



The AIS Challenge at Lake Tahoe

Aquatic Invasive Species Are Well Established in the Lake. Which Lake Do You Prefer?

August 2015

A Brief History of Aquatic Invasive Species at Lake Tahoe: The Tipping Point?

In 2008, with the threat of invasion from some of the most destructive aquatic invasive species (AIS) known (quagga and zebra mussels) approaching Lake Tahoe’s doorstep, Basin partners jumped into action to launch the nation’s most comprehensive boat inspection program. Now seven years later and with not one new invasion, the Lake Tahoe AIS Program is widely considered a national model for how to effectively keep new AIS from entering a water body. This \$1.5 million per year program (funded by user fees and public dollars) has inspected 43,000 boats and decontaminated 21,000 boats while finding hundreds of potential invaders threatening Lake Tahoe, including mussels on twelve boats in 2014.

However, prior to shutting the door on new AIS in 2008, nearly 30 non-native species had already made their way into the Lake. Documentation of these species and their locations around the Lake began in earnest in the mid-1990s even though many were introduced (both intentionally and accidentally) many decades prior. Since their introduction, they have established into prolific infestations and are spreading rapidly, altering the environment in ways that could change the Lake Tahoe we know forever.

Aquatic invasive plants, warm water fish and invertebrates have the adaptive ability to make their surroundings more hospitable for themselves and other invasives, while simultaneously threatening the wellbeing of Tahoe’s native species. These AIS are thriving in the Lake right now. By cycling nutrients, altering food webs, preying on native species and covering pristine beaches with clam shells and mats of weeds, they threaten a \$5 billion economy while destroying the unique clarity that makes Lake Tahoe an annual destination for over three million visitors. The good news is that Tahoe now has a plan in place to systematically control these species and take back the Lake.¹

Photos (clockwise from top left): Tahoe Resource Conservation District (TRCD), peterspain.com, TRCD



Key Invasive Species of Concern (year introduced)²

Signal Crayfish (invertebrate)	late 1800s
Mysid Shrimp (invertebrate)	1960s
Eurasian Watermilfoil (plant)	1970s
Bass, Bluegill, Goldfish (warm water fish)	1970s
Asian Clams (invertebrate)	2002
Curlyleaf Pondweed (plant)	2003
American Bullfrog (amphibian)	2004

Implementation Plan for the Control of AIS within Lake Tahoe

Researchers at the University of Nevada, Reno developed the Implementation Plan in collaboration with the Lake Tahoe AIS Coordination Committee and with review by an AIS expert panel of individuals from academic, management and regulatory backgrounds. They designed the Implementation Plan to serve as an ecologically-based approach to prioritizing species, locations and strategies for removal and control of AIS at Lake Tahoe for the next three to five years. Seven of the most damaging species were categorized into **three categories** of management recommendations.

Category 1 Species | Feasible Control Action

- Eurasian Watermilfoil (plant)
- Curlyleaf Pondweed (plant)
- Warm Water Fish

Resources should be focused on these species first because there are existing control methods that have been used successfully at Lake Tahoe and removal of these species may lead to the reduction of other AIS in the Lake.

Eurasian watermilfoil and curlyleaf pondweed grow rapidly and spread easily, forming dense mats of vegetation. These infestations inhibit recreation, cycle nutrients into the water column leading to increases in algal growth, decrease water clarity and provide habitat for invasive warm water fish. Warm water fish in turn alter the food web through predation, decreasing the biodiversity of native fish species.

Originating on the south shore of Lake Tahoe, Eurasian watermilfoil was identified at 13 sites around the Lake in 1995, increasing to 18 sites in 2012. Curlyleaf pondweed was identified at two sites in 2003 and now occupies eight sites as of 2012.

Both aquatic invasive plants spread through fragments transported by currents and boats as well as by root structures, seed and in the case of curlyleaf pondweed,

by clone structures called turions. In 2006, invasive warm water fish species were found in 12 of 19 sites surveyed, but current distribution is unclear.

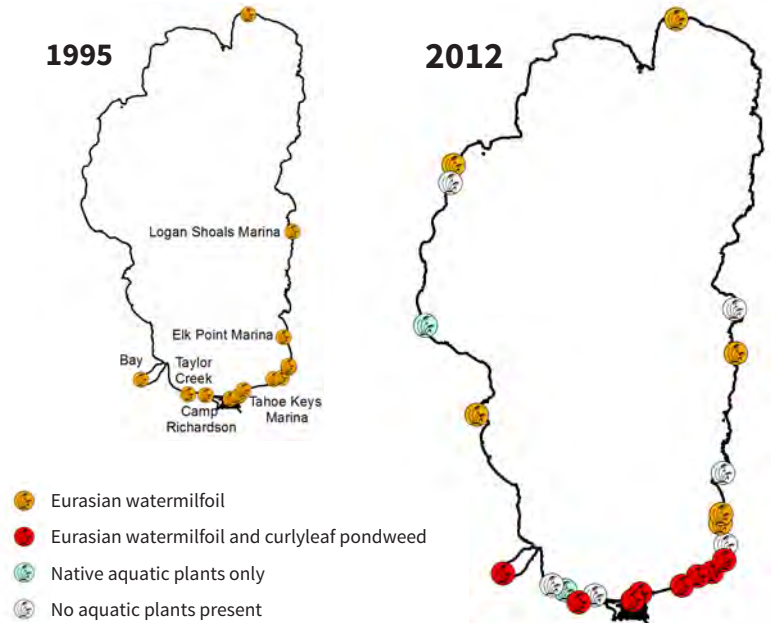
Recommended Action: Control

Efforts to remove a nearly 6 acre infestation of Eurasian watermilfoil in iconic Emerald Bay proved successful through a multi-year comprehensive strategy using bottom barriers to block out sunlight, followed by SCUBA diver-assisted suction and hand removal of plants. As of 2015 there are no longer aquatic invasive plants at this site. This methodology has been used effectively at other infestations in Lake Tahoe including lakeside of the Tahoe City Dam where a quarter acre infestation was removed in 2014. Mechanical removal of warm water fish using electro-shocking has decreased these fish populations in the short term. Multi-year treatments are recommended to occur in concert with aquatic invasive plant removal efforts. All control efforts need to include post-project monitoring to assess effectiveness.

Photos: Phil Caterino (left), California State Parks (right)



Spread of Invasive Aquatic Plants in Tahoe



Category 2 Species | Potential Control Action

- American Bullfrog (amphibian)
- Signal Crayfish (invertebrate)

There are existing control methods that have proven to reduce populations of these species but the long-term feasibility of these methods for use at Lake Tahoe is still unknown.

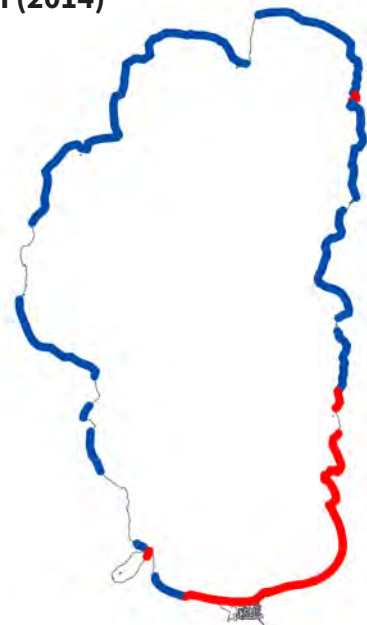
American bullfrogs have been observed along the south shore since 2004, including several breeding populations. Signal crayfish populations dominate the nearshore zone around the entire Lake with the highest densities along the west and north shores. Both species are voracious predators that significantly alter the food web, while crayfish can also provide a food source for invasive warm water fish species.

Recommended Action: Increased Monitoring

Crayfish are currently being commercially harvested but it is unknown if this action is significantly reducing populations. It is unclear at this time if American bullfrog populations are increasing in Tahoe and what unwanted effects may be occurring. Increased monitoring of both species will assist in guiding future control actions. In areas where bullfrogs persist, proposed future projects should include monitoring and potential control actions.²

Asian Clam Distribution (2014)

- Absent
- Present



Category 3 Species | No Feasible Control

- Mysid Shrimp (invertebrate)
- Asian Clams (invertebrate)

At this time, no control method that is allowed at Lake Tahoe has been proven to be successful in effectively reducing populations.

Mysid shrimp were intentionally introduced into Lake Tahoe in the 1960s as a food source for game fish (kokanee salmon and lake trout). They now persist in high densities (300 individuals per square meter) throughout the lake. They dramatically alter the native food web and have been proven responsible for fisheries collapse in other regions. There are no known control methods for mysid shrimp.

In 2002, researchers found low densities (two to 20 individuals per square meter) of Asian clams in a small section of the southeastern portion of the Lake, but by 2014, populations had spread along approximately 13 miles of shoreline from Cave Rock to Baldwin Beach (including a six acre satellite population at the mouth of Emerald Bay), with densities reaching 5,000 individuals per square meter in some areas. Once established, Asian clams dominate the lake bed and have been associated with algal blooms. Their shells also wash up on beaches in large numbers, affecting aesthetics and usability.

Recommended Action: Research Control Methods

Small scale control actions in areas where Asian clams are causing negative impacts to water quality should still be implemented while continuing to research a combination of control methods for future use.²

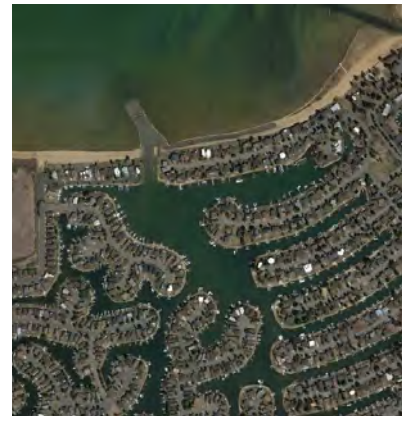
Photos, from top: Carl D. Howe, licensed under CC BY-SA 2.5; Wikipedia user MdE, licensed under CC BY-SA 3.0

Site Prioritization for Control Actions | Category 1 Species

A decision support tool was developed, with factors including fish/plant interactions, infestation size, human visitation and satellite populations. **The goal is to reduce overall expansion of these species in Lake Tahoe**

1. Tahoe Keys Main Lagoon
2. Tahoe Keys Marina
3. Meeks Bay
4. Ski Run Marina & Channel
5. Tahoe City Dam
6. Lakeside Marina
7. Regan Beach
8. Taylor Creek
- 9-11. Crystal Bay Marinas 1,2,3

These ecologically-driven priorities will be further refined in an action list based on factors such as cost and feasibility.



Tahoe Keys

The Tahoe Keys is a large private homeowners development and commercial marina completed in the 1960s within the Upper Truckee meadow. It consists of 1,529 homes covering 372 acres of land and 172 acres of interconnected waterways, with three outlets to Lake Tahoe. Several AIS were introduced beginning in the 1970s and 80s that have now become established populations and a potential source for spread to the rest of Lake Tahoe.

Two of these invasive aquatic plant species, Eurasian watermilfoil and curlyleaf pondweed, along with a nuisance native aquatic plant, coontail, now occupy nearly 100 percent of the waterways. The environment created within the Tahoe Keys provides the perfect habitat for invasive warm water fish and the potential introduction of other AIS. Any efforts for long-term control of these species in Lake Tahoe are

contingent upon control within the Tahoe Keys.

The Tahoe Keys Property Owners Association (TKPOA) invests \$400,000 per year to “harvest” these plants in order to maintain use of the channels. A better solution is needed and the TKPOA has recently completed an Integrated Weed Management Plan (IWMP) to address this problem.

Recommended Action

The IWMP recommends a suite of control actions including the placement of bottom barriers, shifts in landscape practices to reduce nutrient inputs and targeted herbicide application (among others). The implementation of this plan still requires regulatory agency approvals and extensive environmental review with a target date for action no sooner than 2017.³

We Must Continue the Fight

The Lake Tahoe AIS Program, a partnership composed of 40 agencies and organizations, has successfully prevented new introductions of AIS into Lake Tahoe since 2008 and provides the framework for successful implementation of AIS control actions moving forward.

The recent development of two science-based control plans for Lake Tahoe and the Tahoe Keys offers the guidance needed to systematically and comprehensively stop the assault of AIS on Lake Tahoe. Additionally, the recent

passing of California Senate Bill 630 (SB630) provides funding from private pier and buoy leases, a portion of which is directed to AIS control efforts at Lake Tahoe. With the combination of best available science, extensive public education, agency collaboration and private sector participation solving the AIS Challenge is within reach.

We must continue to make progress. The next step is to secure the additional funding needed to expand and improve the control efforts to protect the Lake.

Information in this overview is drawn from the following management plans.

1. TRPA (Tahoe Regional Planning Agency). 2014. Lake Tahoe Region Aquatic Invasive Species Management Plan, California - Nevada. 35 pp. + Appendices.



2. Wittmann, M.E. and Chandra, S. 2015. Implementation Plan for the Control of Aquatic Invasive Species within Lake Tahoe. Lake Tahoe AIS Coordination Committee, July 31, 2015. Reno, NV. 52 pp.



3. August 2015. Draft Integrated Weed Management Plan for the Tahoe Keys Lagoons. Prepared by Sierra Ecosystem Associates for the Tahoe Keys Property Owners Association.



You can make a difference.

Contact one of these organizations or agencies to get involved.



Photos (clockwise from top left): League to Save Lake Tahoe, League to Save Lake Tahoe, Map data ©2015 Google, Tahoe Resource Conservation District