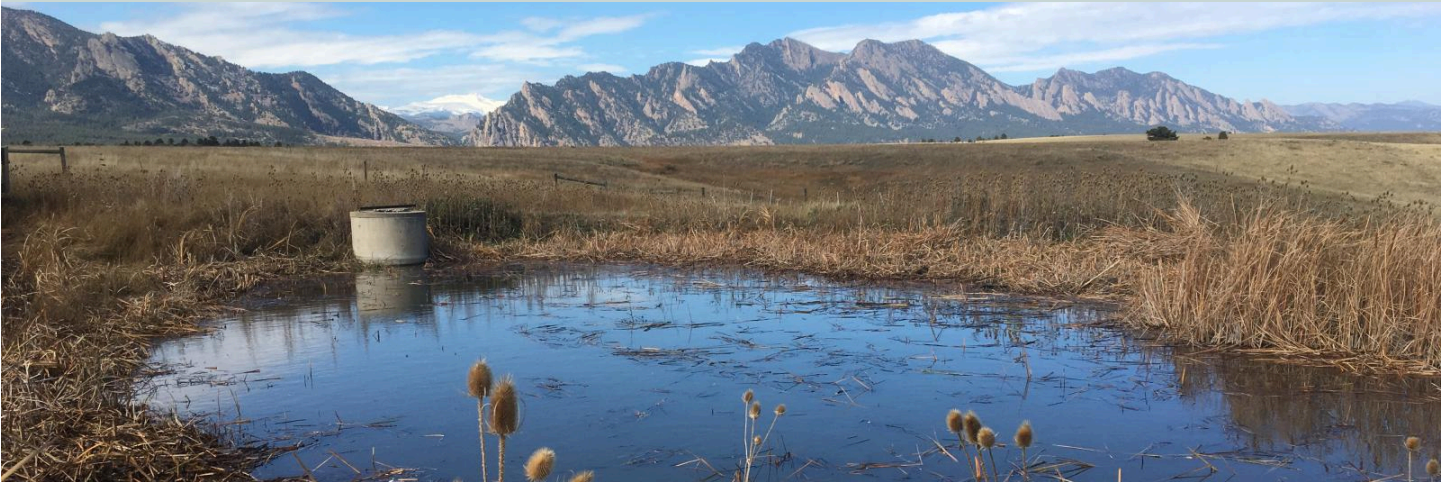




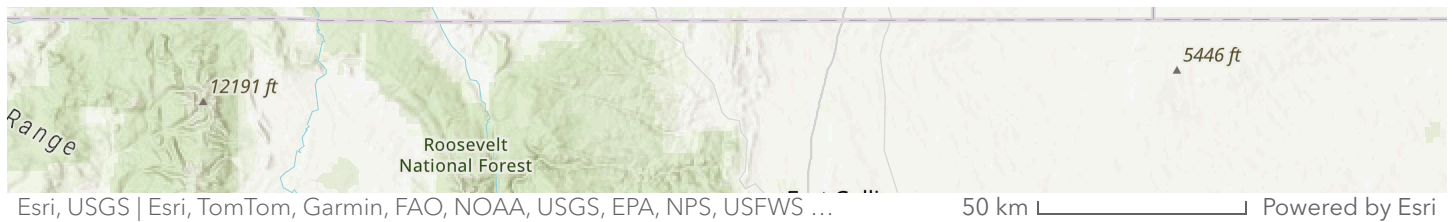
Case Study by CART



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Habitat Restoration and Bullfrog Removal in Support
of Northern Leopard Frog Conservation

A Case Study on Restoration
January 30, 2024



Introduction

The northern leopard frog (NLF; *Lithobates pipiens*) was once common throughout the wetlands of the western and northern United States and southern Canada. Since the 1960s, populations have declined due to habitat loss, habitat degradation, disease, and the presence of invasive species. Declines are especially severe in western North America. While the species is not federally listed under the Endangered Species Act, it is identified as a Species of Greatest Conservation Need in many western states, considered sensitive, threatened, or endangered due to widespread extirpations.

In Colorado, the City of Boulder's Open Space and Mountain Parks (OSMP) department manages Boulder's natural environment, conserves habitats for native plants and wildlife, and provides recreational and agricultural opportunities. The OSMP encompasses 47,000 acres of grassland and forest in the Front Range, a region east of the Southern Rocky Mountains which once supported abundant populations of NLFs. However, since the 1980s, invasive American bullfrogs (*Lithobates catesbeianus*) have displaced NLFs from historical habitats on OSMP. Additionally, invasive cattails (*Typha* spp.) have decreased habitat availability for the species, leaving them particularly vulnerable. To restore habitat and improve outcomes for NLFs on Boulder's OSMP, OSMP wildlife ecologists are engaged in ongoing efforts to remove cattails and manage bullfrogs.



Key Issues Addressed

Historic land use practices have transformed the natural hydrologic regime on Boulder's OSMP. Over the past 200 years, many rivers and streams on the Front Range have been channelized to control flooding and support agriculture, resulting in fewer ephemeral water bodies. Additionally, gravel mining in the region created more permanent water bodies. While NLFs can breed in permanent and ephemeral waters, threats are greater in permanent water bodies that serve as better habitat for bullfrogs and predatory fish.

Bullfrogs threaten NLFs and other native species through predation, competition, and disease transmission. Due to their generalist diet, large size, high fecundity, and high mobility, bullfrogs often outcompete native frogs for food and resources. Bullfrogs serve as vectors for chytridiomycosis ([Schloegel et. al.,](#)

[2012](#)), a disease associated with global amphibian declines ([Fisher & Garner, 2020](#)). While bullfrogs are resistant to the effects of infection, they can act as carriers introducing the disease to vulnerable amphibians ([Borzée et. al., 2017](#)).

Chytridiomycosis is caused by the fungus *Batrachochytrium dendrobatidis* (Bd), which infects its hosts and releases waterborne zoospores. Since Bd survives in water for many weeks, greater density of permanent water bodies is associated with increased infection risk ([Ruggeri et. al, 2018](#)).

NLFs require shallow water to breed and native vegetation just below the water's surface to attach their egg masses to. Invasive cattails thrive in conditions supporting ephemeral water followed by a period of exposed wet mud to effectively set seed. Cattails also spread by rhizomes, forming large dense stands that block access to shallow water and outcompete the low-emergent vegetation (*Carex* spp.) NLFs rely on for breeding habitat. While cattails are also emergent vegetation, they are not suitable substrate for NLF breeding because they block out sunlight needed for NLF egg development.

Project Goals

- Reduce water levels at select sites to eliminate bullfrog egg masses and tadpoles
- Remove adult bullfrogs to reduce disease transmission, predation, and competitive pressure on NLFs
- Remove invasive cattails and plant native vegetation to restore NLF breeding habitat

Image Caption: A pond on Shanahan Ranch prior to cattail (*Typha* spp.) removal. Courtesy of City of Boulder Open Space and Mountain Parks Department Staff.



Project Highlights

PLANTING NATIVE VEGETATION

After removing invasive cattails, ecologists reintroduced native plants such as soft-stem bulrush (*Schoenoplectus tabernaemontani*) to create breeding habitat for NLFs, and other native amphibians, while preventing cattail regrowth.

- **Non-Native Aquatics Treatment Techniques:** Since 2015, project ecologists have removed approximately 500 adult bullfrogs from 10 sites where NLFs had been observed. Removal techniques included seines, dip nets, and air rifles. After 6-7 years of continuous removal, ecologists now only need to remove one or two bullfrogs from some sites while other sites remain bullfrog-free. Bullfrog tadpoles rely on permanent water to complete their 1-3 year metamorphosis, during which they are not able to migrate. Ecologists used a large trash pump to drain select ponds, eliminating bullfrog

tadpoles and egg masses if they missed a breeding event. During winter, bullfrogs hibernate in permanent water bodies that don't freeze. Ecologists prevented bullfrog survival at some sites by installing an Agri Drain water control structure to lower water levels enough to freeze. Water control had the added benefit of eliminating predatory fish.

- **Collaborative Cattail Removal:** To remove cattails, ecologists collaborated with workers from [Boulder Bridge House](#), a non-profit providing housing and employment to people experiencing homelessness. Teams used weed whips specially designed to be used under water to cut cattails, then raked the cuttings into piles to be removed with a mini-excavator, and composted. Since 2019, teams have removed approximately 84 tons of cattails. After teams remove aquatic cattails, the OSMP Vegetation Stewardship crew uses herbicide to manage shoreline cattails.
- **Rotational Grazing:** Ecologists worked with local ranchers at leased sites to support cattle grazing for cattail removal. To ensure grazing did not impact frogs or native vegetation, project ecologists promoted grazing during the fall hibernation at sites without native vegetation. Within a few weeks, cattle browsed cattails and other invasive vegetation including teasel (*Dipsacus* spp.) and Canada thistle (*Cirsium arvense*), to the point in which the need for herbicide use or mechanical removal was negated.

Image Caption: *A pond on Shanahan Ranch after cattail (Typha spp.) removal and reinstatement of native vegetation. Courtesy of City of Boulder Open Space and Mountain Parks Department Staff.*



Lessons Learned

Intensive monitoring was key to the success of restoration efforts. Managers conducted 1-10 visual encounter surveys per year for each of approximately 200 sites. Monitoring ensured that managers had an inventory of bullfrogs, allowing them to respond proactively to prevent bullfrog colonization and breeding events. Monitoring also allowed managers to track the status of NLF populations on OSMP. Ecologists have seen around 10 stable metapopulations following cattail and bullfrog removal.

Ecologists initially removed bullfrogs using seine and dip nets, but have recently begun to use air rifles. Air rifle use requires a special take permit issued by the State, but allows ecologists to remove bullfrogs more efficiently than hand-capture methods that disturb the water and can cause bullfrogs to scatter, making them harder to capture. By targeting adult bullfrogs, ecologists

prevented breeding and future population growth, reducing the overall number of animals and egg masses to be removed.

Cattail removal efforts were initially labor-intensive. After cattails grow to 8-10 ft, they begin to fall over and form thick, tangled mats. Due to the difficulty of removing areas with significant cattail build-up, workers at one site spent approximately 160 person hours removing cattails. However, the time needed to maintain the site eventually decreased to 1-2 hours per year.

Managers must consider specific time and removal techniques when removing cattails. Because cattail seeds may spread during the removal process, managers should try to remove cattails during the dry season to reduce the amount of water that dispersed seeds receive. In one case, late rain caused dispersed cattail seeds to germinate, undoing previous removal work. Since cattails require contact with air to respire, managers should cut below the surface of the water. This causes the remaining cattail stalks to become fully inundated, essentially drowning and killing them. Additionally, managers should remove cut cattails whenever possible to reduce wetland fill and prevent decreases in dissolved oxygen due to cattail decay.

Managers should limit grazing to enclosed areas with invasive vegetation and during the fall when NLFs are overwintering. Extensive grazing can damage wetlands, managers should pay close attention to grazing length and stocking rates. At one site, overgrazing damaged a pond outlet, negatively impacting the habitat.

OSMP ecologists participate in the Colorado Frog Working Group, which consists of land managers and wildlife biologists from government agencies and independent biologists. By learning from other managers' successes and failures, OSMP ecologists saved time and money.

Image Caption: *Cattail (Typha spp.) treatment site prior to cattail removal. Courtesy of City of Boulder Open Space and Mountain Parks Department Staff.*



Next Steps

- Continue monitoring amphibian populations across OSMP
- Continue cattail removal, planting of native, low-emergent vegetation, and bullfrog removal at four to six sites annually
- Meet quarterly with ecologists in the Colorado Frog Working Group to share resources and discuss NLF habitat restoration efforts

Image Caption: *Cattail (Typha spp.) treatment site after cattail removal. Courtesy of City of Boulder Open Space and Mountain Parks Department Staff.*



Resources

February 2024 Case Study Handout

Collaborators

- [City of Boulder Open Space & Mountain Parks](#)
- [Colorado Parks and Wildlife](#)
- [Boulder Bridge House](#)

Resources

- Presentation: [Northern Leopard Frog Habitat Restoration on OSMP - 1st Half](#) by Will Keeley and Ryan Prioreshi
- Presentation: [Northern Leopard Frog Habitat Restoration on OSMP - 2nd Half](#) by Will Keeley and Ryan Prioreshi

- Colorado Parks & Wildlife [Leopard Frogs Factsheet and Habitat Scorecard](#)
- Colorado Parks & Wildlife [Northern Leopard Frog, American Bullfrog Species Profiles](#)
- U.S. Fish & Wildlife [Northern Leopard Frog Species Page](#)
- Johnson, P. et al. (2011). "[Regional Decline of an Iconic Amphibian Associated with Elevation, Land-Use Change, and Invasive Species.](#)" *Conservation Biology* 25(3): 556-566.
- Fisher, M., and T. W. J. Garner. (2020). "[Chytrid fungi and global amphibian declines.](#)" *Nature Reviews Microbiology* 18: 332-343.
- Schloegel, L. M. et. al. (2012). "[Novel, panzootic and hybrid genotypes of amphibian chytridiomycosis associated with the bullfrog trade.](#)" *Molecular Ecology* 21(21): 5162-5177.
- Ruggeri, J. et al. (2018). "[Amphibian chytrid infection is influenced by rainfall seasonality and water availability.](#)" *Diseases of Aquatic Organisms* 127: 107-115.
- Borzée, A. et al. (2017). "[Introduced bullfrogs are associated with increased Batrachochytrium dendrobatidis prevalence and reduced occurrence of Korean treefrogs.](#)" *PLoS One* 12(5): e0177860.
- Bansal, S. et al. (2019). "[Typha \(Cattail\) Invasion in North American Wetlands: Biology, Regional Problems, Impacts, Ecosystem Services, and Management.](#)" *Wetlands* 39: 645-684.

Photo Gallery

- [Photo Album and Credits](#)

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Image Caption: *Waneka pond after cattail removal. Courtesy of City of Boulder Open Space and Mountain Parks Department Staff.*

More Information on CART