the Water Column

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Open water on Lake Auburn January 3, 2007

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President's Message

Bill Monagle
VLMP Board President

Thinking Like a Lake

In the first half of the past century, the great conservationist, Aldo Leopold, wrote a wonderful collection of essays, *A Sand County Almanac*. One essay in particular, *Thinking Like a Mountain*, appealed to me as Leopold ascribed a sense of consciousness to the mountain stating that only the mountain had existed long enough to listen objectively to the howl of the wolf, understanding the wolf's place in the natural order.

While studying lake and ocean dynamics in college, I found it helpful to 'think like a lake' when attempting to understand Lake Michigan's responses to external stresses, such as a steady wind across the surface of the lake. I came to appreciate lakes as virtual complex living organisms in and of themselves.

I'm sure most of you who monitor the health of your favorite lake, whether it be the water clarity or the status of the aquatic plant community, also have developed a fondness for, or emotional bond to, your lake, viewing it as more than simply a physical feature of the landscape. So, go ahead and admit it; you love your lake. Well, I'm sure in its' own way, your lake would be fond of you too.

As you know, our lakes are subject to external stresses much more severe than a gentle breeze across the lake surface. Like humans, lakes can become quite ill when 'stressed out'. I tend to view lake monitors as environmental health-care providers, monitoring the lake's vital signs and providing critical information to support appropriate management measures to protect or rehabilitate the lake. On behalf of the VLMP, a heartfelt thanks to all of you who provide such a valuable service for Maine's lakes. But most importantly, your lake thanks you too.

On a closing note, I wish to thank all who have made monetary contributions to the VLMP's year end fund-raising campaign. By year's end, donations had exceeded those received by the end of 2005! As you know, this past year the VLMP was confronted with significant capital expenditures, such as the purchase of the new pontoon boat and improvements to the Brackett Center. All of these have served to enhance the VLMP's ability to provide the myriad of services for Maine's lakes, including better training for volunteer monitors. The year 2006 was a very good year for the VLMP, and with your continued support, 2007 will be even better. Thank you all.

Lakeside Notes

Scott Williams
VLMP Executive Director

Where's the Ice?

When I was young it was often possible, and reasonably safe, to skate on small ponds in southwestern Maine by Thanksgiving, or shortly thereafter. It is now mid-January, and very few (if any) of Maine's lakes would be considered safe for recreation. In fact, many of our large lakes remain free of ice altogether, following several weeks of unusually warm weather. The Maine Departments of Inland Fisheries and Wildlife and Public Safety have recently issued several warnings to stay off lakes and ponds that *are* frozen, due to dangerously thin ice.

During my regular commute to the VLMPs Brackett Center I drive past the northerly shoreline of beautiful Lake Auburn. For the past month, while gazing out at the sparkling waves and deep blue water, I have been struck by the feeling that something is seriously out of kilter. Let's face it, seeing whitecaps on a Maine lake in January is, in the words of several others who have recently commented on this unseasonable phenomenon, kind of weird.

This should all come as no great surprise. After all, record-breaking warm temperatures were documented throughout Maine in November and December. Speaking of record-keeping, as many of us who have spent time on or near a particular lake over the years know, a good deal of effort has gone into guessing, and ultimately tracking ice-out dates. Some of these "data" were uniquely recorded as scribbles on the inside of a barn door, or retained in some other memorable form. For example, Earl Bacon (father of DEP Biologist Linda Bacon) used to enjoy being able to make the annual claim that he had been swimming in Messalonskee Lake in Belgrade just a day or two before the onset of ice cover. A few days ago he told Linda that the ice-on date for Messalonskee this year will be several weeks later than it typically was in the 1920's and early 1930's! In other words, his late season swim probably took place in November, as opposed to the middle of January. This is a great story, full of imagery and potentially useful anecdotal information. Perhaps you have some of your own to share with us?

Local records were very helpful in the review of information conducted several years ago by USGS Hydrologist, Glenn Hodgkins, in which it was determined that the duration of ice cover for a number of New England lakes has been getting shorter over the past century. However, there is relatively little information available concerning *ice-in* dates. Perhaps we should be paying closer attention to this phenamenon, as well, because the overall annual duration of ice cover on lakes and ponds can certainly influence many of the physical, chemical and biological processes in these complex ecosystems.

You may recall that the winter of 2005/2006 was also unusually warm, as have been a number of recent winter seasons. If warmer weather increases over time, as climatologists who study global warming say it will, changes to our lakes will almost certainly occur, although exactly what those changes might be is the subject of a good deal of speculation. At the most simple, basic level, an increase in both water temperature and sunlight penetration into the water column, resulting from reduced ice depth and duration of cover, could cause an acceleration of biological processes in our lakes. Our lakes and ponds could experience increased algal growth, reduced water clarity, lower levels of dissolved oxygen in the water (as indicated by Green Lake volunteer monitor Bob Dunlap in a recent Water Column article), and an increase in the spread of invasive aquatic plants. But the complexity of lake ecosystems, along with our limited knowledge of the way that they respond to influences, allows us only to venture educated guesses as to what could happen if dramatic changes in the weather occur in the future.

All of this provides another valuable opportunity for volunteers to gather data that could significantly improve our understanding of the impact of climate warming to Maine lakes. If you live nearby the lake that you monitor, consider tracking the date when ice cover is first observed on the lake in early winter (ice-in), as well as the day when the lake becomes free of ice in the spring (ice-out). We are working on definitions for

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A Maine Lake in Winter

By Keith Williams
Certified Volunteer Lake Monitor on Highland Lake in Windham

Long after most volunteer lake monitors have put away their Secchi disks for the year, Keith Williams is drilling holes in the ice on Highland Lake in Windham, in an effort to expand his and our understanding of the physical, chemical and biological characteristics of that lake's ecosystem. His scientific background serves him well in this effort to document the dramatic changes that the lake undergoes through Maine's four seasons.

We often reiterate that each lake has a unique personality, and because of this, Keith's account of Highland Lake may not strictly apply to the one that you monitor. But many of the processes that he describes are universal, and perhaps they will motivate you to explore your lake's personality beyond the end of summer.

Scott Williams

When my wife and I moved to southern Maine nearly two decades ago, it was during winter, and I had not before seen a frozen lake. Several weeks later an unusual late winter rain fell, putting a sheet of water above the ice on our lake (Highland Lake in Windham, Falmouth, Westbrook, not to be confused with the much larger and famous Highland Lake in Bridgeton). The ice was still thick enough to support cars and pickups, and some local character drove up and down the lake at high speed pulling behind a water skier! We were astonished, called friends and family in Texas, saying, "Yankees don't water ski behind a boat, but behind a pickup!" explaining what we saw. They didn't believe us.

Nearly all the lake monitoring in Maine takes place during a season when it is pleasant to get on the lake and appreciate the wonderful scenery and relaxing experience, but there is a lot more going on in winter than just ice fishing. Each lake has its own personality. The following explanation of conditions encountered during the winter applies to the lake I monitor, but it may also apply to yours if it is deeper than about 7 to 10 meters, and large enough for the wind to induce vertical mixing currents.

A Prelude to Winter Conditions

The prelude to winter starts about mid-September, as the summer-warmed water begins to slowly cool down. As autumn progresses, the warm top layer (epilimnion) of the lake chills, the boundary between the top warmer layer and the bottom colder layer (hypolimnion) sinks deeper into the lake, until eventually in about mid-fall the temperatures match and the lake "turns over" meaning the lake mixes completely. Mixing takes place because cold water is denser than warm water, down to a temperature of about 4º C or 41º F, so very slow vertical currents set up displacing the warm water with cold. This continues for as long as two months, until the surface freezes. Due to contact with the air, the mixed water is near maximum saturation with dissolved oxygen and carbon dioxide. Because the terrestrial plants have been slipping into dormancy and consuming less rainwater and groundwater, stream flow and groundwater seepage into the lake generally increases during autumn. Vertical mixing continues even after "turn-over" (a.k.a.: mixing) until the water temperature drops to water maximum density, 4° C, sometime in early to mid-December.

The Onset of Lake Ice

Lake surface freezing starts on very cold, clear windless nights, starting first along the shoreline (the lake has never frozen over in just one night). Some years our lake may freeze over in a very thin layer, only to be followed by some hours of high winds and warmer temperatures that break up the ice. Sometimes Mother Nature may try two or three times before the lake is solidly frozen for the rest of the winter. At first, additional ice accumulates on the bottom of the cover due to thermal transfer through the ice to the air, but later far more ice accumulates on the top of the ice surface, due to water freezing there, especially in snowy mild winters. On warmer days the sun heats the snow enough to melt a small amount, which then re-freezes during cold nights. Occasionally I have observed a layer of water between two layers of ice, due to water on top of the base ice freezing on a very cold night, before the layer of water itself freezes.

This profile of an ice core taken from Highland lake shows the horizontal stratification lines that were created as the ice formed.

Lake ice has a columnar structure, from the size of a pencil down to the size of pencil lead. The undersurface of the ice may be smooth, or frazzled, or have ridges up to a couple of inches tall, or stalactites up to a couple of inches in size. The lake ice on northern Maine lakes may occasionally become more than a yard thick, but varies from year to year. Snow on ice has an insulating effect, so winters of heavy snow and light winds are likely to cause thinner lake ice. Ice free of air bubbles and coloration transmits nearly as much sunlight as liquid water, but fresh snow cover greatly diminishes the light penetration, the more so the thicker the snow cover. Wind can redistribute the snow such that there may be barren ice patches but other spots with more snow in drifts. Most winters the ice wrinkles up in pressure ridges from a few inches to over a yard tall, usually near a shoreline. Those ridges form because freezing water expands about 8.5%, and even when several inches thick, high wind can drag the ice, setting up ever so slight waves, that induce very small long wave movement in the water under the ice. The location and height of ice ridges on my lake varies from year to year. One year it traversed the width of my lake at "The Narrows." During very cold days and nights when new ice is forming, cracking ice can sound like snap crackle and pop, or rattling sheet metal, while flexing ice can be heard making groaning sounds, or you may hear a "blup" sound as water waves reverberate across the lake, moving in and out of ridge cracks.

Water Movement

Under the ice, water movement is much slower than it is during the summer, because wind-induced waves and currents are absent, so circulation doesn't reach deep below the surface. Except for the top one meter or so of the water (just below the ice), the lake water column is a uniform 4º C (41º F), temperature at which water is at maximum density. Streams feeding the lake don't freeze completely, and forest ground doesn't freeze solid down to the water table. As a result, more water typically enters the lake during the winter than during the summer, although variations in watershed hydrology and precipitation during the year can change this generalization. On the average, more water enters the lake in January and February than in July and September. The stream water is near freezing in the deep of winter due to contact with the cold air and ice in the streams. Stream water is thus ever so slightly lighter than the water in the rest of the lake. It thus spreads out upon entering the lake and slides under the ice to the lake outlet. Most of the water movement in winter is from the stream inlets, in a layer about a yard thick, flowing to the lake outlet. The remainder of the lake water doesn't exit until spring turn-over, which occurs after the ice is off the lake surface. Groundwater usually seeps into the lake near the fringes, and is usually a little above freezing.

Heat from the metabolism of organic decay, and from sunlight warming the sediments can result in very slow vertical density currents that set up as the warmer water rises and is displaced by

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colder water. When the water reaches a uniform 4º C, resulting in uniform density, the lake turns over and mixes with relatively little wind energy. Much less energy is required to turn over the lake in the spring, because of the relatively low temperature variation in the water column (compared to conditions in the summer/fall).

Biology Under the Ice

The creatures at the bottom of the food chain, bacteria and fungi, are not often measured in most lakes. These organisms decompose the dead algae, zooplankton, fish, leaves, and twigs that end up in the bottom of the lake. The sediments under my lake have been sampled only once under ice for animal life. In a 1-meter square sample (about 1.2 square yards) there were nearly 2,000 individuals, including the larvae of the phantom midge, true midges, mollusks, sludge worms, water mites, and seed shrimp. The total weight of those creatures was about one-tenth of an ounce in the 1.2 square yard sample.

In my lake during the winter, the algae are most abundant near the surface, peaking about 10 feet below the ice, six times as dense as deeper in the lake, but quickly falling off just three feet deeper. The winter production of algae, and zooplankton populations, are about one-tenth what they are in the summer.

At the top of the food chain, the fish population has been heavily manipulated to benefit fishermen. There are chain pickerel, and the most common game fish are brown trout, salmon, and smallmouth bass, but no sunfish, eel, nor white sucker are caught under the ice. Good fishing depth is generally about six to ten feet under the ice, and on the bottom where the fish can graze on the insect larvae.

Winter Chemistry

Since early 1999 our Water Quality Committee has sampled my lake under the ice for alkalinity, pH, and carbon dioxide. Stream water entering the lake in winter tends to be more acid, higher in carbon dioxide, and more varied in alkalinity than the summer lake water. Dissolved oxygen diffuses through the ice, so throughout the winter the water just below the ice is near saturation with oxygen. If you were to monitor your lake under the ice, you would probably find as the winter progresses, dissolved oxygen diminishes with depth, due to the metabolic consumption of oxygen during organic decay, as described above. In late winter, before ice-out the concentration of dissolved oxygen near the bottom of the lake may be a fraction of what it is just below the ice.

Carbon dioxide accumulates due to the respiration incident to decomposition, such that its concentration near the lake bottom may be more than five times that just under the ice by the time of ice-out. Acidity increases (pH decreases) somewhat with depth as winter proceeds, due, in part, to increasing levels of carbon dioxide. Alkalinity (a measure of the ability of the water to resist, or "buffer" changes in pH) doesn't vary as much with depth. Sometimes the liquid layer about three feet thick under the ice is strongly influenced by stream water as it slides just below the ice upon entering the lake, as described above. This can result in very different conditions.

Ice-Out

Come warmer temperatures in late March and April, with increasing hours of sunshine, the snow and the top of the lake ice begins to soften and melt (sometimes known as "rotten" or "candle" ice). Little melting takes place at the bottom of the ice, most melting is internal to the ice and top surface. Sunshine warming the dark sediments in shallow water induces melting around the shoreline, and warming stream inflow causes melting around the stream mouths. As "mud season" progresses and stream flow peaks, the stream water warms to 4º C, which is close to the density of the lake water column. This begins to impinge into the lake, spreading out in plumes into the depths of the lake, even just above the sediments, inducing both vertical and horizontal currents. This, combined with the force of the wind on the open water, causes "spring turnover" to occur. Complete turnover can take place as rapidly as in two days, but generally it takes longer, depending on weather conditions when the ice finally leaves the lake.

Carbon dioxide is "out-gassed" as the lake exhales (the lake "burps"), and bottom oxygen is replenished as the water circulates vertically, so its entire contents come in contact with the air at the surface. Melting of the main body of the lake may take place in fits and starts, and parts of the lake may actually re-freeze on cold days. Some years it may take the lake two weeks to completely thaw, finishing between late March and late April. After that, wind-driven and vertical density currents due to warming completely mix the lake. This marks the end of the winter cycle on our lake. By early May, the water has already started to warm, and the first effects of the summer thermal stratification cycle can be measured.

Would you like to tell the story of your lake? We would love to hear it!

Articles need not be of a technical nature, and may be in the form of a personal account or history of efforts to protect the lake. Contact us at 783-7733 or vlmp@mainevlmp.org.

Lake Shoreline Aquatic Habitats

Part 1: An Introduction

By Dave Halliwell
Aquatic (Fisheries) Biologist with Maine DEP

Most of us Maine folks have had the chance to visit a rural lake or pond whose shore-line is totally undeveloped - that is, no visible signs of houses, docks, roads, unnatural clearings or human-made beaches. Perhaps you spent considerable energy and time hiking into this environment and as you rest to eat your lunch, you are refreshed by the variety of shoreline birds, and if you are very fortunate, larger mammals and birds, such as deer, moose, beaver, otter, osprey, and eagles.

What you don't readily see, unless you look very closely into the shallow depths along the shoreline of the lake, is the variety of aquatic life, fish, bugs, crayfish, frogs, and more. As a rule, the more remote and undeveloped a waterbody - the greater abundance and diversity of resident aquatic organisms.

Perhaps you brought along a fishing rod. If you're lucky (or skilled), you may catch a sample of what lies beneath the surface of the shimmering waters. Native brook trout abound, as they have since the retreat of the glaciers, 10,000 years ago! Maybe you catch several good-sized trout and decide to cook them up for dinner. While cleaning them, you notice their stomachs are full. You open them up and find partially digested remains of smaller fish. Pearl and redbelly dace, lake and creek chub, fallfish and common shiner are some of the native minnow species common as forage fish for the larger brook trout. The trout also will feed on their own young (they're cannibalistic!!). When trout are younger, they primarily feed on larger aquatic and shoreland invertebrates, or 'bugs'.

This great abundance and diversity of aquatic life (ranging from trout to minnows to amphibians to bugs) is found in undisturbed waters. Remote and relatively undeveloped lakes and ponds are not very common in southern New England and are less common in southern Maine than areas in the northern woodlands. In northwestern Maine, a history of land use by large forestry companies, whose focus was not on developing their lands, has served to protect ponds by maintaining mostly undisturbed lake shorelines for resident critters. Excessive disturbance and removal of the vegetation along the shore, such as overhanging shade trees and shrubs and submerged or floating tree trunks and branches, certainly reduce and can alter much of the existing aquatic life.

Recent studies in Maine and Vermont woodland lakes have confirmed the importance of maintaining natural vegetation and woody debris along lake shorelines to have a healthy aquatic community. Our lakes are now facing much greater development pressures, as older seasonal cottages get converted to year round dwellings and what is left of the undeveloped lakeshores are carved up. But this problem, long recognized in populated areas, is now happening elsewhere. Large-scale residential development is a looming reality in our less populated towns and unorganized regions. Wherever lakes are developed, it is very important to protect critical shoreline habitat for all aquatic life. So, if you want to keep catching those fat brookies, leave the shoreline of the lake as natural as possible.

Photo by Ryan Burton

Last summer Dave Halliwell (above) sampled the littoral zones of lakes in northwestern Maine that are part of the Deboullie Ecoreserve. These remote lakes with undisturbed shorelines are home to a great diversity of aquatic life.

In the next issue of the Water Column, Dave continues his series on lake shorelines with a detailed look at the impacts of development on these important habitats.

Meet Maine's Lake Monitors

Each volunteer has their own story of how they got involved in monitoring and protecting their lake. For some it may have started with childhood memories of the family camp, others may have fallen in love with their lake late in life, or may have taken action in response to a possible threat to their lake or pond. Each story is unique but shares a common commitment to volunteer service and protecting Maine's lakes and ponds.

Stories and photos sent to us by certified monitors are now available on the VLMP website. To see them click on Meet the Monitor on the VLMP home page. Individual lake pages on the VLMP website also have a link and photo for certified monitors on that lake.

Certified Monitors: Share Your Stories

Certified Water Quality Monitors and certified Invasive Plant Patrollers can now share their personal stories of lake monitoring on the VLMP website. On the webpage for your lake there will be a "Meet the Monitor" button that links to a page with your photo and bio.

To submit your bio, please write up a couple of paragraphs about yourself and email it with your photo to vlmp@mainevlmp.org.

Some questions you might want to answer when writing your bio include:

- Why did you become a volunteer?
- What is it about your lake that makes it special to you?
- Are you involved with any other activities that you'd like to share?

www.MaineVolunteerLakeMonitors.org

Meet The Monitor

For more Meet the Monitor stories see the VLMP website.

Will Reid

Wesserunsett lake water quality monitor

I have been monitoring Wesserunsett Lake in Madison since 1982. My wife Margaret (she's holding the eaglet in the photo) and I have had a camp on that lake since 1974, a log cabin built by her great-uncle for her father in the late 1920's. Margaret's grandparents and parents had camps on the lake and now we have children and grandchildren who spend summers at our daughter Elizabeth's camp and at our camp.

When I was a boy, I spent countless hours exploring and fishing a small pond near my house. This was the beginning of a life-long interest in natural resources, especially aquatic, and a desire to protect them. I have pursued that interest and desire academically, professionally, and as a volunteer. Being a VLMP monitor was an opportunity to contribute data that could be used to help protect a lake our family has personal ties to. I have enjoyed seeing Elizabeth become actively involved in this program as a certified VLMP monitor (Secchi disk, dissolved oxygen, and total phosphorus) and a regional coordinator.

I have participated over the years in a number of other volunteer efforts relating to natural resources. These include investigating crayfish distribution in Maine with Matt Scott, contributing data to the Maine Amphibian and Reptile Atlas project (MARAP), surveying vernal pools in Madison and Skowhegan for the Maine Audubon Society, participating in the Maine Damselfly and Dragonfly Survey (MDDS), chairing the Skowhegan Conservation Commission, being a trustee of the Lake Wesserunsett Association and chairing its water quality and invasive aquatic plants committees, and participating in the Maine Audubon Society Annual Loon Count since 1983.

In addition to the volunteer work, I have completed several studies in the past two years relating to Wesserunsett Lake. These include a comprehensive report about the lake for the LWA and a vernal pool report. I have also served as the Executive Director of the Somerset Woods Trustees (SWT), a land trust with a number of holdings. One of those is a bald eagle nest site in Skowhegan that produced the eaglet Margaret is holding. Hopefully, this bird will join the other eagles that we often see at the lake. One of the areas eagles frequent at Wesserunsett is on a property that is for sale, and both the LWA and the SWT would like to see that land acquired for conservation purposes and not developed. Elizabeth and I are working with the LWA, SWT and others to achieve that goal.

Brackett Environmental Center News

Maine's Lake Campus and Volunteer Training Center

Many Thanks!

We would like to recognize the many supporters of the Brackett Environmental Center this year. The Auburn Water District has continued their help with the development of the Center. This past summer the District replaced the roof of the Bracket Center with all new shingles.

The Brackett Center continues to develop with the assistance of volunteers. Special thanks to Dick Thibodeau for donating a large chest freezer and to Jarrett Poisson for facilitating the donation of two laptop computers and a network server from TD Banknorth. Thanks to Mark Fuller, Richard Jennings, Phoebe Hardesty and the VLMP Building and Maintenance Committee members for contributing their time and skills.

New at the Brackett Center

In partnership with the Delta Institute we now offer field guides and nature texts at the Brackett Center with a portion of each sale going to support VLMP programs. Stop by to see this unique collection including titles like *Pond Watchers: Guide to Ponds and Vernal Pools of Eastern North America*. For a complete listing of titles offered through the Delta Institute see their website www.vfthomas.com.

Wish List

We are seeking financial support and in-kind donations for the following:

New or quality used	*Professional Services*
Office Furniture	Electrician
Display Tables	Painting
Conference Table	Carpentry
	Brush hogging

Where is the Ice? - Continued from page 3

both, in order to insure consistency in data provided by volunteers, recognizing that ice-in may be a more difficult call, and that both dates could be difficult for large lakes with complex shapes. Beyond the implications that this information may have for lake water quality, the public has had an interest in local information concerning ice cover on lakes for centuries. Ice-in and ice-out data would ostensibly be of general interest if made available on the VLMP website link to individual lakes, with the potential to draw the general public in to consider the broader implications of lake data.

If you, or someone you know has kept track of ice data for the lake that you monitor, please consider sharing this information with all of us. It just might complement some of the other data that have been collected on your lake over the years. We're also working on developing a way for volunteer monitors to post lake ice data directly to our website. Stay tuned.

Global warming is a frightening prospect not just because of the consequences that are thought to be understood about this process, but more so because of what is not known. There is no question that volunteer lake water quality monitors and invasive plant patrollers will play a vital role in our understanding of this phenomenon. This is a particularly critical time for volunteers to be gathering data, because it is possible that the influence of climate change will exacerbate many of the known threats to Maine lakes, including cultural eutrophication and the spread of aquatic invaders. Time will tell, but not without your help! As Bill Monagle suggests in this newsletter, VLMP volunteers have their fingers on the pulse of Maine's lakes and ponds. Regardless of the nature of the threat to our lakes, the information that volunteers collect will have a strong bearing on our ability to understand and protect our lakes, now and for the foreseeable future.

Where's the ice? --We'll wait to hear from you.

Please share your knowledge and experiences with all of us. Both historical data and personal accounts relating to lake ice are welcome. Please send to vlmp@mainevlmp.org or VLMP, 24 Maple Hill Rd, Auburn, ME 04210

Littorally Speaking

Battling Invaders with Our Bare Hands: Manual Harvesting

By Roberta Hill, Laurie Callahan, and Jackey Bailey

This article is the second in a four-part series focused on the challenge of controlling invasive aquatic plants in Maine. In the fall issue of the Water Column the topic was aquatic herbicides. For the remaining three installments, the focus will be on various "non-chemical" control methods (alternately referred to as "manual," "physical" or "mechanical" methods). Most groups currently involved in combating variable milfoil infestations in Maine are utilizing one (or more) of these non-chemical control methods. The first we will look at is manual harvesting.

Jim Chandler, one of Maine's most experienced milfoil divers, arrives at the surface with a bag full of variable milfoil

Though many of the variable milfoil control efforts in Maine involve a combination of manual control methods, most involve some use of the method known as "manual harvesting." Manual harvesting is a useful technique for removing scattered individual plants and controlling small infested "patches." With manual harvesting, plants and their root systems are individually removed from the infested area, collected, and transported away from the waterbody for disposal. The means by which the plants are approached, handled, and even the way in which they are disposed of may vary, but the basic concept remains the same. Think "weeding the garden by hand, or with hand tools." Now think "weeding the garden under several feet of water." This should give you a pretty good sense of the work.

IMPORTANT! - All invasive aquatic plant control projects are subject to regulation under Maine's Natural Resources Protection Act. Before planning any control project, contact the Maine Department of Environmental Protection for specific permit requirements. *All native aquatic plants are strictly protected by Maine law.*

The depth at which the invasive plants occur determines the approach (or combination of approaches) that are used. For invasive plants occurring along the shore in shallow water it may be possible to approach the task by simply wading from plant to plant. The major problem with this approach is that it is difficult for harvesters to "tread lightly" enough to avoid disturbing sediments and causing turbidity. Brown clouds of fine sediments obscure visibility and release excess nutrients back into the water column, neither of which is desirable.

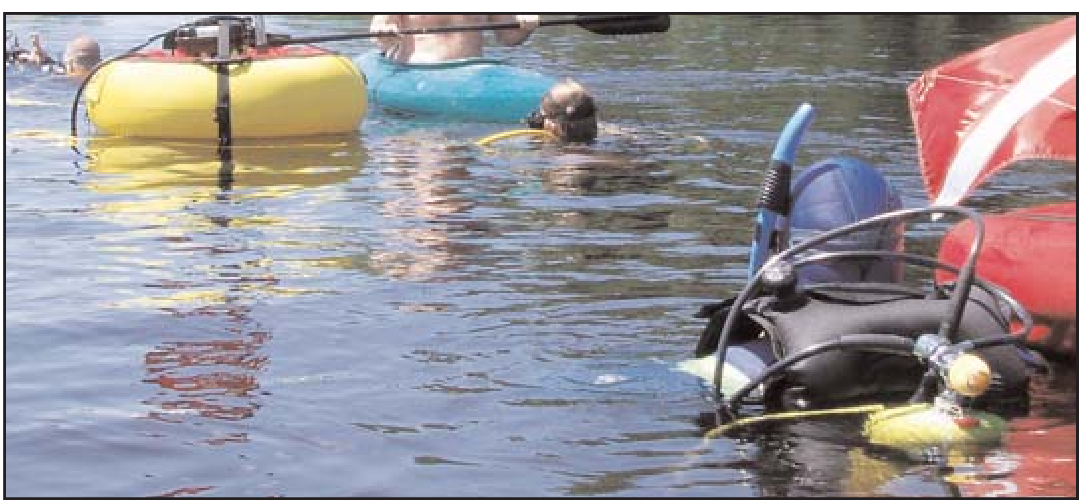
When the plants to be removed are in very shallow water, one way to reduce disturbance and turbidity *somewhat* (remember you are removing plants by their roots; disturbance is pretty much unavoidable) is to approach plants using a shallow draft boat such as a canoe or kayak. The obvious drawback here is the inherent "tippiness" of these lightweight craft, but avoiding calamity is possible by working in two-person teams: one person (the harvester) bending over the gunnels to work the plant from the muck, and one person (plant collector, fragment scout, and counterbalance) carefully shifting his or her weight in the boat to keep things stable.

Another way to minimize disturbance when harvesting in very shallow areas is to use a snorkel, mask and --if conditions are suitable and care is taken--fins. (Fins keep the feet buoyant at the surface, reducing the disturbance of the bottom, but when they come in contact with the bottom they are even more destructive than feet.) As with the method above, it is helpful (and safer) to work in teams: one or two snorkelers in the water pulling plants, and one or two spotters in a boat, keeping an eye on the snorkelers, handling plants as they are removed, and retrieving stray fragments.

In deeper water--greater than 3 or 4 feet--the approach is made by way of SCUBA divers or divers using a "hookah," a system that allows multiple divers to breathe air from a compressor at the surface through long flexible air tubes. Most of the manual harvesting currently being done in Maine is being done by trained divers. Again teamwork is key--divers working in teams of two or three, attended by spotters in boats at the surface, skimming fragments, and handling plants that are pulled up by the divers. (Please contact the VLMP for more information on manual control training opportunities.)

There are a number of techniques for extracting invasive plants from the substrate. The factors at play include: composition of the substrate, number of plants to be removed, whether they occur in dense single-species patches or are scattered among native plants, time of year, the size of the plants, and the resources that can be brought to bear upon the project. The primary tools used for extracting plants are the hands. The harvester, wearing gloves, finds the base of the plant, reaches down into the substrate gingerly loosening the root hairs, then lifts the plant, roots intact, from the sediments. In some cases, small hand-tools, such as those used for weeding a garden, may be needed to gently prize plants loose. Whether the work is being done by hand or with hand tools, it is VERY IMPORTANT to remember that any small stem or root fragment left behind is capable of sprouting a new plant. *Great care must be taken to minimize fragmentation.*

Removing plants causes turbidity; so much of this hand work is done in conditions of poor visibility, compelling divers to learn to recognize the target invaders as much by feel as by sight. The visibility problem can be mitigated somewhat by working methodically in one direction, and striving to keep ahead of the leading edge of the sediment plume. Another solution is to work a defined area, or "plot," until the turbidity becomes



SCUBA divers, divers using a floating hookah system, and spotters in boats at a recent MCIAP training event.

unmanageable, then to leave that area to settle, (perhaps shifting to a second area away from the plume) then returning to the initial plot to "mop-up" the plants that were missed earlier.

Another area where variation in technique and equipment occurs is in transporting plants to the surface. If you are working in very shallow water (or, in deeper water, removing only one or two isolated plants) getting plants to the surface is not much of an issue. If you are removing dozens, hundreds, even thousands of plants in deeper water, the way in which the plants are transported to the surface has great bearing upon both the efficiency and efficacy of the project.

For smaller deepwater projects, divers generally use dive bags to collect plants. Dive bags (the type used by urchin divers) are made of lightweight nylon mesh with a wide, aluminum-frame mouth that opens and snaps shut like a clam shell. Bag-size can vary depending on the number of plants that one is attempting to pull during the dive, and the personal preferences of those who will be handling the bags. (Some divers find that cutting down standard dive bags to ½ to ¾-size makes them more manageable, others prefer larger bags.)

Getting the octopus-like variable milfoil weeds into the bags can be a challenge. The upper parts of plants may be coaxed into the bag prior to digging in after its roots, to keep the plant under control and to minimize fragmentation. Larger plants are sometimes wrapped around the diver's hand like a forkful of spaghetti prior to bagging. It may be necessary to remove some plants in sections--removing the upper part first, and then the lower part and roots.

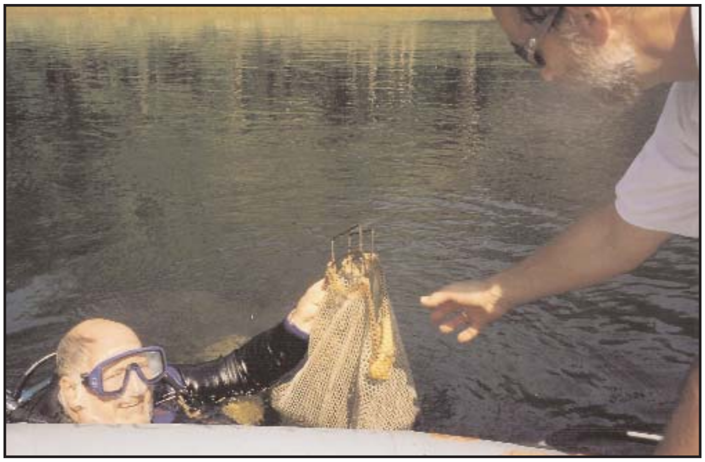
Volunteers wading into Dingley Brook, in Raymond, to remove variable milfoil.

Once bags are full, divers may swim them up to the "handlers" in boats at the surface or alternatively, bags may be transported to boats by more mechanical means. One fairly simple and inexpensive mechanical technique is to rig up a pulley system. Clips are attached at intervals along a loop of rope. (The rope should be long enough to extend from the surface to the bottom, then back again.) The loop-line is threaded through smaller loop anchored to the bottom and another smaller loop secured to the boat. Divers clip loaded dive bags to the line, yank on the line to signal helpers in the boat, who pull up the bag, empty the weeds into the hold of the boat, reattach the bag, signal the diver, and run the bag back to the bottom. Slick. (We have also seen a system of cables and ropes rigged up across an infested stream to transport 5-gallon buckets full of plants to trucks waiting on shore.)

A much more sophisticated method of transporting plants to the surface is used in a control method called "diver-assisted suction harvesting." In this method, there are no bags. Divers extract plants by hand as above, and then feed the plant material directly into a 4" diameter suction tube for instant transport to the work platform at the surface, generally a pontoon boat or barge. Diver-assisted suction harvesting will be the focus of a later article in this series. Also please see "A Day in the Life of a Milfoil Diver" in the Fall 2006 issue of the Water Column.

Quality control is extremely important. First, the emphasis should be on patience and diligence. Hand harvesting is hard work. If it is not done with great care and meticulous attention to detail, all your hard work may be in vain. Worse, the activity may result in more harm than good. It is, for example, essential that everyone involved in pulling up plants knows how to differentiate the target invasive species from any look-alike native plants in the area. Attending an Invasive Plant Patrol workshop is a good prerequisite.

Second, every fragment created during the course of the control project has the potential to cause another infestation, both within the infested lake or--if the proper vector comes along to some other *uninfested* waterbody. *After safety, fragment control should be the number-one consideration of everyone involved in the project.* Strategies for controlling fragments include: choosing the proper means to approach the plants, extracting plants with care to minimize breakage, having spotters and skimmers at the surface to gather up stray fragments, and installing fragment barriers



Teamwork is key -- Diver Scott Gregory hands a bag of harvested plants to Scott Williams.

around project sites. Fragment barriers can be nets, screens or plastic sheeting suspended from poles or floating booms to catch stray fragments.

Third, weather and light conditions can have a significant impact on the efficacy of the project. Work days and the specific hours of activity should be planned to optimize weather and light conditions. If conditions suddenly degrade, call it a day.

Last, despite your best efforts to maintain quality control, it cannot always be assumed that every single fragment or plant is removed, or even seen. Some plants may get covered over with sediments during the course of the disturbance. It may take time for some fragments to float to the surface and others will settle on the bottom, become entangled in nearby plants, or remain neutrally buoyant in the water.

For this reason, follow-up monitoring and ongoing control is essential. After harvesting, the site should be monitored on a monthly basis (more frequently if possible) during the growing season. It is preferable to use snorkelers or divers for this effort as they will be able to immediately remove any invasive plants that are spotted. If surveyors in boats are used for the follow-up monitoring, a system for directing divers to precise plant locations must be developed and employed. Whatever the particulars, the system must make it as easy as possible for divers to find the marked plants and remove them in a timely manner. Labeled buoy markers, corresponding to labeled marks on a map, is an example of a simple and effective plant marking system. As with the actual control work, all monitoring activities should be properly documented.

All plant material must be disposed of properly--dried and composted distant from any body of water (permanent or intermittent), buried, disposed of as solid waste, or burned. If harvested material is in large enough amounts it may be feasible to contract with a disposal service.

Mapping and marking control sites (recording GPS coordinates if possible) facilitates ongoing monitoring and control. It is important that records are kept for all control activities, including dates, times, people involved, hours spent, amount of plant material harvested, etc.

And of course the first consideration for any project of this kind should be SAFETY! All diving involving SCUBA equipment should be done by certified SCUBA divers *only*. (MCIAP has a list of certified SCUBA divers who have been trained in invasive milfoil removal.) Diving and snorkeling sites should be marked with flags or markers. The rule is that boaters must stay a minimum of 200 feet from marked diver areas, but boaters cannot be relied upon to know or follow the rules. Divers and snorkelers should always be attended by spotters at the surface. Spotters should be aware of the divers' position in the water at all times and keep a careful watch out for unwary boaters.

Like virtually all known methods of controlling invasive aquatic plants, manual harvesting has its drawbacks and limitations. But--especially when used in combination with other control methods--manual harvesting does have an important role to play in the ongoing struggle to control the spread of invasive aquatic plants in Maine.

One of the longest-running and most successful manual harvesting projects in the state is being carried out by a group of dedicated individuals on Cushman Pond in Lovell. For more information on the Cushman Pond project and other manual control projects in Maine, please see the new "Battling the Invaders" link on the MCIAP webpage.

IMPORTANT! - All invasive aquatic plant control projects are subject to regulation under Maine's Natural Resources Protection Act. Before planning any control project, contact the Maine Department of Environmental Protection for specific permit requirements. ***All native aquatic plants are strictly protected by Maine law.***

Maine Volunteer
Lake Monitoring Program
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Auburn, Maine 04210

VLMP 2007 Annual Meeting: July 28, Augusta

Other Up Coming Events:

3/2 ~ Maine Milfoil Summit, Lewiston
3/21 ~ Maine Water Conference, Augusta
6/23 ~ COLA's Maine Lakes Conference

For more information about any of these events contact the VLMP at 783-7733 or see our website www.MaineVolunteerLakeMonitors.org.