

IOWA'S WATER

Ambient Monitoring Program

Shallow Lakes in Iowa Water Quality and Biological Assessments

Since the early 1900s water quality in most of Iowa's shallow, natural lakes has slowly declined. Numerous causes have contributed to these declines, but the most important and prevalent causes are sustained high water levels, introduction of rough fish, and increased silt and nutrients. These changes have caused increased turbidity, which reduces vegetation. The loss of aquatic plant life further exacerbates declines in water quality and game fish populations (in lakes where game fish were historically present). Submerged and emergent plants maintain high water quality by anchoring sediment, preventing it from becoming suspended. Plants also compete with unicellular algae for nutrients and minimize wave energy, which can resuspend sediment. This sediment contains nutrients that become available to algae when sus-



Dead rough fish (predominantly carp) following management activities at Diamond Lake, Dickinson County.

ended. Aquatic plants also provide food and habitat for invertebrates which, in turn, are essential food for bait fish, small game fish, and waterfowl.

Plants also provide cover for young fish and a substrate for egg deposition by game fish such as northern pike and perch. Many of Iowa's shallow lakes have lost nearly all submerged and emergent vegetation, and excessive turbidity and algal blooms are common. As a result, the fisheries and waterfowl use in these lakes have suffered.

In an effort to improve water quality and bring back abundant vegetation for fish and wildlife, the Iowa Dept. of Natural Resources (IDNR) Wildlife and Fisheries bureaus are planning renovations on a number of these lakes. These efforts are in conjunction with Ducks Unlimited's "Living Lakes Initiative," a conservation effort focused



Above: In degraded shallow lakes, algae and turbidity prevent aquatic plant growth necessary for wildlife habitat.



Photos

Top: A vegetation assessment is performed at Virgin Lake, Palo Alto County.

Middle: Water quality samples are collected from a canoe at Cheever Lake Preserve in Emmet County. Cheever Lake is a rare example of an Iowa shallow lake with clear water and abundant vegetation growth.

Bottom: IDNR employee holds a large example of a Bigmouth Buffalo (*Ictiobus cyrinellus*), a common rough fish in Iowa's shallow lakes.

on shallow lake improvements in Iowa and Minnesota (www.ducks.org/conservation/initiative84.aspx). Renovation activities will vary from lake to lake but in-lake improvements (e.g., water control structures, fish barriers, active fishery management) and watershed improvements (e.g., wetlands, buffer strips, etc.) will be common management actions. By manipulating water levels, sediment can settle out, vegetation can take root, and rough fish can be killed off. Likewise, fish barriers may be installed to slow the reintroduction of "bulldozing" rough fish like carp and buffalo. Also, fathead minnows overgraze zooplankton which allows algae populations to explode. In some lakes, active fishery management will promote gamefish and displace rough fish. Improvements to the lakes' watersheds will lower the amount of silt and nutrients "feeding" the lake. Without management actions, these lakes will not revert to a "clear water" state.

The IDNR Watershed Monitoring and Assessment Section has been performing

water quality monitoring and biological assessments on several shallow lakes, which have been selected for renovation feasibility studies. This monitoring has been performed in response to a need for pre-renovation water quality and biological data. Monitoring began in 2006 and continued during 2007. After the lakes have been restored, follow-up sampling will document the changes that occurred.

Seven lakes were sampled in 2006: Diamond (Dickinson County), Four Mile (Emmet and Dickinson Co.), Dan Green Slough (Clay Co.), Virgin (Palo Alto Co.), Pickerel (Buena Vista Co.), Lizard (Pocahontas Co.), and South Twin (Calhoun Co.). In 2007, sampling at these lakes continued, but Diamond Lake and Four Mile Lake were drawn down and sampling at these lakes temporarily ceased. However, Cheever Lake (Emmet Co.), a relatively undisturbed shallow lake, was added in 2007 to serve as a reference. Monitoring of Cheever Lake provides a benchmark or goal that illustrates what water quality should be in a shallow lake.

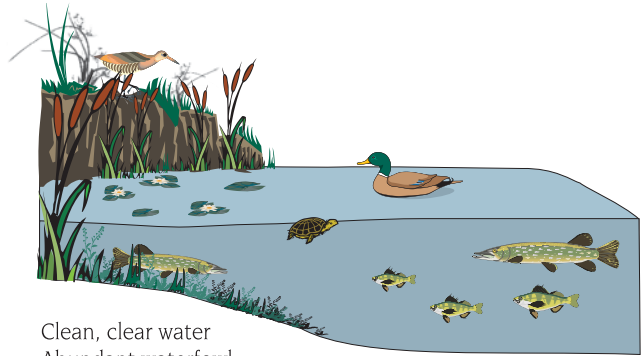
Water samples were collected semimonthly from May to September at each lake. Physical and chemical parameters, including turbidity, specific conductivity, temperature, and pH, were recorded at each visit. Water samples were analyzed for total phosphate, orthophosphate, total Kjeldahl nitrogen, nitrite + nitrate, ammonia nitrogen, total suspended solids, and chlorophyll *a* (a measure of unicellular algae). Once a month, phytoplankton and zooplankton were also collected. Finally, aquatic vegetation and invertebrate assessments occurred once each summer at the peak of vegetation growth.

Monitoring has shown that these lakes have no submerged plants (pondweeds) and in most cases have reduced emergent (i.e., cattails and bulrushes) plant fringes. Also, high turbidity values, high chlorophyll *a*, lack of invertebrates, and fish communities dominated by rough fish are typical in these systems. The deepest Secchi depth (a measure of water clarity) recorded in 2007 was 15 inches, however, the majority of readings were less than 7 inches. In comparison, Cheever Lake, a shallow lake in a relatively undisturbed state, has very clear water (visibility to bottom throughout), abundant vegetation and few rough fish.

Management activities at Diamond Lake and Four Mile Lake have been successful in eliminating rough fish and have shown significant re-growth of emergent plants. Additional monitoring will highlight successes and provide information for future management of these and other lakes.

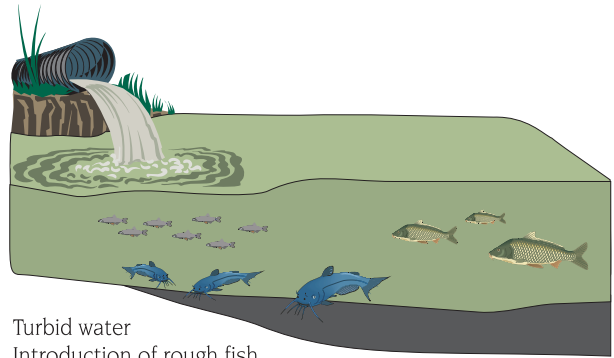
Diagrams to the right
Shallow lakes usually exist in one of two possible states: clear (1,3) or turbid (2). Without management actions, lakes in the turbid water state will not improve. However, with appropriate management activities these lakes can quickly "flip" back to the clear water state.

1. Pre-Settlement



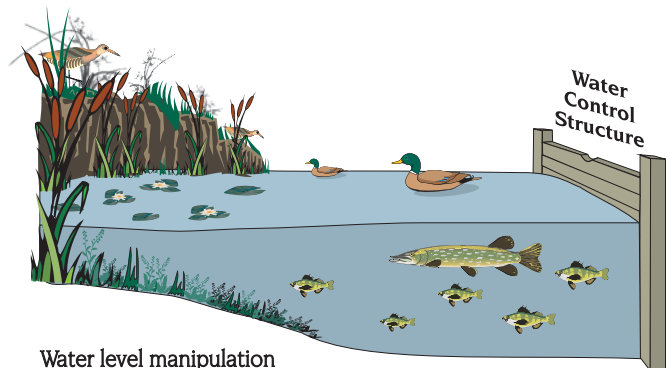
- Clean, clear water
- Abundant waterfowl
- Abundant, diverse emergent and submerged plants
- Fluctuating water depth
- Lots of invertebrates and zooplankton
- Absence of rough fish
- Abundant recreational opportunities

2. Influence of Human Landuse



- Turbid water
- Introduction of rough fish
- Increased drainage to lake; more nutrients and silt
- Sustained high water levels
- Loss of vegetation, invertebrates, and plankton
- Less waterfowl, dominance of phytoplankton
- Few recreational opportunities

3. Restoration Management



- Water level manipulation and landuse improvements promote:**
- Clean, clear water
 - Abundant waterfowl
 - Plant regrowth
 - Rough fish removal
 - Binding of sediments by plants/sediment removal
 - Abundant recreational opportunities



The results of monitoring will be useful in demonstrating the success of these renovations to resource managers, the public, and to project funding agencies. These data will be necessary to demonstrate the conditions of the lake before and after management activities.



While the renovation projects may have considerable initial costs and have temporary side effects (as in the case of drawdowns), the end result will be improved recreational uses for the public for many years. These improvements will have positive economic benefit and numerous intangible benefits. By providing data to inform both resource managers and the public, these monitoring efforts will aid in successful renovation of Iowa's shallow lakes.



Photos

Four Mile Lake, Emmet County. Sequential photos to the left illustrate vegetation and water quality conditions before and in response to management activities. Ongoing water quality and biological monitoring efforts will measure and record these changes.

Top: High water levels and turbid conditions were present before management activities began in 2007.

Middle: Wetland conditions following initial water level reduction in May 2007.

Bottom: Regrowth of vegetation due to lowered water levels. Vegetation helps anchor sediment when water levels are raised.

Acknowledgements

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