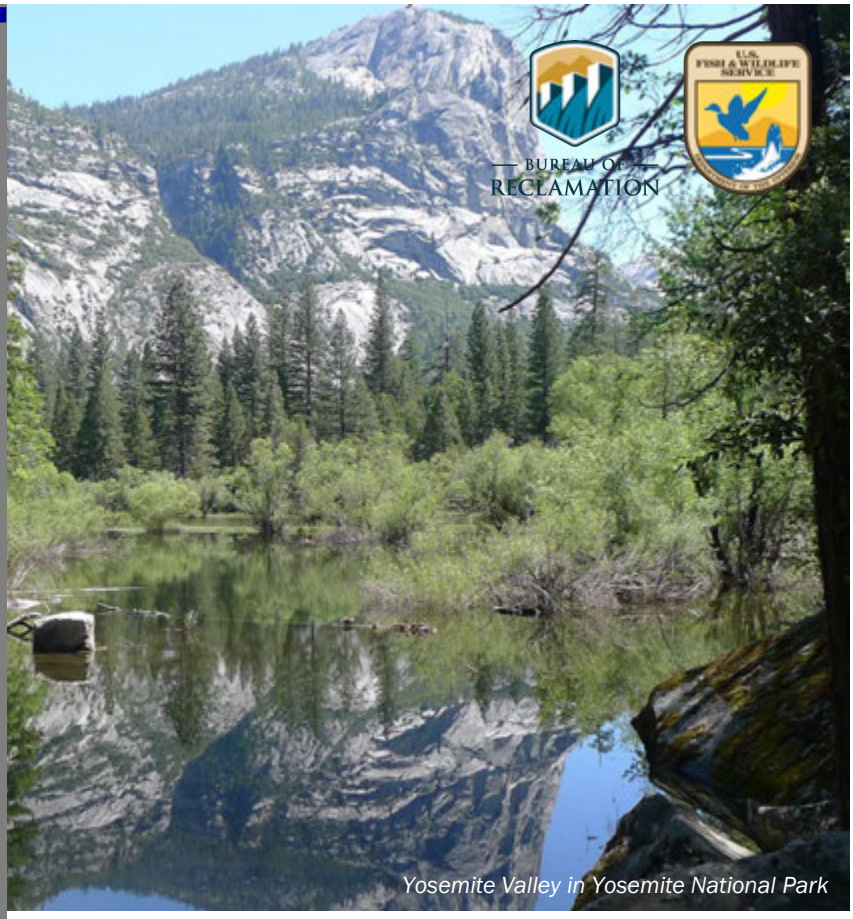
RESTORATION

Successful Bullfrog Eradication at a Landscape Scale in Yosemite National Park

Known for its dramatic landscape and towering granite walls, Yosemite National Park is also home to a unique assemblage of native reptiles, amphibians, and fishes. Yet, non-native American bullfrogs (*Lithobates* (*Rana*) *catesbeianus*) were introduced to Yosemite in the 1950s, with the first bullfrog documented in 1955 at the Ahwahnee Hotel's reflection pond, and have likely contributed to the decline of many native aquatic species since then. National Park Service (NPS) biologists have conducted bullfrog control since the early 2000s. To date, they have achieved eradication within 1,500 hectares of the Yosemite Valley, with the last bullfrog documented in 2019.



Yosemite Valley in Yosemite National Park

KEY ISSUES ADDRESSED

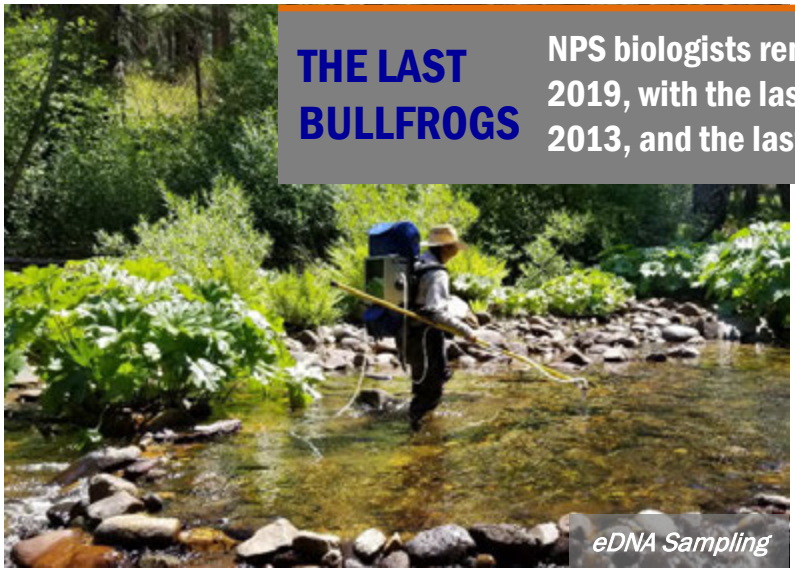
Bullfrogs are highly successful invaders due to a combination of biological characteristics including high fecundity and generalist diets that enable them to establish populations outside of their native range. Bullfrogs also prey upon and outcompete native species. Native aquatic populations have declined in the Yosemite Valley, likely due to abundant bullfrog colonization by the 1960s, including several species of native frogs, the Western toad (*Anaxyrus* (*Bufo*) *boreas*), and Western pond turtle (*Actinemys* (*Emys*) *marmorata*). Given its unique geography, intact high-quality habitat, and year-round flows, Yosemite Valley offers NPS biologists the opportunity to increase native reptile, amphibian, and fish recovery through extensive bullfrog removal efforts.

PROJECT GOALS

- Eradicate bullfrog populations from Yosemite Valley in Yosemite National Park
- Use environmental DNA (eDNA) sampling to ensure remaining bullfrogs are detected
- Re-establish native aquatic species after achieving bullfrog eradication, including the California red-legged frog (*Rana draytonii*)

THE LAST BULLFROGS

NPS biologists removed over 8,000 bullfrogs between 2005 and 2019, with the last egg mass removed in 2012, last tadpole in 2013, and the last adult recorded in 2019.



eDNA Sampling

PROJECT HIGHLIGHTS

Annual Surveys: Bullfrogs were removed opportunistically since the 1990s, and annually from 2005 to 2015 with a one to two-person crew from mid-May (onset of breeding) to late August with mechanical removal techniques. Crews surveyed all available bullfrog breeding habitats including slack water, ponds, and stagnant streams. Bullfrog breeding was detected at six total locations (five natural locations and one artificial pond), and bullfrogs were observed in 15 flooded areas.

eDNA to Monitor Success: NPS biologists incorporated eDNA in 2015 to increase their bullfrog detections. From 2016 to 2019, biologists were able to detect bullfrogs with eDNA that they did not observe with traditional visual survey methods. Through eDNA surveys, biologists were able to detect if bullfrogs were still present in the valley following mechanical removal efforts.

California Red-Legged Frog Reintroductions: Biologists began California red-legged frog re-introductions in 2016. Red-legged frogs were captive-reared at the San Francisco Zoo, with over 1,000 adult frogs reintroduced into Yosemite Valley between 2016 and 2019.

Collaborators

- Yosemite National Park
- Goldberg Lab, Washington State University

Funding Partners

- National Park Service
- Yosemite Conservancy

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Photos courtesy of National Park Service
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LESSONS LEARNED

Bullfrog removal in the Yosemite Valley demonstrates that, in the context of this project location, successful bullfrog removal increased opportunities for native aquatic species recovery. For example, California red-legged frog reintroductions have been successful, with egg masses observed at multiple locations in 2019, evidence that frogs translocated from captive rearing at the San Francisco Zoo are successfully reproducing. In addition, while anecdotal, park visitors and residents have observed that tree frogs are much louder at night and are seeing western toads that haven't been observed in decades. Overall, native amphibian populations visually appear to be increasing, although further surveys will need to be conducted before making population-level assessments of resident native aquatic species.

In Yosemite National Park, bullfrog removal was very well received by visitors and the general public. Generally, through outreach and education, bullfrog removal was well-supported to restore native species, such as California red-legged frogs.

eDNA was used for detecting remaining bullfrogs that were not found with other survey methods. eDNA, used in conjunction, with traditional methods can therefore be a useful strategy for monitoring non-native species like bullfrogs.

NEXT STEPS

- Continue annual bullfrog monitoring using visual encounter and eDNA survey methods
- Continue monitoring California red-legged frogs using visual encounter and capture, mark, recapture techniques

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Juvenile Bullfrog on a Lillypad