Vol. 1, No. 1, July 28. 2009

The Sand Lake Observer

Big Sand Lake has undergone many changes resulting from a growing population. Properties of the lake, its flora and fauna, and associated changes are described along with some possible restorations.

Properties of the lake. Big Sand is over two square miles in size and mostly between two and 20 feet deep. The maximum depth is 57 feet. Recent water levels rise and fall over about a foot with the amount of rainfall. The water seeps in and evaporates out. It is rather clear compared to lakes nearby. Soft black detritus formed by decaying plants covers the sand bottom in weedy areas. This sediment, carried by currents to the outlet, has accumulated to a depth of ten feet in places. Other areas are swept clean by ice and waves exposing the sand bottom.

Largemouth bass are now a major top piscivore (fish eater), and bluegill are the most abundant game fish. Small northern pike and crappie along with a few walleye and bullhead are also caught. The food chain is largely dependent on higher plants because much of the lake is shallow enough for light penetration to the bottom and because phytoplankton are scarce. The phytoplankton, diatoms, green algae, and blue-green bacteria, also provide food. Some algae attach to the surface of growing weeds where zooplankton graze as well. All these light-dependent groups feed the herbivorous (plant eating) zooplankton that go on to support other animals including fish. The final fate of this material, after being eaten, is to resupply the lake with minerals. These minerals then start a new cycle with the energy of light.

Water Level Changes. Major changes in Big Sand since early last century were due to the growing population of new residents. Highway 70 diverted inflow from the Warner Lake system south to Clam River. Even before the highway, this inflow was minor as compared to seepage. Rainfall over the watershed is the main input. Groundflow from rains is greatest toward fall as tree growth slows and less moisture is transferred to the air.

Damming the broad bed of Sand Creek by Sand Lake Road in about 1938, reduced outflow to Yellow River, raising the lake to modern levels. A little flow was provided by a 16 inch culvert. A larger, but still flow-restricting culvert now spans the road but at higher elevation. Reduced flow appears to allow settling of detritus, thereby raising the bottom of the bay that further restricts outflow. Sand Creek now runs dry for the first time in over 60 years. The water level of Big Sand then depends on the balance between seepage from rainfall over the watershed for input, and evaporation for output. Evaporation rates can be very large. They are accelerated when water or ice temperatures are warmer than the air. Without outflow there will be an increase in minerals and dissolved organic chemicals along with the increase in sediments mentioned. Damming has tended to stabilized water levels. They have normally varied by only about a foot over the last half century, but there were some higher water levels in the 50's. Conversely water was much lower during the 30's due to dryness and an unobstructed creek bed. It was then possible to walk across the lake.

Fishing. In the 40's good catches helped draw first the Indians, and then several summer resorts. Large bluegill and crappie, 5 to 10 pound northern pike, and a few large bass were taken. Bullheads were easily caught and small ones were common around the shore. But their broods are small and they are a favorite prey. Dogfish were the lone rough fish and populations remain

consistently low. They gather their brood in a cloud and are easy prey when small as well. Redhorse suckers were another good forage fish once speared in Sand Creek. Some small walleye apparently survived to grow large following their formative years by using superior night vision to feed in low light. It was underwater warfare. Small fish were eaten by large. Medium sized fish were also in peril often showing the marks of a survived battle. That left the big ones for us human prey.

A current creel census shows low fishing pressure and good success with moderate size bluegill, but very little else. The number of fishers is low compared with early years. Largemouth bass are now numerous but do not grow to legal size. These limited harvests compare with memories of native walleye, washtubs of 14 inch crappie, and riding around in a little boat pulled around by two large northern pike tethered to the anchor chain. Walleye can no longer reproduce in the lake due to elimination of gravel beds for spawning by Highway 70. Walleye were repeatedly stocked by Natural Resources, but survival was very low so the program ended. The Indians then began stocking from their hatchery, and still spear some in springtime. Redhorse suckers no longer collect below the culvert through Sand Creek Road. Muskellunge were stocked in the 50's but did not sustain. Although they prefer warmer temperatures of Sand Lake as compared to northern pike, forage fish may have been insufficient to sustain them. Small perch were once present but the larger ones were probably consumed by the pike. Neither small panfish nor the abundant silver shiners supply enough food energy to support either the muskey or the pike.

Changing Wildlife Populations. Amphibians are returning. The chorus of leopards, peepers, tree frogs, minks, toads from the marshes around Big Sand is now strong. Their global crash was due to several factors including a recently identified fungus. Agrochemicals are another suspect for amphibian loss. The annual application of atrazine to corn fields is 76 million pounds and some accumulates in water. This small molecule mimics an electron carrier in plants and could affect processes in animals as well.

Garter snakes are chasing the frogs, and a harmless puff adder was recently seen showing its cobra-like hood. Box turtles and snapping turtles are as abundant as ever. Bald eagles, osprey, sandhill cranes, large seagulls, and spring migrations of coot, pelicans, and Tundra Swans formerly absent, are returning. However the small gulls that once nested on the mud flats and bitterns with their swamp-pumping call have not appeared along with the rafts of waterfowl and abundant shore birds that feed on wild rice.

Nesting geese have been unsuccessful in the west end but a few goslings from the main lake seem to survive. Geese are an important host for the adult form of a parasite causing a temporary but nasty swimmers itch. The problematic stage is a short lived cercaria that is liberated from snails into the water to search for their required alternate warm-blooded host. They accumulate briefly on the surface of shallow water on warm sunny days and will penetrate the skin of some people. An application of Permethrin can stop the itching.

Dissolved Nutrients. BSL already has sufficient phosphorus from our P-rich soil for lawns, but numerous lakes further south have been spoiled by nutrient additions. Lake Mendota became weed-choked before infection by the invasive Asian water-milfoil. So phosphate in runoff, rather than invasive weeds, was probably the problem. Because of weed stimulation, the Wisconsin P-bill seeks to reduce phosphorus additions to lawns around lakes by limiting the sale of phosphate-containing fertilizer. This is supported my most Wisconsin legislators including our District

Representative Hraychuck. Legislation to safeguard groundwater is also under consideration due to the increasing contamination of groundwater.

Phosphate removal by mowing weeds, as done in Clam Lake, does not immediately clean up water systems, but rather provides a temporary respite. This is due to high internal loading of phosphate in the sediments that is slowly released by heterotrophic bacteria. The other key requirement of weeds is combined nitrogen, but ambient nitrogen can be captured from air by the blue-green bacteria, leaving phosphate in control. A better strategy is to minimize lakes as a long-term sink for phosphate by reducing phosphate and nitrogen from lake-shore lawns. They do fine without either if there is a little soil in the sand. Clover will sometimes appear naturally in mowed areas if moist, or it can be seeded in. It also can get its nitrogen from the air and makes a good choice for lawn around lake-side homes. Attractive native grasses will also seed in on their own and are easily started under a cover crop of rye.

Rice Beds. Wild rice was the staple food of the Ojibwas, and stands of rice on Big Sand with yields of 1,000 pounds per acre are within memory. This nutritious grain supported much wildlife. Thus Wisconsin in Ojibwa means a good place to live. Rice also supported Americans even before the Ojibwas, and the Dakota before them. However only two small rice beds now remain. The chief problem here and elsewhere is increased water levels from damming. Also weeds help retain the organic sediments required and break waves that would otherwise lift out young plants. Removal of pickerel and other weeds to form a swimming beach probably eliminated one stand. Wild rice prefers less than a foot of water and soft sediments with good rates of nitrogen cycling. It is commonly said to need flowing water, and an absence of pollution. More certain is that substantial inflowing or recycled nitrogen is necessary. However increased water levels and sediment loads may have formed new areas in Big Sand where rice will now sustain if seeded.

Other Interesting Plants in the Lake. One of the pretty long-blooming plants is the white water lily that appears in mucky shallow water. Its thick patterned rhizomes that show up from muskrats digs start next years plants. The floating pads get a good supply of sunlight but the bioenergetic cost of the big stems to support them confine growth to two or three feet of water. Mixed in are spatterdock with their compact yellow blooms. The smaller purple oval pads with thin stems are watershield. Their undersides are coated with a slippery gel that resists grazers. In shallower water pickerel weed can be found with its purple flowers. Although a tough magnet for fish hooks, it tends to anchor vegetation and give rise to a bed of emergent plants.

Fluffy Bladderworts are often seen floating in shallow water. The bladders are actually sacks with a trap door used to harvest zooplankton. These open sacks are fringed with hairs that trigger expansion sucking in their prey. Others hairs on the inside repeat the action packing larger creatures inside before the trap door clamps down. Bacteria then digest the victim releasing minerals to help the plant grow.

Pond weeds are among the most abundant covering much of the lake. Twenty five species such as Richardson's pond weed are known. It has a broad leaf but some are narrow and grass like. The tips are emergent snorkels that pump down carbon dioxide and bloom later in the summer. Some are pollinated by bees, others by wind. Another common weed is the coon tail that comes up on boat anchors. It tapers to pointy dark green rings that look a little like Eurasian Water-milfoil. Twelve additional species of milfoil are known in Wisconsin.

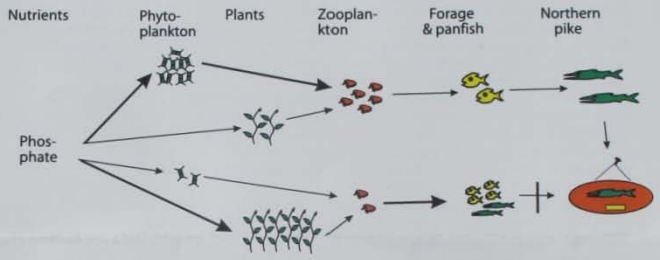
Changes in the Balance Among Species. During the 40's when trophy fish were still landed, much of the food chain was phytoplankton based. Weeds were abundant as well, tangling up hooks and outboard props, but turbidity from phytoplankton was greater. There were three short strong blooms of phytoplankton over the summer: diatoms, green algae, and bluegreen bacteria. This reflects one of two alternate stable states as shown below. Sometime before the turn of the century there was a dramatic change in the ecosystem. First noticed was an abundance of foot-long skinny northern pike that replaced the big ones in the 50's. Then scads of small 2-inch pan fish appeared. Sometime before 2005 water clarity increased giving visibilities to 14 feet according to Secchi disc readings, and weed beds grew as macrophytes replaced the phytoplankton. Lakes are known to switch between alternate stable states for various reasons, but the likely cause here was fishing out the larger northern pike. This led to consumption of zooplankton that fed on macrophytes, so the large-leafed pond weeds became more abundant. These plants consume the same minerals as phytoplankton so these microorganisms were starved out giving the new food chain shown. The small panfish could hide in the abundant weeds and graze on the zooplankton. But without predators they still overgrazed their food supply and became stunted. Panfish are poor forage fish due to low energy content, so the northern pike did poorly as well. Continued fishing for the big ones favored reproductive efforts at maturity of only three years preventing further growth to normal size. This is the reason for the small pike at present.

A return to the fish and phytoplankton-rich stable state could be underway. An abundance of medium sized pan fish and a lot of small bass have replaced the many tiny bluegills present in the 60's. Water clarity may be decreasing slightly and a light phytoplankton bloom has appeared. The bass have displaced pike as top predators. Largemouth bass are able to suck up small panfish with less energy expenditure than an ambush piscivore like a northern pike. But a combination of overfishing the large ones, and overconsumption of the small fish by remaining bass leaves a large population of bass that are under legal size and perhaps stunted as well. It is not unusual for over fishing to cause a population collapse. This is a problem for many fisheries. In some places, fisheries such as cod, clam, billfish, grouper, and crab have disappeared. In others over fishing is thought to be responsible for the collapse of whole ecosystems such as observed in certain coral reefs.

Potential Invasive Species. Of Wisconsin's 15,000 lakes, 22 are infected. Introduced species become invasive when they displace those native to the area. Their success usually depends on an absence of native enemies. Eurasian Water-milfoil is the most problematic of local invasives. Also called *Myriophyllum spicatum*, it can be identified by having more than 12 pairs of leaflets on each feathery leaf. Only Ham, Round and Trade Lakes in Burnett County are known to be infected. Another invasive is curly leafed pondweed, but it is considered less problematic. Asian Milfoil has rather low vigor but like curly leafed pond weed, it germinates early in the spring. Leaves drop off leaving a small stem which forms a canopy that can shade out native species.

Currently controlled in Ham Lake, property owners volunteered $13,000 in one year to control the Asian milfoil. The auxin (plant hormone) analog 2,4-dichlorophenoxyacetic acid was applied along with subsequent spot treatments and hand removal. Commonly called 2,4-D, a report in *Occupational Environmental Medicine* has linked it with mortality due to lateral sclerosis. Fluridone is also used. It has a noxious looking chemical structure and toxicity has been demonstrated. It appears that some of the problems attributed to the milfoil and pond weed are

Piscivore-dependent Alternate Stable States



TOP: **Algal blooms and large fish.** Phytoplankton absorb most phosphate and increase to support many zooplankton; some crop weeds. The zooplankton support forge fish which feed northern pike. The pike grow large, culling out smaller fish.

BOTTOM: **Clear water, weeds with small fish.** The small fish are not eaten but poorly fed and stunted in size. Reduced feeding pressure on the weeds allows heavy growth. The weeds absorb phosphate, starving out the phytoplankton .

2) Rice Bed Restoration. Wild rice beds that supported local harvests and major populations of wildlife are essentially gone Yet a few nearby lakes have the usual cycle of good years. While damming by roads, increased water levels, reduced flowage, clearing of barrier weed patches, and boat wakes all probably affect the rice, it is possible that seeding efforts can be successful. Both the west end and the west bay once had good stands, but they are now barren. Areas of the west bay now have around a foot of water over a bed of detritus that is relatively weed free. A limited seeding effort failed last year, but a small, better designed testing effort could help resolve the problem, lead to more extensive seeding, and restore some rice to the lake. Rice beds produce very large amounts of food and are therefore a big draw to wildlife and thereby improve the lake.

3) Lakeshore Restoration. Shoreline restoration can help filter polluting runoff from homes and help return waterfowl and other wildlife to the area. Chemical stability, resistance to invasives, and thereby lake quality are all improved. Input of chemical fertilizers can be minimized, a problem that accumulates over the years and has already led to extreme eutrophication in many lakes. Indians on the east side now do a very nice job of lakeshore preservation; their homes are invisible from the water. Most others have done a good job of this as well. Burnett County gives financial and other support to this effort. Some might want to plant pickerel weed with their pretty pyramid of purple flowers, plants to anchor weed beds that help shield the rice. Others might want to allow regrowth of some larger wetland plants. Dragonfly Gardens in Amery is one place where some of these can be obtained. The wildlife so attracted is valued by many. Also reduce use of fertilizer, both white and wild clover makes nice lawns when kept moist and requires none. Unfertilized native grasses are a little thinner, but there are some perfectly acceptable lawns of them, and they require little mowing.

D. K. Button
dkbutton@ims.uaf.edu