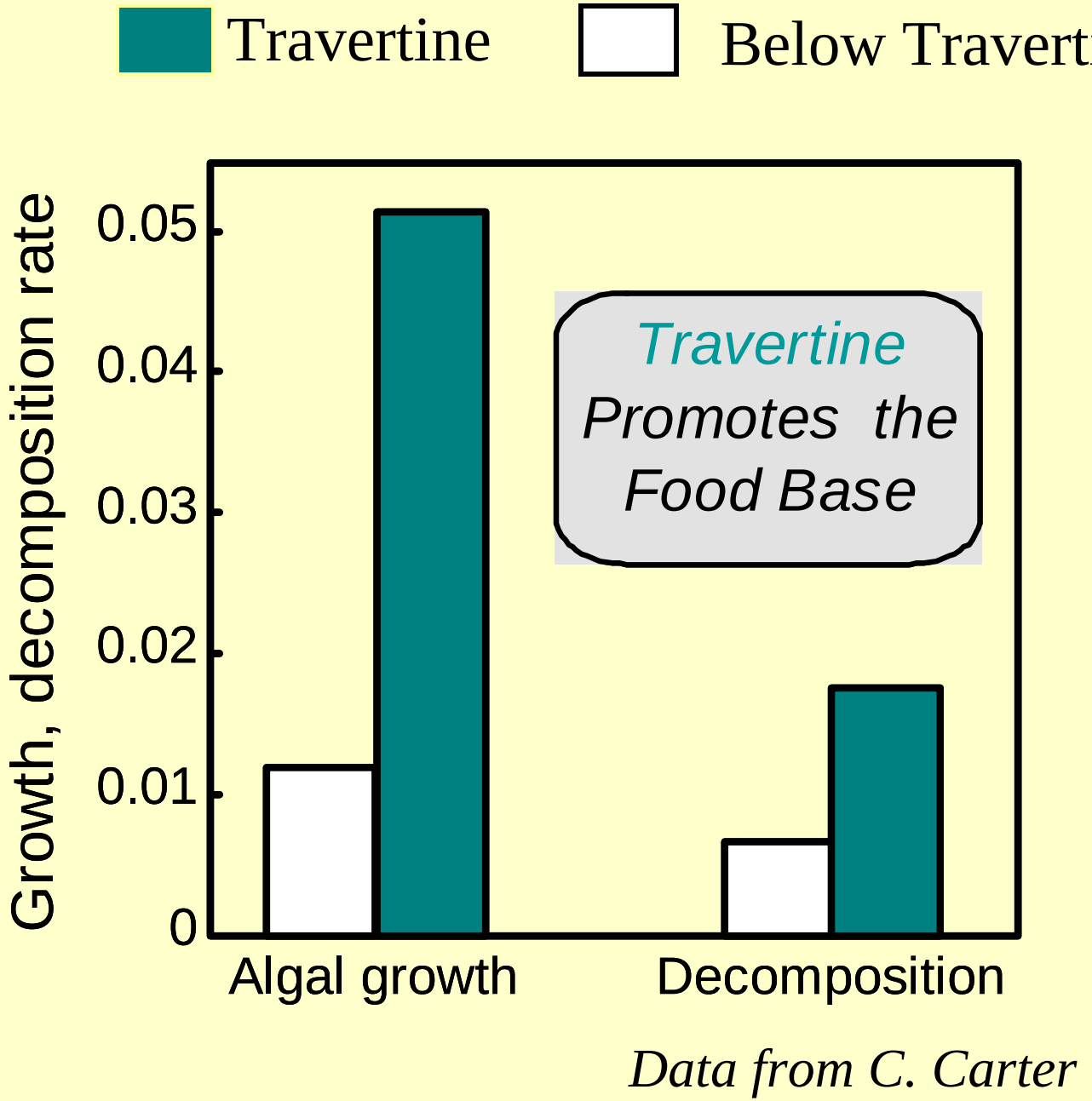


Current travertine dam zone
1 km reach

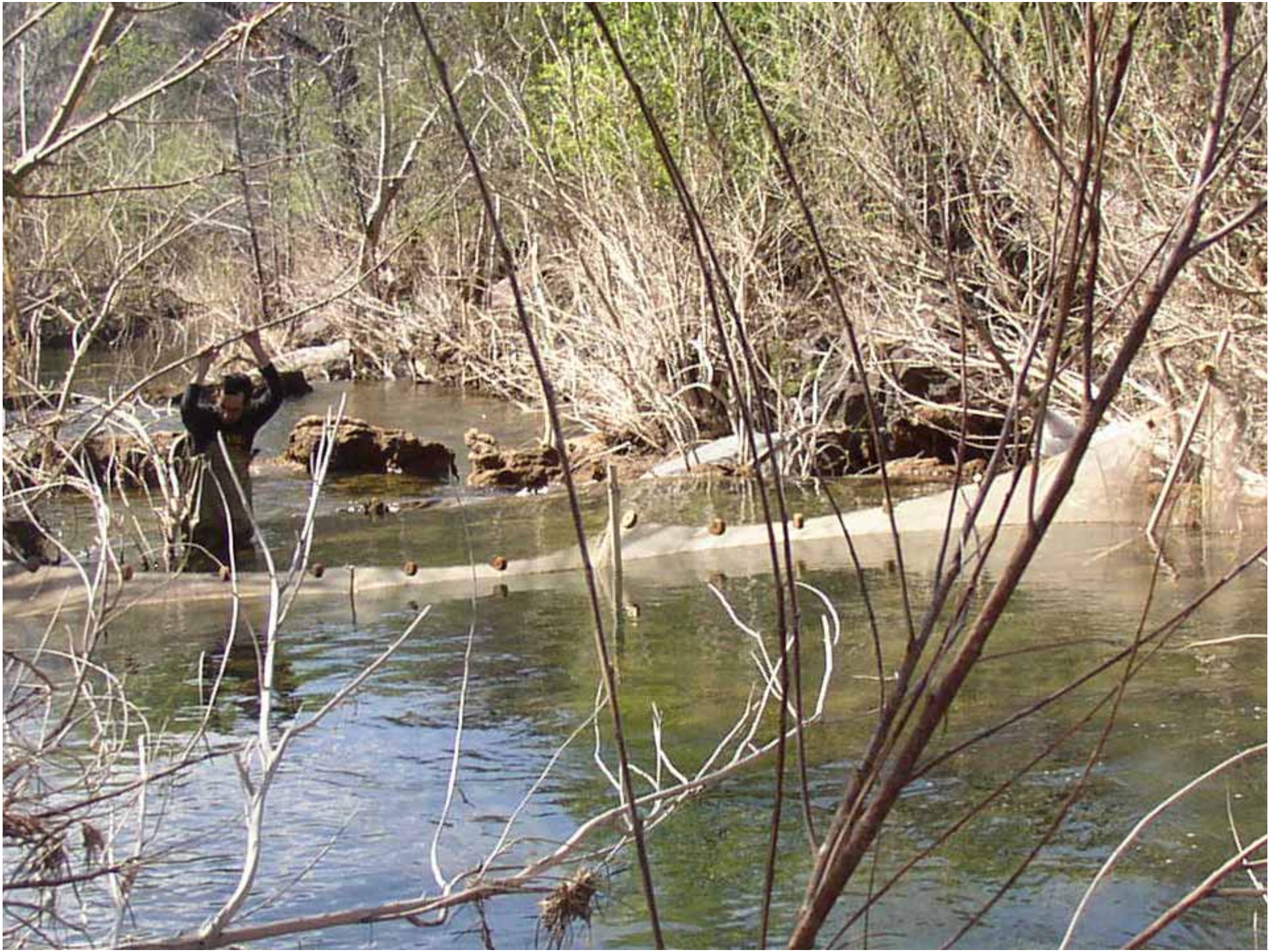
Future travertine zone
10 km reach

Will more travertine be good or bad for native species?

Approach: Compare ecosystem in reach with travertine dams with reach with normal riffle pool morphology



Data from C. Carter



Ecosystem Responses

1)Primary productivity & decomposition, higher in travertine
2)Insect diversity and fish densities,
higher in travertine
3)Nitrogen retention higher in travertine zone
4)Leaf litter retention higher in travertine zone

Indicators of a “fixed ecosystem”

Native fish densities will increase below dam where exotics are removed.

Trophic position of native fish will increase where exotics are removed

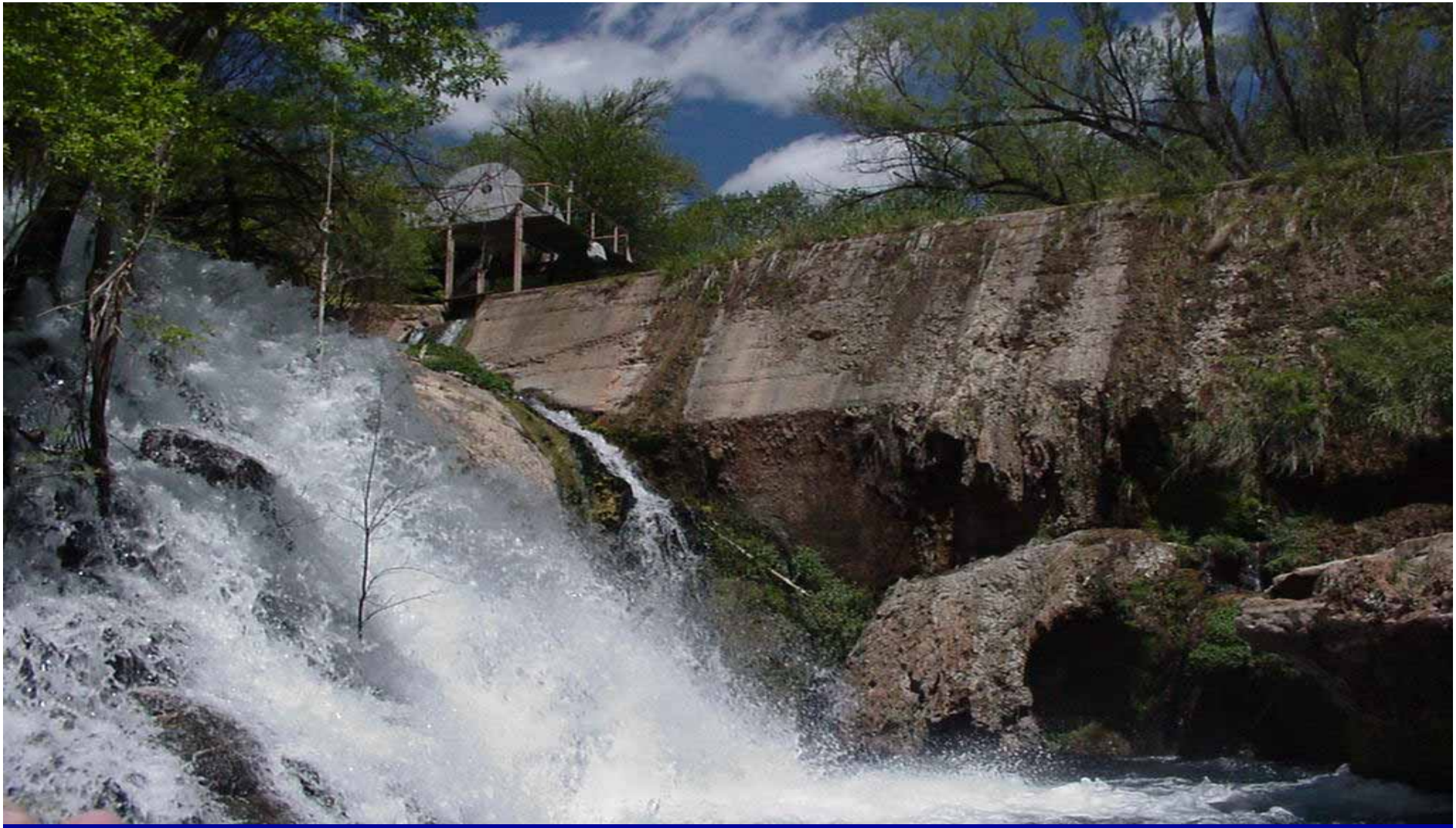
Resource overlap will decrease with restoration of flow (less overlap in isotope values for functional feeding groups)

Indicators of a “fixed ecosystem”

Travertine dam formation will increase extending the travertine zone

Productivity will increase

Fossil Creek will be a source of energy for riparian species (lizards, birds, spiders)



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