



## Section 319

# NONPOINT SOURCE PROGRAM SUCCESS STORY

# Oregon

## Eradication of Invasive Species Restores Lake Water Quality

### Waterbody Improved

The danger of toxins from blooms of blue-green algae led officials to sometimes close Diamond Lake for contact use recreation. As a result, Oregon Department of Environmental Quality (ODEQ) included Diamond Lake on the 1998 303(d) list of impaired waters for pH and algae. Excess algae resulted from a shift in the trophic levels after the introduction of tui chub, a nonnative fish species. After careful planning, project partners successfully eradicated the fish in the fall of 2006, and water quality conditions improved dramatically. Currently, all water quality standards are being met and ODEQ expects to remove Diamond Lake from the list in the next assessment cycle in 2010.

### Problem

Diamond Lake is situated between two volcanic peaks in the southern Oregon Cascade Mountains in the Umpqua National Forest (Figure 1). Perched at 1,580 meters, or about 1 mile elevation, Diamond Lake developed into a world-renowned trout fishery after Oregon Fish and Game officials began stocking it with rainbow trout in 1910.

Oregon first added Diamond Lake to its 303(d) list of impaired waters in 1998 due to high pH and chlorophyll *a* values found during the summer when the lake experienced excessive algal blooms. In 2004 it was also listed for low dissolved oxygen and high pH values during the fall, winter and spring. Algae blooms resulted from a shift in trophic levels due to the introduction of tui chub, a nonnative species of fish used as live bait by recreational fishermen. The tui chub overtook the lake's ecosystem and consumed many of the small aquatic organisms that normally control algae growth. Toxic blue-green algae proliferated, which caused the lake to fail to support its designated uses of aesthetics, fishing and water contact recreation.

ODEQ developed the Umpqua Basin Total Maximum Daily Load (TMDL) in 2006. The TMDL determined that biomass limitation through the eradication of the tui chub would improve water quality and restore the lake's beneficial uses.

### Project Highlights

Thorough planning efforts led to a well-coordinated drawdown of the lake in September 2006 and subsequent treatment with rotenone to remove the

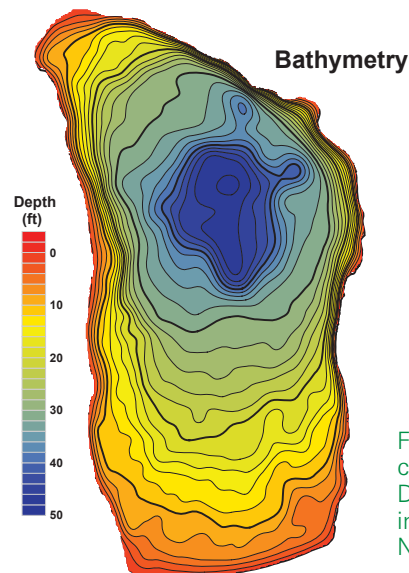


Figure 1. Depth contours of Diamond Lake in the Umpqua National Forest.

tui chub. Rotenone is a naturally occurring chemical derived from the roots of several tropical and subtropical plant species. Routinely used to control unwanted fish species, rotenone is rapidly broken down in soil and water and usually loses toxicity within six days. The lake drawdown reduced the quantity of water to be treated and maximized the mechanical removal of tui chub biomass before rotenone application. Pretreatment netting removed 68,000 pounds of tui chub. Mechanical and hand removal of the dead chub after rotenone treatment recovered an additional 35,000 pounds of tui chub carcasses. All chub were composted and later used as a nutrient supplement for farming operations.

## Results

Diamond Lake met all water quality standards not long after chub removal. In late 2007, chlorophyll *a* values decreased from a high of 50 µg/L before rotenone treatment to less than 10 µg/L (the water quality criterion) after treatment (Figure 2). Algal production is being held in check by the reestablished zooplankton populations. Midsummer water

Figure 2. Reduction in algal blooms, as represented by chlorophyll *a*, before and after chub removal.

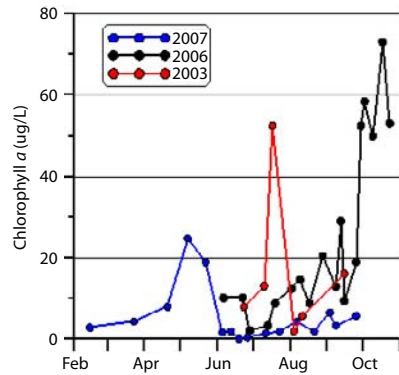


Figure 3. Transparency depths with and without tui chub shows the Secchi disk readings at the height of the tui chub population in 2006 and extreme clarity in the summer of 2007.

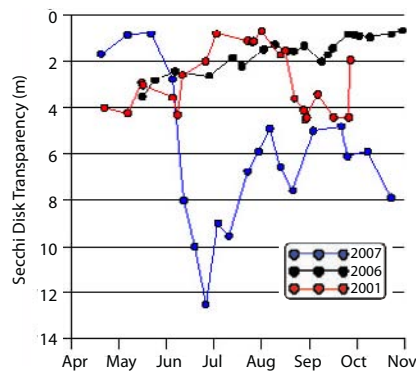
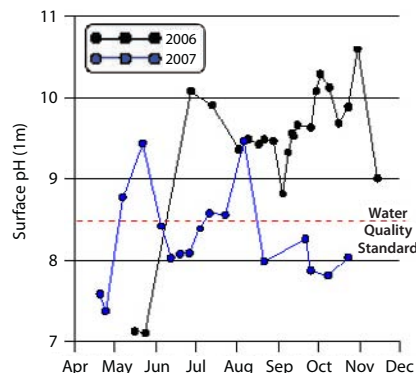


Figure 4. Observed overall decrease in pH after eradication of tui chub. Excursions over the pH criteria in 2007 are natural and can occur during extended periods of above-average air temperature and below-average wind velocities.



clarity increased from an average of 10 feet to nearly 50 feet, the lake's depth at its deepest point (Figure 3), and blue-green algae declined from the dominant type of algae to a very small percentage of the algal community. The lake remained cooler in 2007, which can be attributed to reduced algal populations in the upper layers that absorb solar energy. After the spring of 2007, scientists observed that pH values recovered to below or near the 8.5 criteria value (Figure 4). Zooplankton populations have rebounded and trout restocking led to increased angler catches in 2007.

Water quality improvements have restored the aquatic life designated use. On the basis of the data, ODEQ expects this waterbody to continue to meet standards in the future, warranting the delisting from the 2010 303(d) list of impaired waterbodies.

## Partners and Funding

The project co-leaders included Umpqua National Forest and Oregon Department of Fish and Wildlife. ODEQ led water quality efforts, while many private and public entities played supporting roles. State Representative Susan Morgan brought together a wide range of responsible and interested parties focused on solving the deteriorating Diamond Lake water quality conditions. Additional partners include Partners for Umpqua Watersheds, Oregon Wildlife Heritage Foundation, Oregon Division of State Lands, Oregon Department of Agriculture, Douglas County, PacifiCorp, and several other state and federal agencies.

Clean Water Act section 319 funds helped support several phases of the project, including database development, baseline monitoring for the TMDL assessment and analyses of water quality following lake drawdown and rotenone application. In total, this project used \$166,338 of section 319 funds, including the state match. Diamond Lake's restored waters generate \$3.5 million annually for the state and local economies.

To keep Diamond Lake sparkling, Oregon Department of Fish and Wildlife, Oregon State Marine Board, Umpqua National Forest, and ODEQ have launched an intensive invasive species prevention campaign. The partners are communicating the following message: "Spread the word...not the unwanted species."



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