

Using benthic barriers to control Asian clam (*Corbicula fluminea*) in Lake Tahoe, CA-NV: Field observations, monitoring results and lessons learned one year later

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New Invasive Species Discovered at Lake Tahoe



Eight year old Kristian Aynedter was walking along Nevada Beach with

learning more. David Herbst, PhD, of Sierra Nevada Aquatic Research Lab in Mammoth Lakes, CA identified the shells as *Corbicula fluminea*, the Asian freshwater clam. Dr. Herbst has known of this invasive clam's presence in lakes of Southern California, but it appears that this is the first time the clam has been found at Lake Tahoe.

In Southeast Asia the small adaptable clam is used as a food source. *Corbicula fluminea* first brought the clam

fish bait, released from aquariums, and transported as larvae in the bilge water of boats. The Asian clam is considered a fouling organism, and is likely to affect the local ecology with the potential to infest water intakes around the lake.

The Aynedters are a great example of how concerned citizens can take the initiative to be a part of the effort to save Lake Tahoe. By asking questions about their surroundings they were able to alert the



League to Save Lake Tahoe Newsletter, Spring 2003

Large populations
discovered in
S/E Lake Tahoe

Large-scale
Barrier application

Lower
Truckee River

Nevada Beach,
Lake Tahoe

Lower Truckee River
tributaries

Rapid response,
experimentation,
surveying

Monitoring
and results

Emerald Bay discovery

Timber Cove,
Lake Tahoe

1981

2002

2003

2005-2006

2008

2009

2010

2011

2012

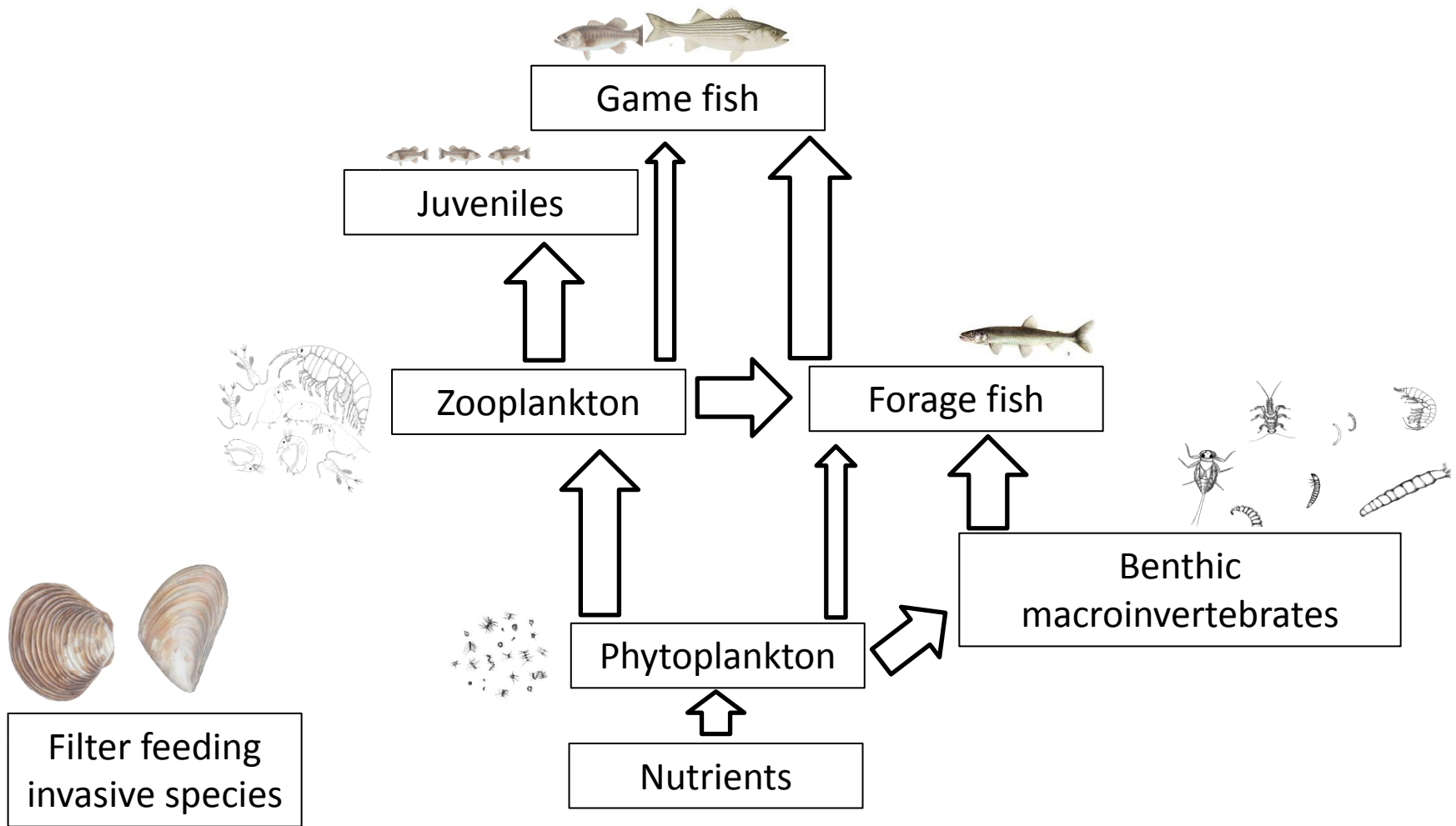
Asian clam (*Corbicula fluminea*) association with filamentous algal blooms attracted public attention and instigated rapid response



- ↑ Sediment porewater SRP, NH_4 , Ca^{2+}
- ↑ Filamentous algae
Cladophor glomerata, *Spirogyra sp.*, *Zygnema sp.*
- ↓ Aesthetic values



Filter feeding invasive species can disrupt food webs in ecosystems in which they establish: Benthic production can account for 10 – 90% of carbon in lacustrine fish populations (Vander Zanden et al. 2011)

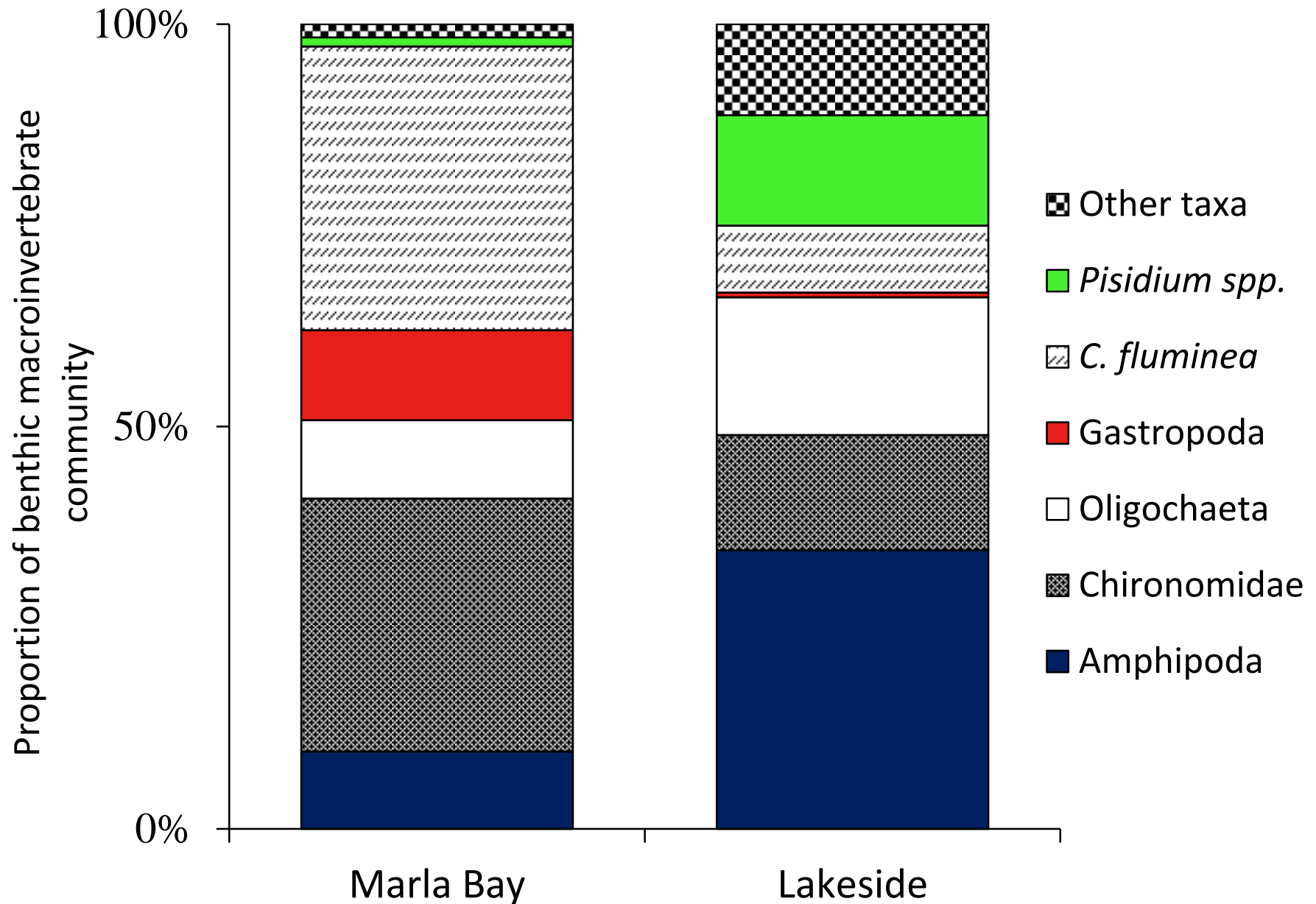


Benthic species in the Tahoe ecosystem: Potentially impacted by invasive species

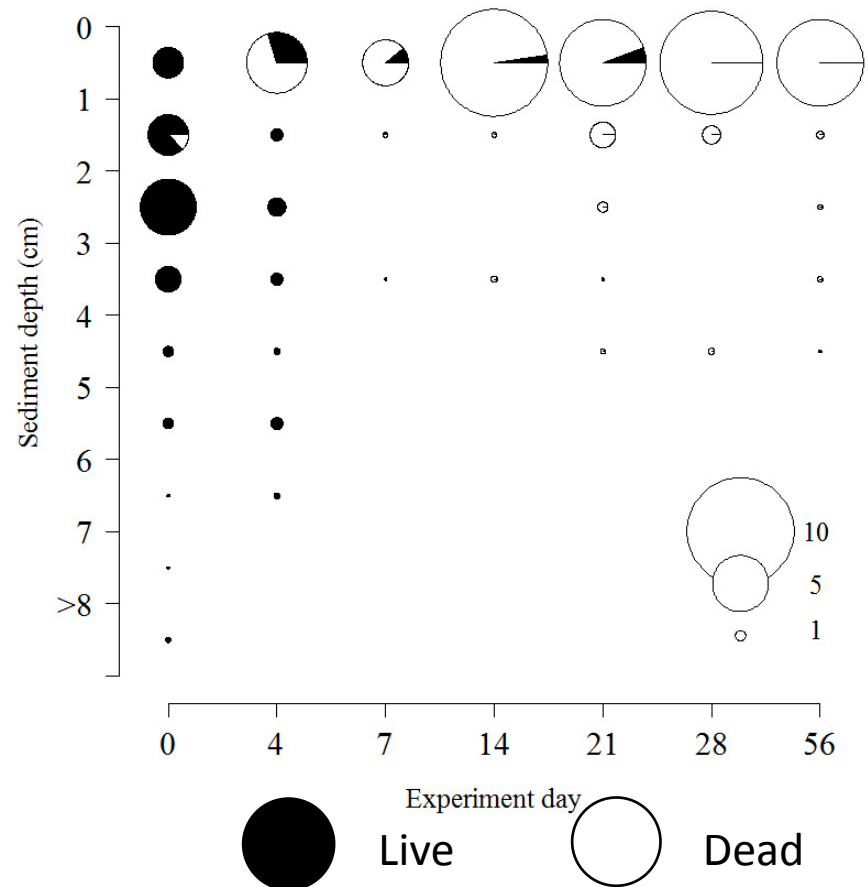
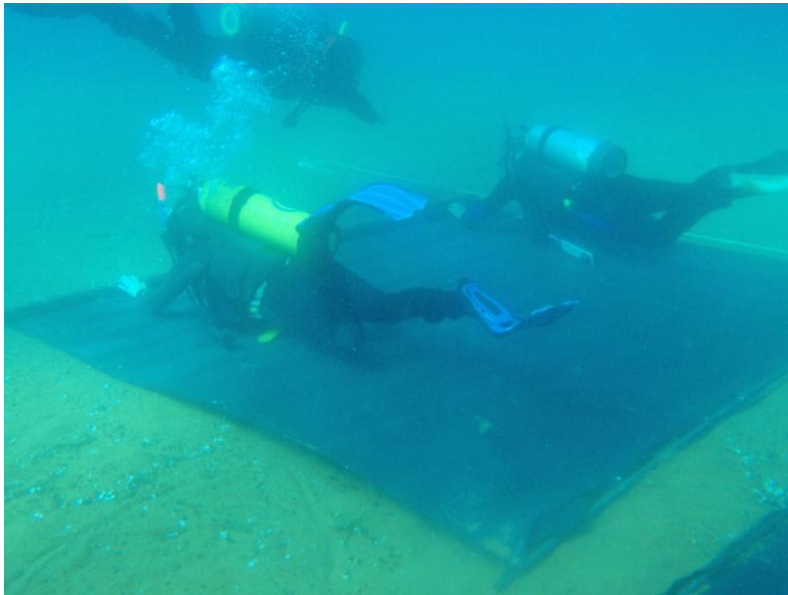
- Oligochaeta (worms)
- Chironomidae (midges, flies)
- Trichoptera (caddis flies)
- Gastropoda (snails)
- *Pisidium* spp (native clams)
- Amphipoda (crustaceans)
- Crayfish

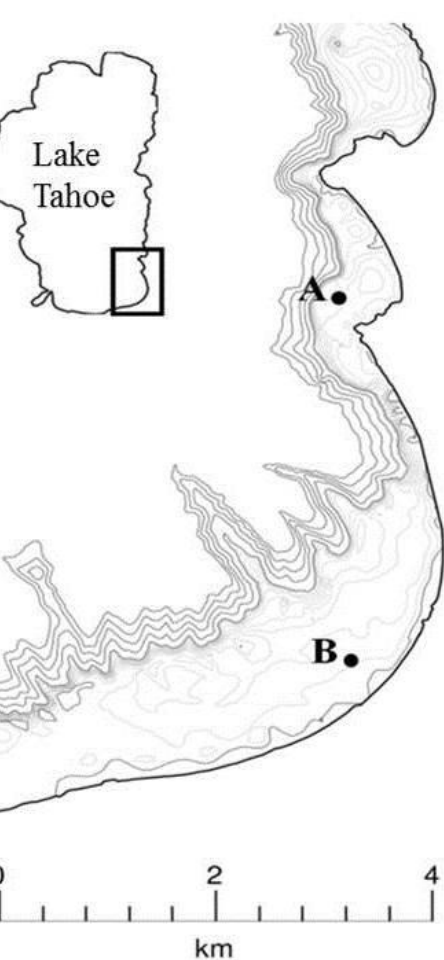


Benthic community composition in Lake Tahoe

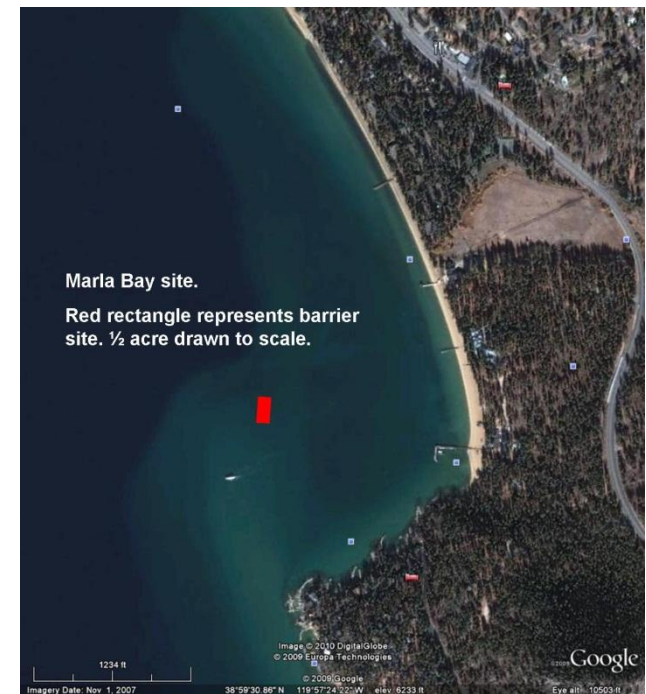
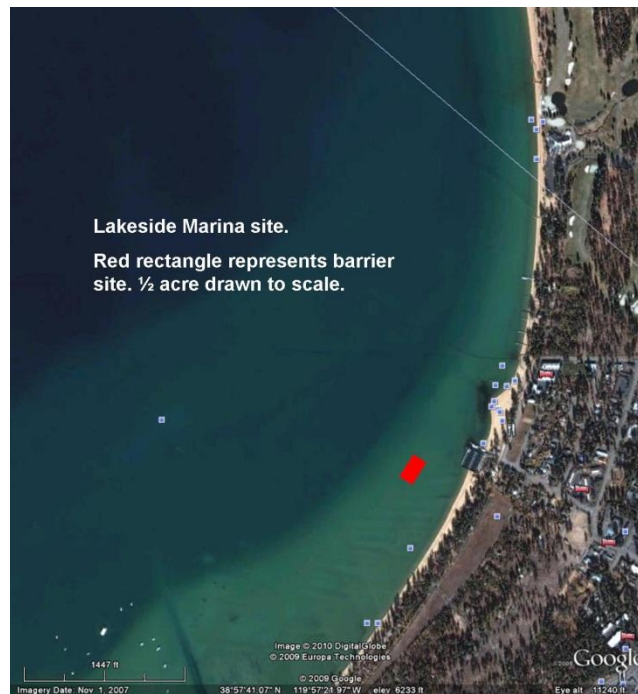


Asian clams are habitat limited when dissolved oxygen concentrations are low: Artificially induce hypoxia using EPDM pondliner results in 100% mortality after 28 days

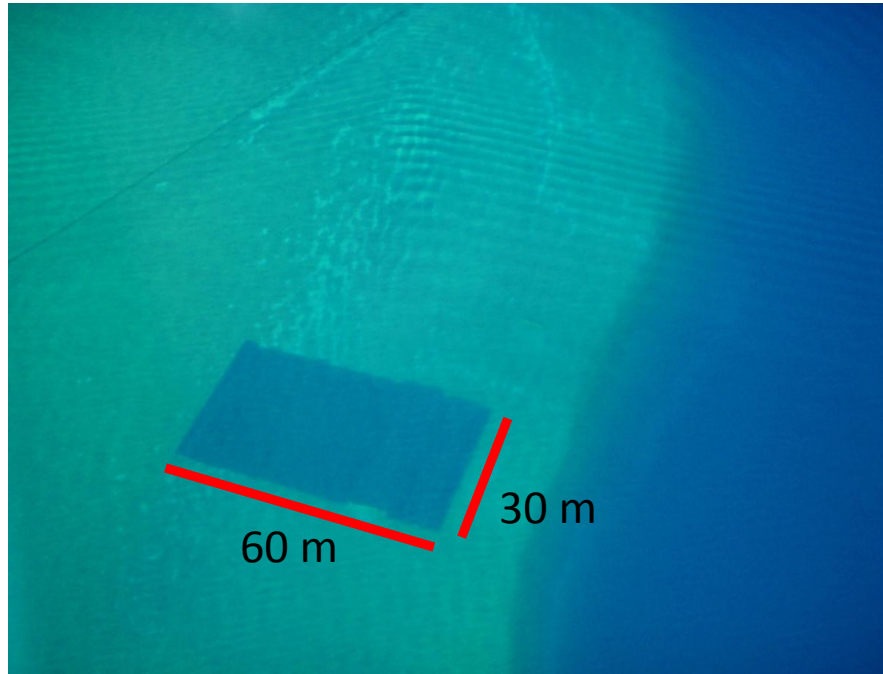




Two sites were selected to place bottom barriers in Lake Tahoe: Marla Bay, NV and near Lakeside Marina, CA



Collaborated with agencies and stakeholders to experiment with a large scale bottom barrier deployment: total 1 acre applied in Lake Tahoe

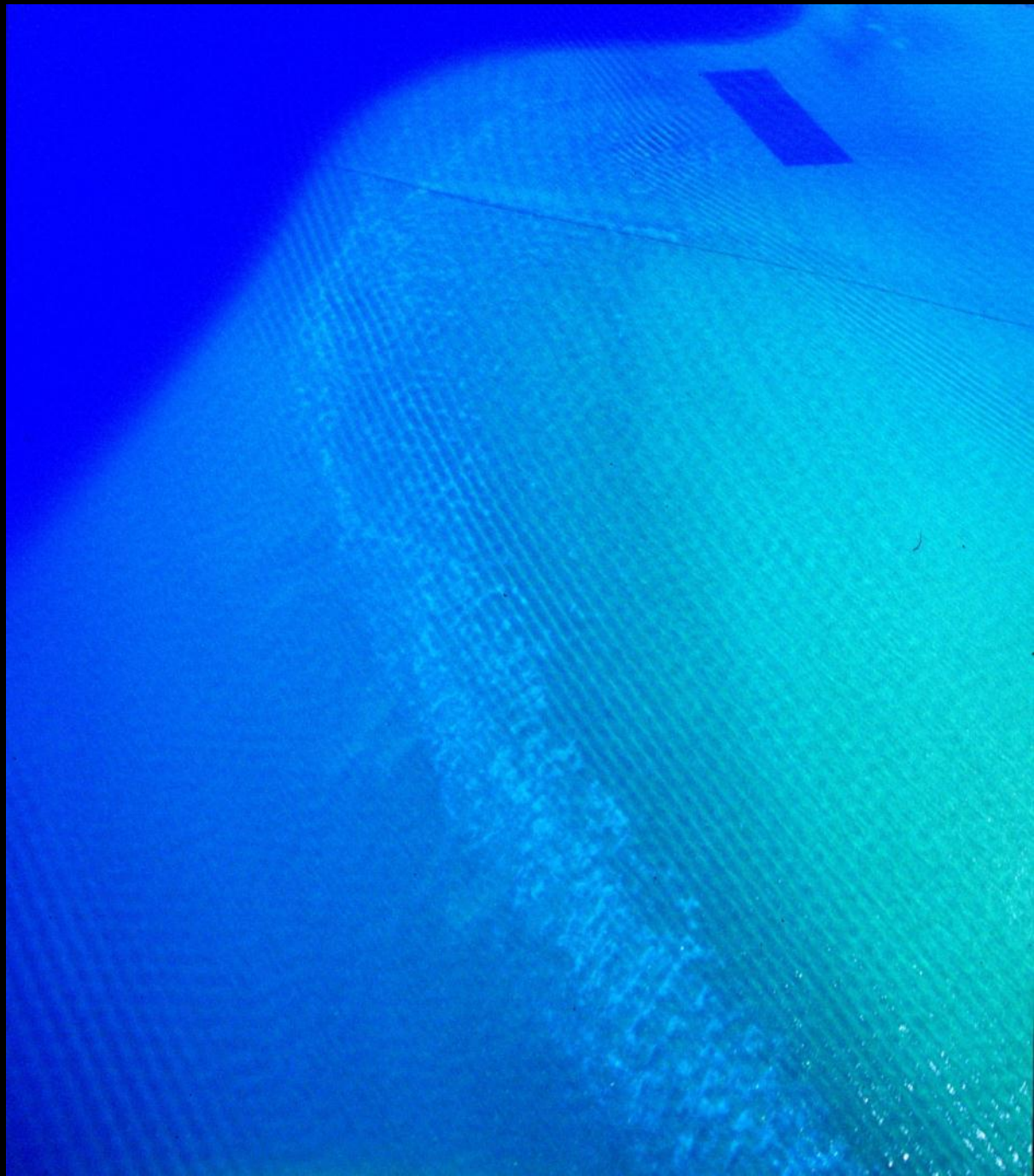


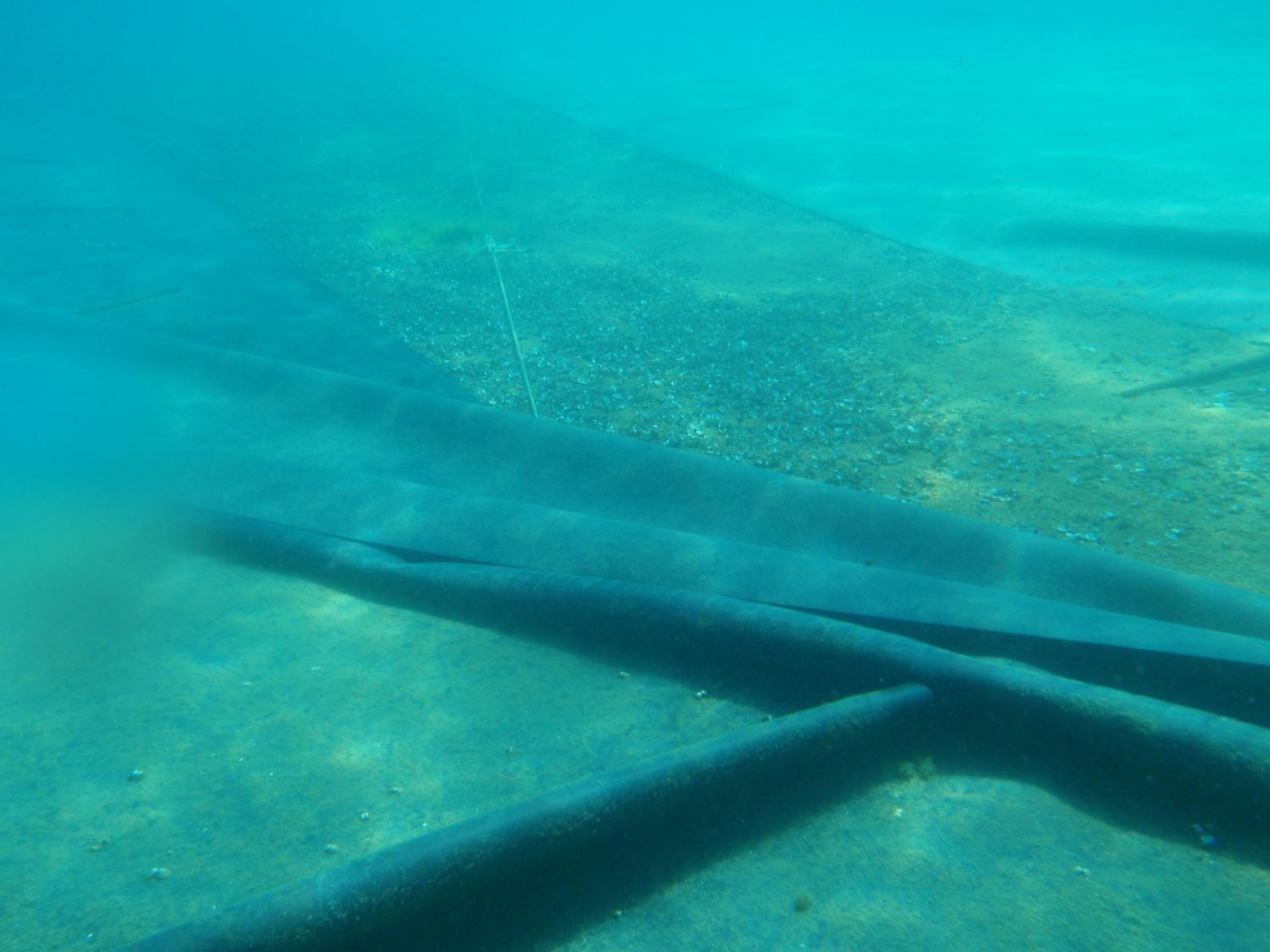
Aerial photo: $\frac{1}{2}$ acre of EPDM pondliner in Lake Tahoe, NV

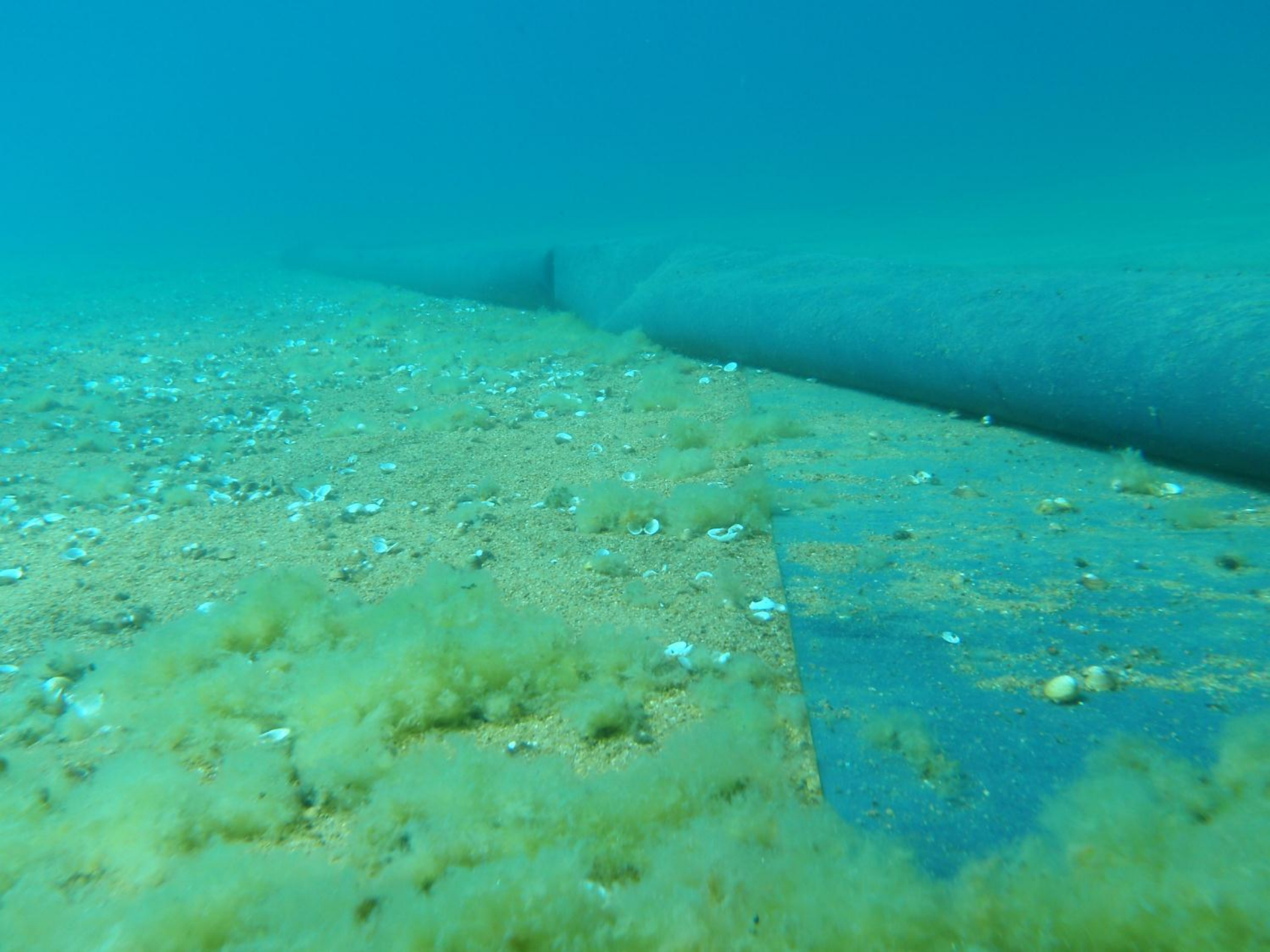


Barrier application in regulated environment included involvement from multiple agencies, science teams and media





















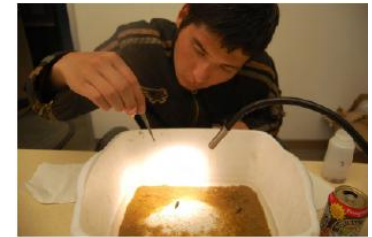




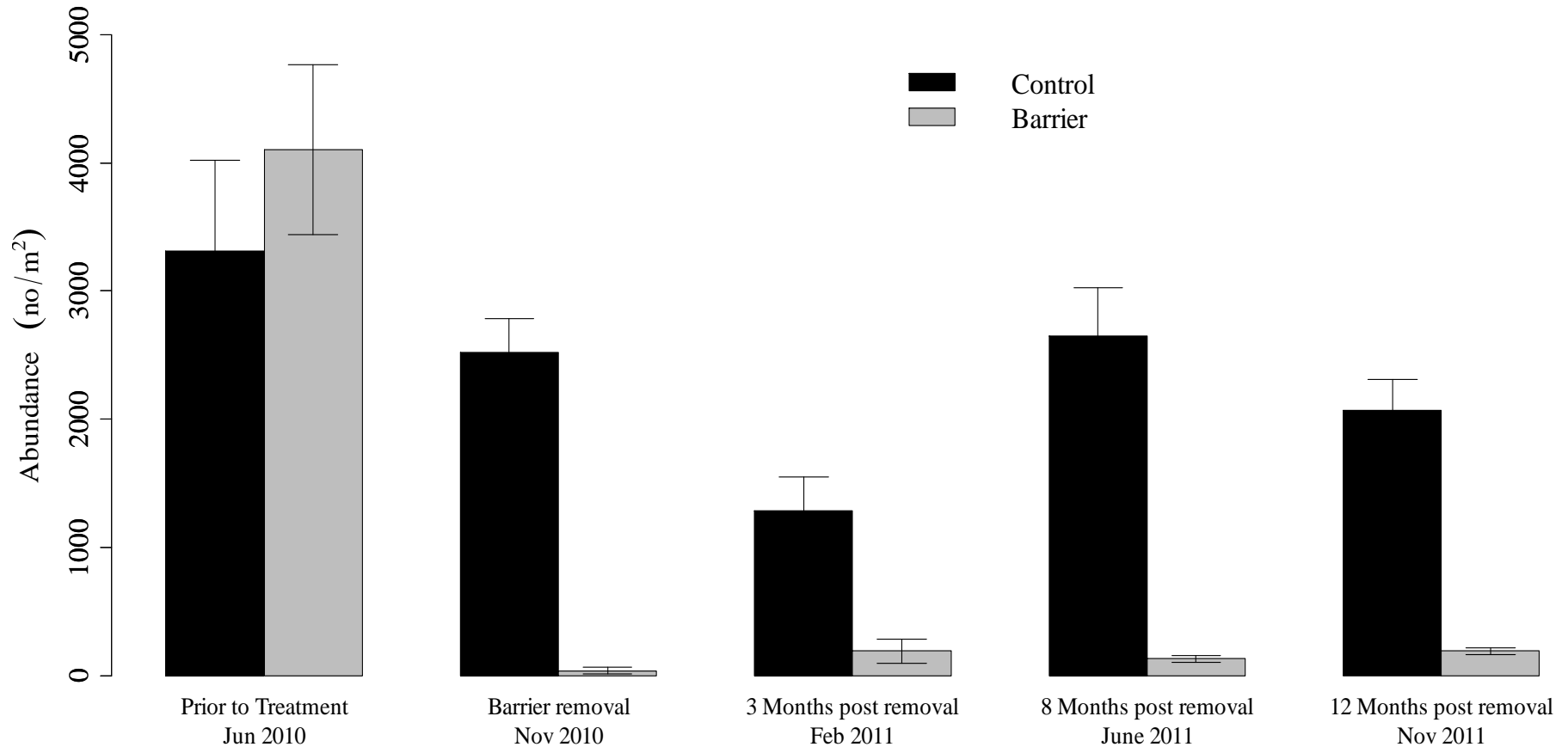
And then we monitored....



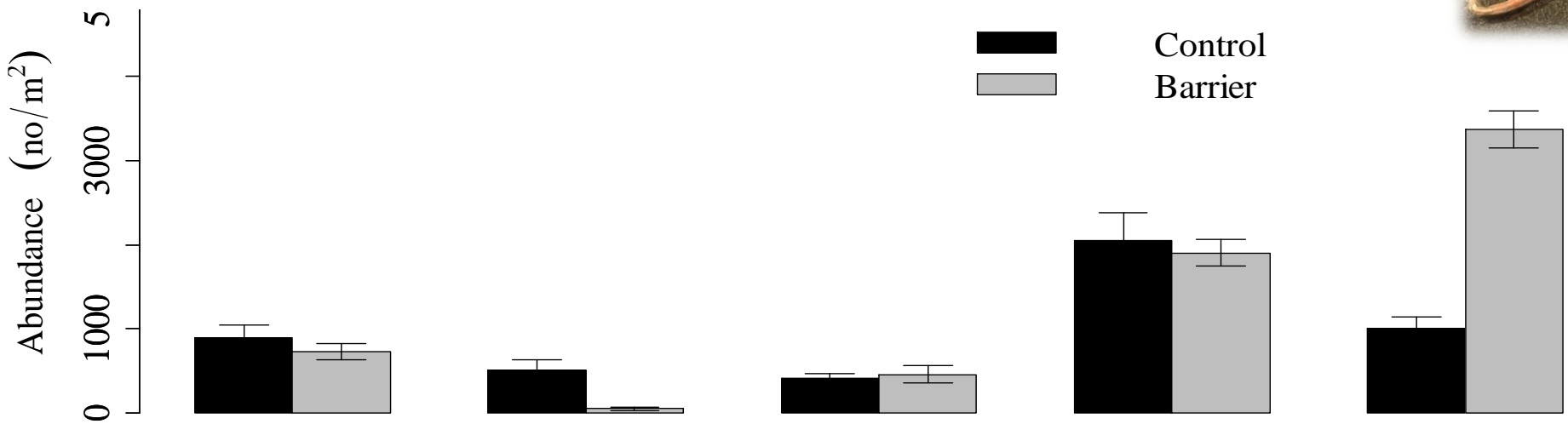
Over 40 individuals from universities, agencies, non-profit organizations and homeowners associations contributed to the field effort for Asian clam in Lake Tahoe



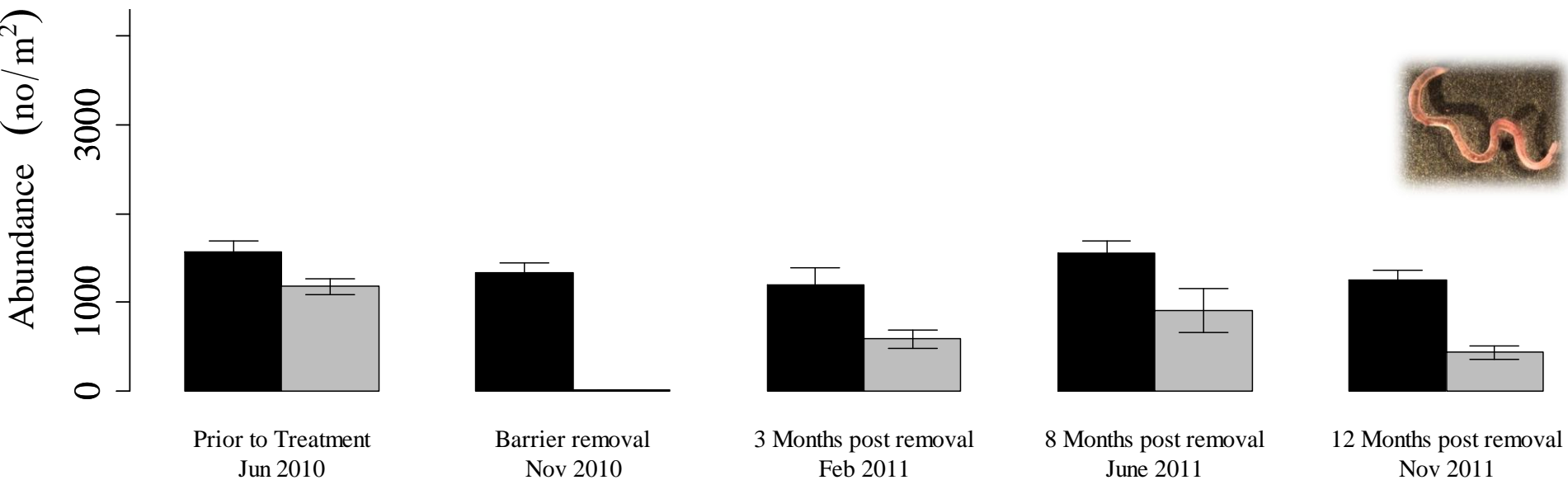
Results from 1 year period of monitoring bottom barrier treatment plots: Asian clam population densities over 90% reduced



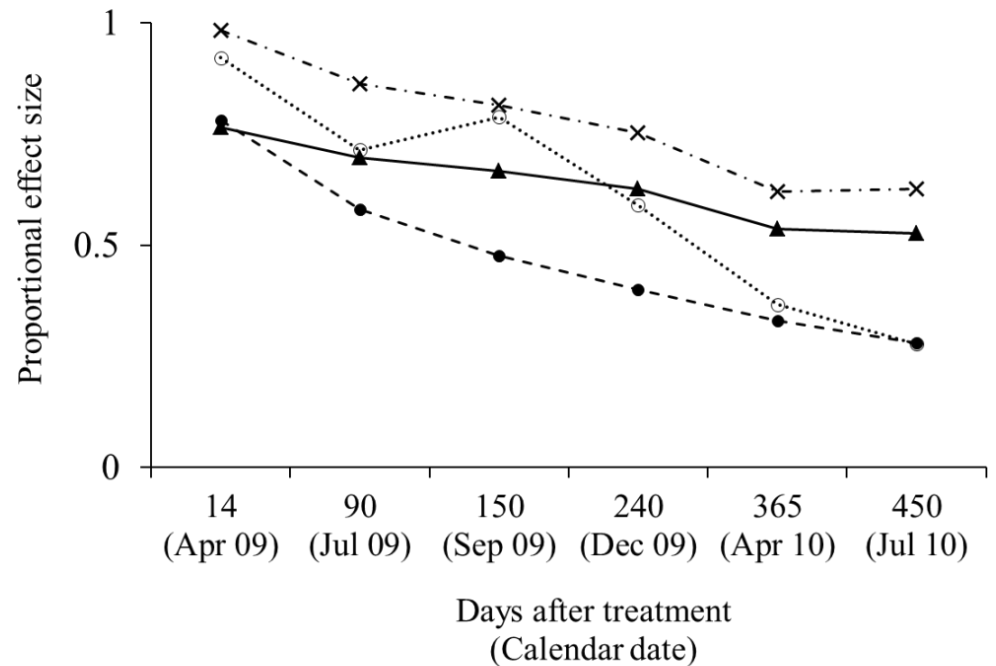
Chironomids are impacted immediately after removal of barriers, greater abundances than control conditions after 1 year



Oligochaeta are impacted immediately after removal (>99% reduction) and populations remain different after 1 year

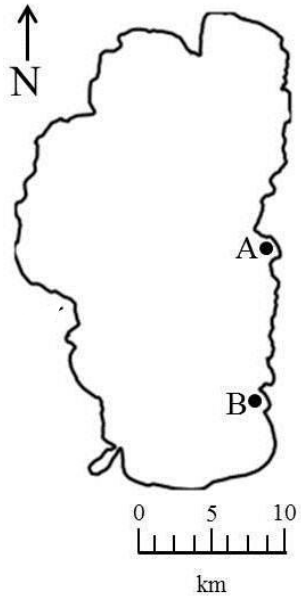


Monitoring of suction removal sites: Asian clam, native Pea clam, total invertebrate abundance and diversity indices remain impacted after 450 days

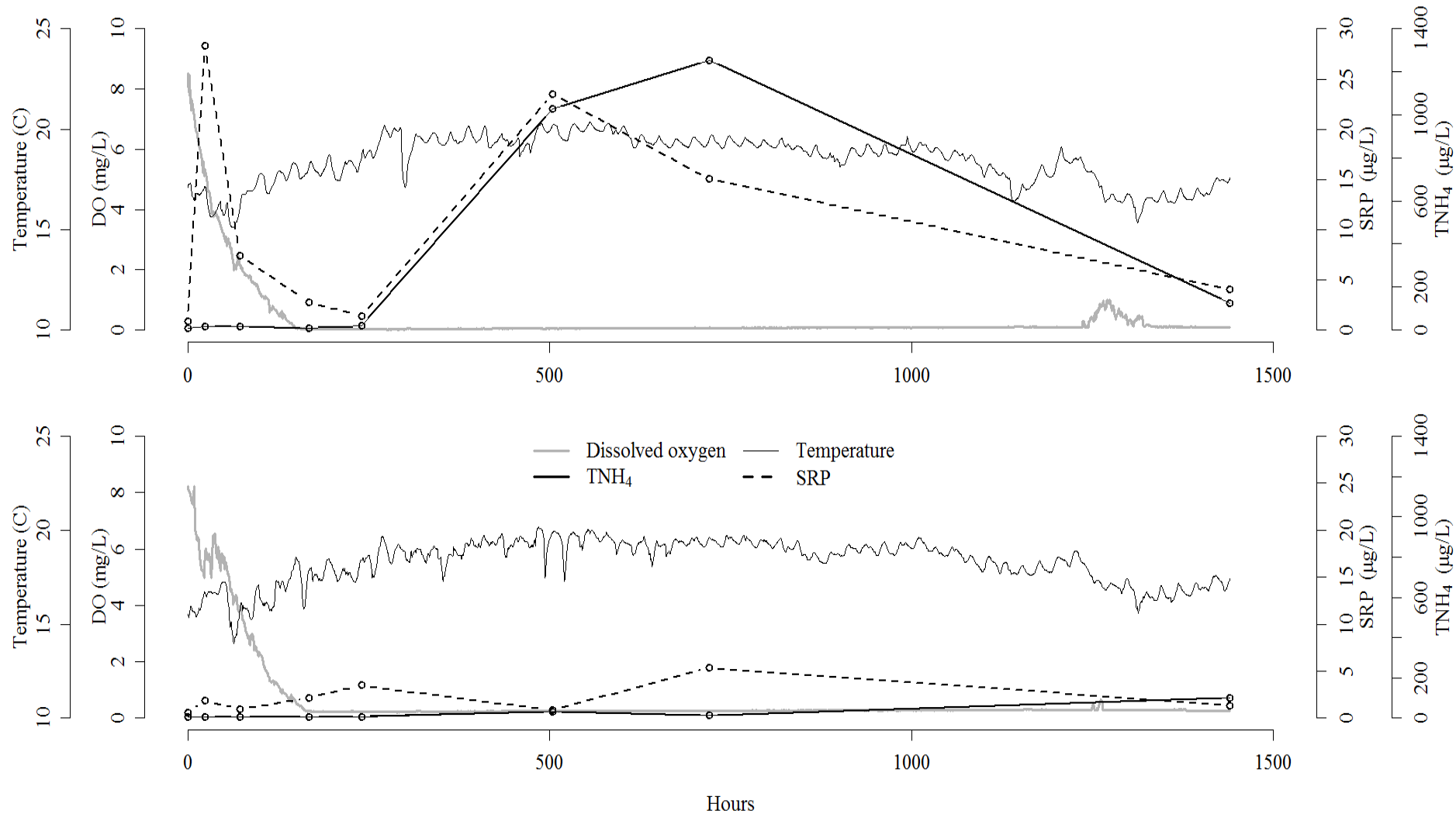


-●- Total invertebrate ···○··· *Pisidium* spp. —▲— *C. fluminea* -x- Simpson diversity index

Alternative mechanisms for Asian clam mortality: Field experiment to look at the development of nutrient concentrations in bottom barrier conditions



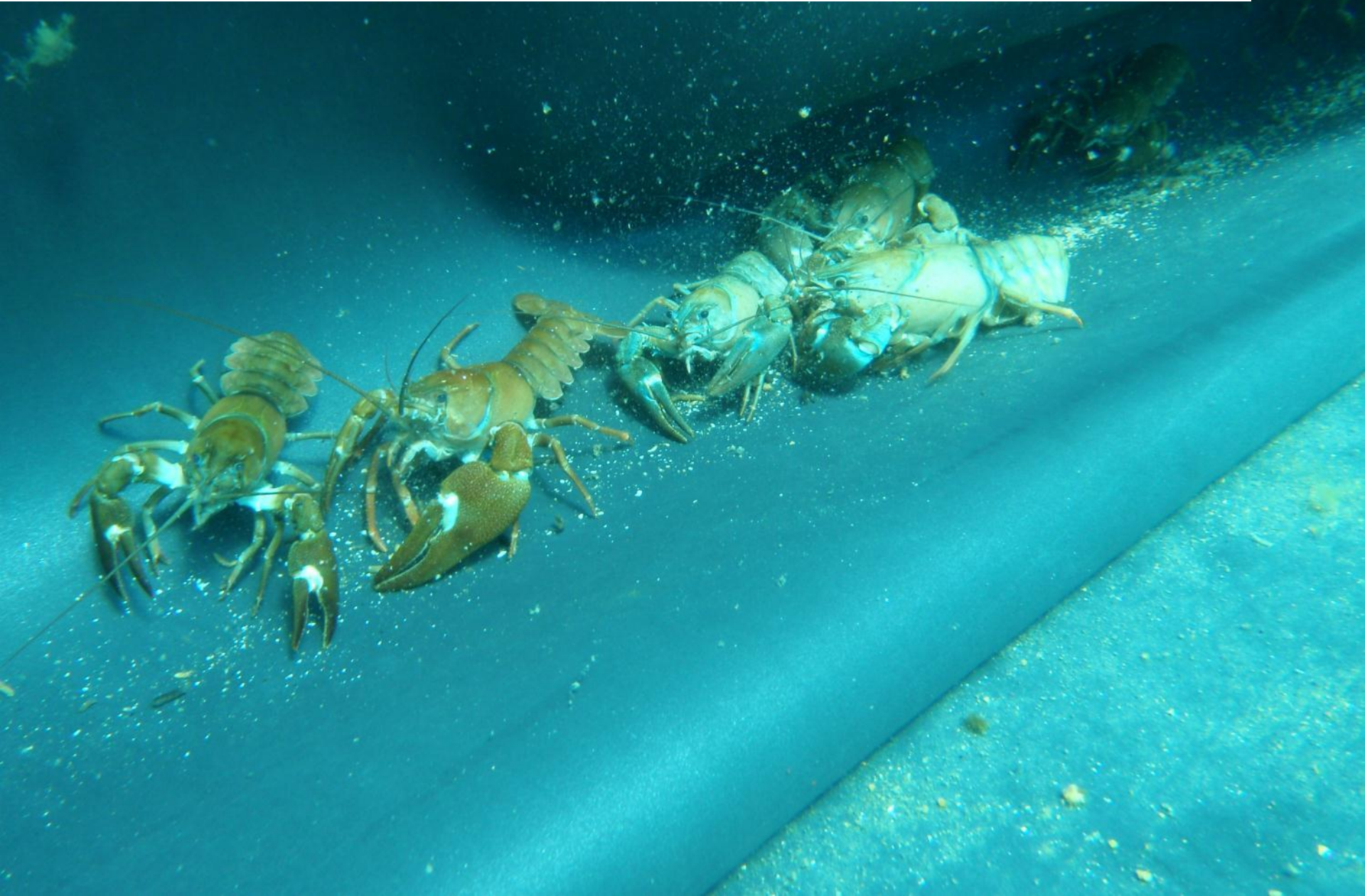
Presence of Asian clam significantly introduces ammonium to the bottom barrier environment—potentially affecting mortality rates



Impact of management: Increased filamentous algal blooms in bottom barrier locations



Impact of management: Increased nonnative crayfish (*Pacifastacus leniusculus*) in bottom barrier locations



Conclusion



- EPDM bottom barriers can reduce dissolved oxygen concentrations in 3 – 5 days under specific conditions
- Exposure to anoxic conditions for 28 days results in 99 – 100% Asian clam mortality
- Native benthic macroinvertebrate populations are also experiencing mortality as a result of bottom barrier application
- After 1 year, Asian clam population abundances in barrier plots are at approximately 9% of non-treatment areas
- Recolonization patterns show shifts in relative abundances of native and non-native benthic macroinvertebrates
- Management of Asian clams is impacting the benthic environment in the short term (up to 1 year period)

The management of invasive species establishment requires:

- Rapid response
- Understanding of impacts to ecosystem functioning
- Knowledge of short term and long term impacts of management actions and associated costs
- Comprehensive management plan
- Coordination between science, management and policy



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