Little Rice Lake, Forest Co, WI - 2021 Aeration Installation

History, Design, Installation Inventory, Procedures, and Lessons Learned

Grant#: LPT70421

Summary

Due to numerous fish kills throughout the history of Little Rice Lake flowage, the Little Rice Lake Association (LRLA) installed an aeration system in the lake during the summer/fall of 2021. This final effort was preceded by numerous years of setting the stage where this installation could happen. This report will briefly summarize the history of these efforts but will mainly focus on the design of the aeration system, the equipment used along with sources thereof, installation procedures, and lessons learned in hopes of helping others who will surely follow in our footsteps and install aeration systems of their own.

The intent of this report is to add to the body of knowledge which already exists. However, even with what was found, detailed installation procedures couldn't be located, so that is the focus of this report. This is not intended to be all inclusive as there are several steps, including permitting, which are not covered herein. There are surely enough differences from lake to lake and county to county that details of any install will be different.

History

Little Rice Lake is an approximately 1200-acre flowage along the Wolf River located in the far SW part of Forest County, WI. The lake was impounded in the 1940's, and because of it's shallow nature, has suffered numerous fish kills through the years. The lake's greatest depth is approximately 8' with much of the lake in the 3-4' depth range.

After two back-to-back fish kills in the winters of 2013/14 and 2014/15, the lake was shocked by DNR personnel, and it was determined there was a fish kill in the range of 95%. Due to this severe die-off, concerned citizens on and near the lake decided to take action and attempt to reduce the severity of any future fish kills. The steps going forward included establishing the Little Rice Lake Association (LRLA), partially funding a comprehensive lake study (completed by Flambeau Engineering in ~2019, having numerous meetings with local DNR wildlife experts, and finally writing a grant proposal which was approved and funded by the WI DNR in early 2021.

Aeration location and design

The aeration system's location was determined after the engineering study was completed. Three good quality locations were recommended, and LRLA decided upon a location on the south side of the lake for the following reasons: 1. Good water depth (6-7') was accessible within 3-400' of the lakeshore 2. Easy access to existing electric service and 3. Willing landowners who generously allowed LRLA to build a pumphouse on their property.

The design selected was based upon recommendations by the DNR and recent successful installs at two nearby lakes to also reduce fish die-offs. These two lakes were Halsey Lake and Lost Lake located to the NE in Florence Co. WI. Without the experience and willingness of people involved in these installs to share their knowledge and time, the install on Little Rice Lake would have been MUCH more difficult. The design involves having a blower on land with 4 individual pvc lines emanating from the blower and extending into the lake at a location deemed appropriate. The last section of each pvc line has holes drilled into them to allow the air pumped by the blower to enter the lake and keep the ice open via air circulation moving warm water up through the water column.

Equipment Inventory (main parts)

The most important part of the aeration system is the blower used to supply the air to the lines submerged on the lake bottom. What must be considered is the pressure balance between the volume of air at a given pressure the blower produces and the number and size of holes in the pvc. If these are not in balance, there could be too much back pressure on the blower (causing wear and tear), or too many holes resulting in air not being injected into all the open holes. Because of this consideration, we used the same design which was used successfully at Halsey Lake.

Blower: SdB-50 Rotary Blower. Ordered from Air Power Products Ltd (AAPL) from Cambridge, Ontario – the only supplier in North America

(4) 500' roles of 1 ¼" pvc. Lowest cost from Menards – sku 6899806

<u>Barrier system</u>:

(80) 6' garden stakes. Ordered from Menards – sku 2683333

(2) 1000' roles of reflective rope. Ordered from Sgt. Knots online

Roles of reflective tape to put on stakes. Ordered from Amazon

Plastic clips w/ set screws to hold ropes on stakes. Ordered from Geotek of Stewartville, MN (item A38P)

(45) pool noodles. Used to float rebar weighted pvc into position and then reused to help create barrier poles

1000 11" long standard strength zip ties. Used for temporarily attach pool noodles onto pvs/rebar combo, and create barrier poles

<u>Various parts</u>

Warning signs to be posted at public access points. Purchased from Rent-A-Flash Marathon, WI

Buoys to mark end of each pvc line. Ordered from Amazon – crab pot buoys

640 high strength zip ties to strap rebar to pvc lines. Purchased from Amazon

(32) 20' long 1" rebar rods cut into 2' lengths

(4) ice cream bucket sized concrete weights with eyehooks made to attach to end of pvc lines. Dual purpose: to ensure end of pvc line stayed submerged and connect buoys to

100' of 3" perforated flexible pipe to run 4 air lines from blower shed to lake edge. This 3" pipe was used to offer additional protection for the 4 air lines and allow for pulling of any lines which may fail without having to trench or bury a new line

Supplies to build an 8' X 10' shed to hold blower and barrier supplies when not in use

Various pvc fittings and valves used to plumb the four aeration lines from the blower shed to the edge of the lake

Air Line Installation Procedure

Before the air line installation began, the location for the pre-determined end of the line locations were marked using temporary buoys made from plastic jugs.

The 4 pvc air lines were uncoiled several weeks before installation to allow them to straighten. The pvc lines were then drilled using a 1/8' drill bit with holes 4-5' apart over the last 100' of each line (20 holes/line). The 4 air lines were then deployed starting from the lakeshore input location so pre-installation work could begin. The 2' long rebar segments were then attached to the air lines using 2 high strength zip ties each placing rebar 3' apart along the pvc. An endcap was installed at the end of each air line and the concrete weights were also attached at the ends, and buoys attached to the concrete weights. The approximately 5' long pool noodles were attached to the air lines with a gap of ~6' between each using the standard strength zip ties. Note: the rebar and pool noodles were only attached to the first 150'-200' of the air lines to ensure we could pick them up during the install into the lake.

A crew of 3 people were on a pontoon boat and the end of an air line was placed on the pontoon and held in place. The ground-based crew (minimum recommended number of people needed here is 6) then picked up the section of the line with rebar and noodles and moved it toward the lakeshore as the pontoon moved toward the pre-marked end of line buoy. Once the section with noodles and rebar is deployed into the lake, the next section of rebar and noodles is zip-tied onto the pvc air line and then deployed into the lake. After the entire length of the air line is in place, the pool noodles need to be cut off the line and the line will sink to the bottom of the lake. This process is repeated for all air lines to be set. The total time to complete the final installation steps was about 6 hours with a crew of ~12.

Once all lines were emplaced, the latitude and longitude for the end of lines was recorded. This was done to help design an oxygen study requirement of the grant, and to have a record of the ends in case of issues down the road.

Lessons learned during installation

1. The weather is critical during deployment. Wind and waves will move and bow the air lines and cause issues during installation. Highly recommend installation on a day when the wind is forecasted to be light and also start early in the morning when the wind tends to be lightest.
2. We used two people in kayaks and a chase boat to cut off the noodles. One kayaker holds the rebar/air line in place while the other cuts off the zip-ties. The chase boat is used to collect the freed noodles and take them back to shore.
3. When deploying the air line into the lake, we ran into issues with the first line we ran sinking prematurely due to water entering the line and weighing it down. This issue was avoided on the next lines by placing a kayak perpendicular to the line near the end of the perforated pipe. This kept the water in the first 100’ of perforated pipe and allowed the rest to float into position until the pool noodles were cut off. You can see how the kayak was placed on one of the pictures at the end of this report. We also placed pool noodles closer together in the first 100’ to help with floatation.

Barrier Installation

Section 167.26 of the Wisconsin Statutes states that any person who removes ice or causes its removal from any stream, pond or lake shall place around the margin of the opening made by such removal a fence. Please read and become familiar with this statute and the details thereof to ensure liability is minimized. This statute will help determine the number of poles and length of rope needed to purchase to ensure proper installation.

We decided to install the rope barrier ~150’ from the edges of the perforated air lines. The barrier poles were created using a recommended methodology – see included in pictures. The barrier poles were installed when the ice thickness exceeded 5”. The poles were erected around the air lines every 25’ – the holes were drilled using a 5/8” and ¾”bits along with 12” extensions utilizing on a good quality battery operated drill (see pictures). Approximately 5 people put up the barrier in about 3 hours.

Once the barrier is up, and before the blower is started, the recommended procedure is to drill holes in the ice in a line above where the air is to be injected. This will allow for the air/water to circulate to the surface and eventually clear all ice in the area. Lake Halsey found this process took about 2-3 days.

Lesson learned: The barrier was erected when there was ~7" of ice. However, a warm spell two days later (50 degree highs) resulted in the holes drilled to put up the poles expanding to about 6-8" and most of the barrier fence falling. Therefore, the entire barrier had to be taken off and reinstalled later. We aren't sure why the holes expanded as much as they did but can think of three factors: 1. The warm weather certainly contributed. 2. There was a significant amount of snow on the ice causing a significant weight load. Did the drilling of the holes result in water overflow onto the top of the ice cause a 'wallowing out' of the holes? 3. The base of the barrier poles were bright colored pool noodles. Did these noodles absorb a significant amount of heat during the warm day causing the holes to expand? If so, spray painting the bottom noodles white may reduce this risk.

Additional Lessons Learned

1. The work to get the electric line run to the pumphouse was by FAR the most difficult and frustrating step. In the Little Rice Lake area, WPS is the supplier of electricity. The install process starts the ball rolling with the filling out of an online form, which is straight forward. The impression is given that this is the only thing needed to begin and end this process. However, even though we inquired multiple times if there were additional steps and/or information needed (and we were told no more was needed), the install process was delayed many times by additional requirements by WPS which seemed to never be forwarded to the LRLA. When an inquiry was made via email as to why the line had not yet been run, we were THEN told they needed more information, and they were waiting for us. Then once the electric line was run, the install of the meter took several months because it was determined by WPS that this service was for a commercial entity even though the initial online form stated the line was needed and all bills would be paid by LRLA.

I don't blame the individuals we contacted who work for WPS. However, the process seems to be designed to be as inefficient as possible with numerous groups and contractors working for and with WPS to install a single line with no entity in charge of moving the process along. Part of the issue may be we were working with WPS during the Covid-19 pandemic, but this was never brought up by WPS as a factor. We filled out the initial online form in mid-August and as of this date (1/2/22), the install is still not complete.

2. We decided to have the 4 pvc air lines enter the bottom of the pumphouse through a 6" wide 90-degree pvc pipe to better protect the lines. However, the 6" wide pvc pipe was too small to allow for spacing and alignment within the shed. The idea was good, but we would recommend using a 12" pvc. See included pictures.

3. We decided to build an additional valve system along the lake edge. We learned from Halsey Lake their pvc air lines froze along the shoreline before they were able to turn the blower on after installing the barrier line system. We were told it took several weeks to get the lines free of ice before they were able to begin blowing air into the lines. Because our pumphouse had to be 75' from the shoreline due to county regulations, we decided we needed to create a valve system close to the shoreline to allow access near the shoreline if our lines froze. From this valve system, we could have access close to any ice plugs and attempt to remove them from the lines to allow for air flow into the lines. See included pictures.

An additional idea behind the near lake valve system is to prevent the water from moving up into the pvc air lines. The thought is if the nearshore valves are shut in immediately after the blower is shut down, this will prevent the water from moving up into the lines to the shoreline and keep the water/air interface below the lake freeze line.

Acknowledgements

Bill Newhouse (Halsey Lake) – Bill was an immense help throughout the install. He gave us a copy of his paperwork early on (deemed 'the bible'), lined up multiple visits to Halsey Lake to view their install and aerator in action, helped to install our lines, and showed infinite patience with our numerous phone calls, texts, and emails.

Mark Smith (Lost Lake) – Mark gave lots of advice and help by sharing the aeration install they had completed several years before our install. The lessons they learned, and shared, saved us many hours of work.

DNR Personnel –

Scott Van Egeren: Water Resources Management Specialist

Helped with the grant application and educated/guided us through the aeration process.

Greg Matzke: Fisheries Biologist

Supported grant application and used his guidance in aeration specs.

Thomas Carlson: Wildlife Biologist

Supported grant application.

Jill Sunderland: DNR Grant Specialist

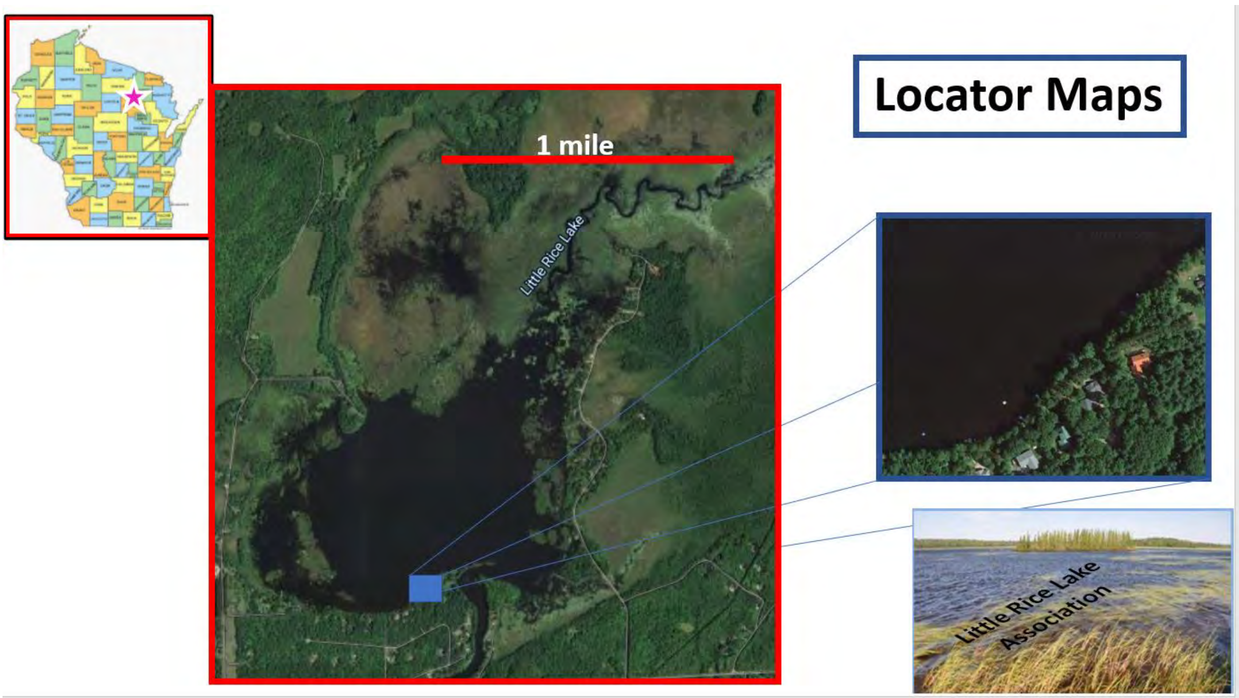
Kept us on track during the grant application process

Chris and Gail Dockry (Little Rice Lake): Chris for leading the effort to justify, fund and install the aeration system by way of the LRLA presidency (and before) for a total of 8 years. And thanks to Chris and Gail for allowing the pumphouse and operations to take place on their lake property.

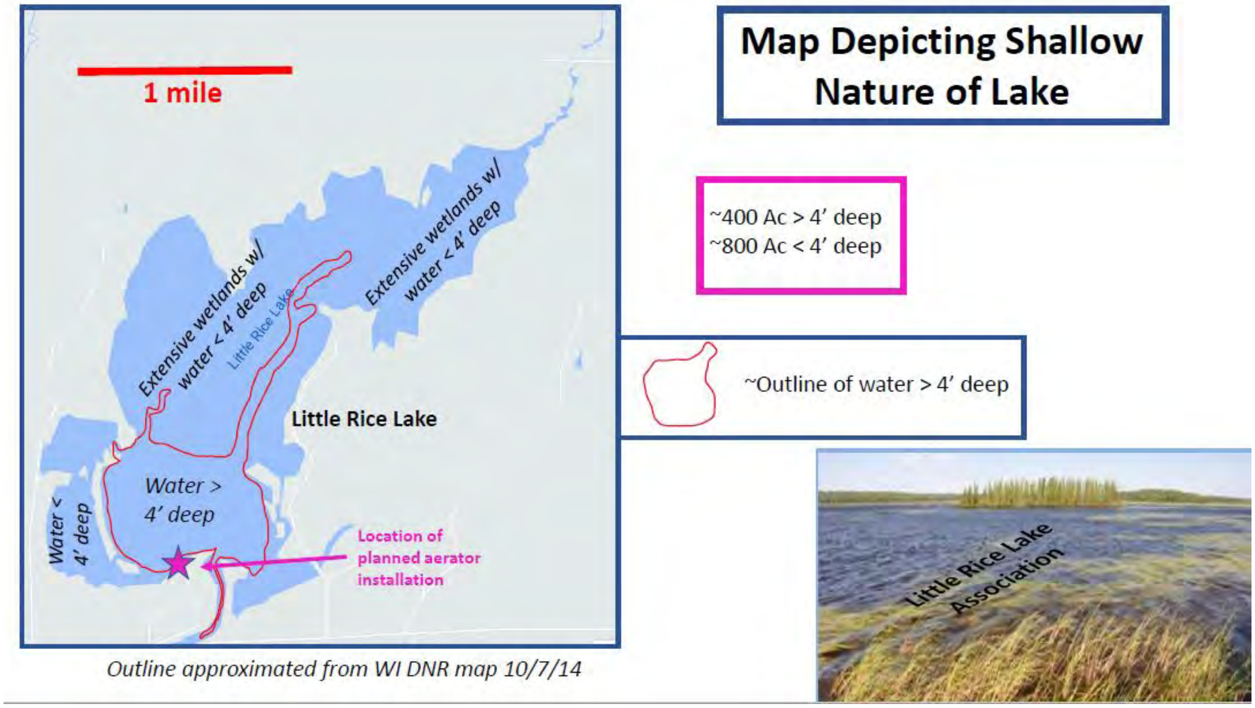
Members of the LRLA and others who helped with donations, grant application, pre-install/install/post install work to ensure Little Rice Lake will have a viable fishery for many years to come.

Submitted by: Dave O'Bright and the Little Rice Lake Association, 2022

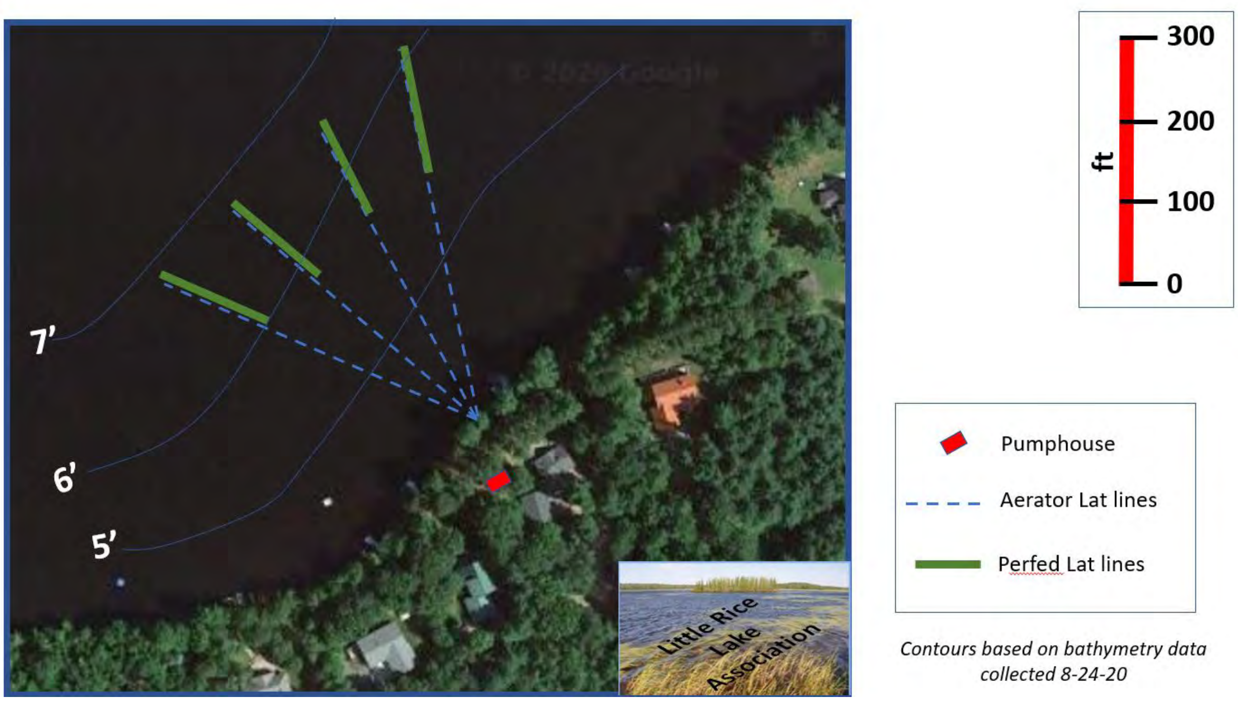
Supporting Pictures and Documents



Location Map



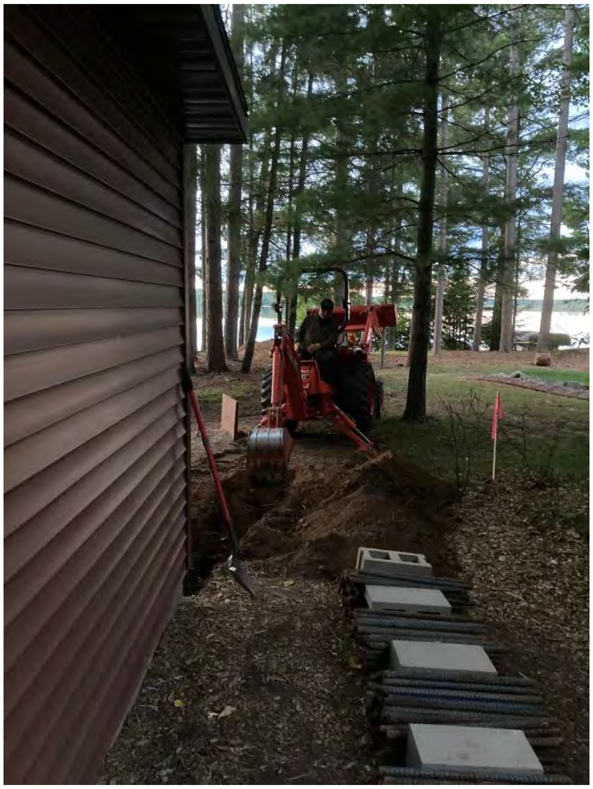
Grant supporting map



Planned location of aeration lines.

Initial pumphouse build

Finishing pumphouse build



Trenching from pumphouse to lake. Note cut rebar stored near pumphouse.

PVC air lines entering Little Rice Lake pumphouse

PVC air lines entering Halsey Lake pumphouse for comparison to Little Rice Lake installation.

4 pvc airlines encased in 3” pvc from pumphouse to edge of lake

Blower in pumphouse. Note valve system and odd angles of pvc airlines due to undersized 90-degree pvc used to enter the pumphouse.

Blower electrical control panel within the pumphouse designed and built by Andy Mott

Valve system near lakeshore. Note: valves are shoreward of the T's, and caps are on end of each T in final step.

The four pvc air lines laid out to be installed. Note noodles and rebar attached and ready for deployment.

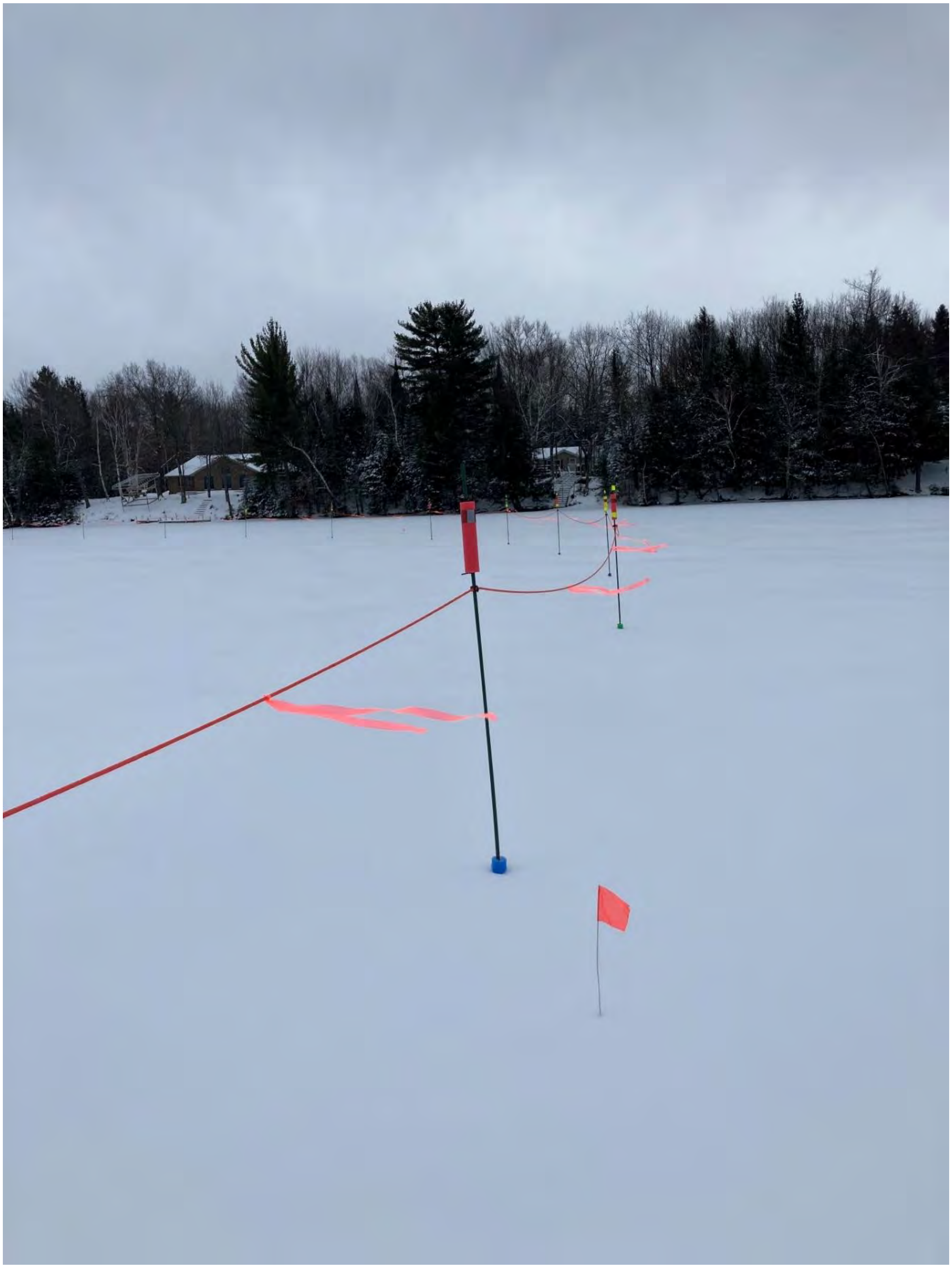
Installing an individual pvc air line in the lake. Note the extra noodles attached to the first 100’ and kayak laid perpendicular and ready to be deployed to help with floatation.

Buried pvc air lines entering lake. The lines were buried at the shoreline interface to hopefully help freezing issues experienced by Halsey Lake.

Barrier pole design. 6' pole with pool noodles on top and bottom, reflective tape, and rope holder (black piece below upper noodle). Zip ties were used to keep noodles in place.

Bits and extension used to drill holes in ice to put up barrier poles.

Wallowed out hole after barrier was placed on ice the first time



Final barrier install for first season.

Thin ice sign installed at one of the 3 access points on the lake

Additional Resources from Other Sources

We got a copy of this from Halsey Lake. Source unknown but good resource for installation procedures.

Having electricity at the site, or at least near the site, is critical, as the aerators are driven by electric motors. Water of at least five feet maximum depth should be within several hundred feet of the shore.

The presence of public land or a willing landowner on which to site the project is important. Liability can be an issue when installing aeration systems. The landowner where the system is to be located must obtain the water regulations permit, and becomes liable for the aeration system. Therefore, it is best if the landowner is not an individual, but is a unit of government or a lake district. The liability aspect must be made clear to the landowner. Maintaining an open water barricade in accordance with Wisconsin Statute 167.26 is important in regard to liability.

Compressed air aeration systems are less labor intensive than aspirating aeration systems, and so are often the most practical if a lake group is to operate the system. However, because aspirating aeration systems are generally more powerful than compressed air systems, they may be better suited to aerate lakes greater than 250 acres and shallow lakes less than 10 feet maximum depth. A compressed air system was only marginally successful on six ft deep Camelia Lake, but a 2 hp aspirating aerator was much more successful at preventing winterkill. Four 3 hp aspirating aerators have prevented winterkill conditions from occurring in the northern one-half of 1,534 acre Prairie Lake for 15 years.

<u>Installation of the Open Water Barricades.</u> A very important part of any aeration project is the placement and maintenance of a barricade around the open water created by the aeration system. Wisconsin Statute 167.26 states that "(2) Any person creating ice holes by aeration of water, may, in lieu of the requirements of sub (1), erect and maintain a barricade around such holes consisting of uprights spaced every 25 feet or less, connected by a continuous rope, cord or similar material placed 3 ½ feet off the surface of the ice. The connecting rope, and/or similar material shall have reflectorized ribbon or tape attached to it, so as to be highly visible, and shall be of sufficient strength to permit retrieval of the barricade following melting of ice. Any person erecting such a barricade shall remove the barricade and all parts thereof from the ice or water immediately after the ice has melted. (3) Persons barricading ice holes in the manner specified in this section shall not be liable for damages suffered by persons who enter within the barricaded area."

It has been the practice of some operators of compressed air systems to turn on the aerators and let the open water area develop, and then place the barricade around the open water. This method does not meet the standards of Statute 167.26, as for a time there is unbarricaded open water present, creating a potential liability.

A better way to operate is to: 1) turn on the aerators before freeze-up to blow the water out of the air lines and to identify the locations of air bubbles rising to the surface. Mark these locations using GPS or another method; 2) turn off the aerators until the ice is thick enough to walk on, and erect the barricade around the area that will become open water, making sure the barricade is large enough; 3) drill some holes through the ice where the air bubbles will come to the surface, then turn on the aerators and let the open water develop.

Any materials can be used for the barricade as long as they meet the standards of Statute 167.26. A convenient method is to use 5/8 in diameter, 5 ft long fiberglass fence posts with a 3 in by 3 in PVC sponge net float pushed up about one ft onto each fence post. Holes are drilled into the ice every 25 ft or less, forming a perimeter of the barricade, and a fence post is placed in each hole so the net float rests on the ice. The float gives the post upright stability, and the post will float for easy retrieval in the spring.

Fence post clips and zip ties can be used to attach ½ in black polypropylene rope to the fence posts. Reflective tape and markers can be purchased to place on the fence posts and rope. Black markers attached to the posts and rope provides definition against the white snow making the barricade easier to see during the day (See Appendix Table 1 for barricade material list and vendors). Signs should be placed at public access sites warning of open water due to aerator operation.

Design, Installation and Operation of a Compressed Air Aeration System. The compressed air aeration system is permanently installed at the site. The system consists of one or more air compressors housed in a shelter on the shoreline, which push air through two or more air lines which extend along the lake bottom to the deepest part of the lake that can be reached in 400 feet or less (Figure 2). Air is released from the end of the air lines into the water where it bubbles up through the water column to the surface. This action creates a current which causes warmer water near the lake bottom to rise to the surface, creating an ice-free area which allows water to be reoxygenated. The air lines should be run inside a length of 4 inch PVC pipe from the aerator shed out into several feet of water depth to protect the lines from damage. A barricade needs to be constructed around the open water.

The aeration system must be operated throughout the winter months, from December into March. Most compressed air aeration systems are not powerful enough to increase dissolved oxygen levels, or even hold them steady, but they slow the rate of decline so that adequate dissolved oxygen (greater than 2.0 ppm in the upper five to ten feet of water) is still available in late winter.

Because funding is often a concern when working with small groups of partners, the procedure has been to install the smallest aeration system which has a reasonable chance of preventing winterkill from occurring. If the system proves inadequate, it can be enlarged.

Lakes with a maximum depth of at least 10 feet and a mean depth of at least six feet can often be aerated successfully with a compressed air system. In general, one ¾ hp aeration unit may aerate a 30 to 50 acre lake, with an additional ¾ hp unit added for each 30 to 50 acres. Because fish are attracted to areas of adequate oxygen, it is not necessary to maintain desirable oxygen levels throughout the entire lake.

A single aeration unit consists of a ¾ hp or 1 hp oilless vane compressor, a two valve outlet, a muffler system, and two air lines each consisting of ¾ inch weighted heavy duty polyethylene tubing. Pre-weighted polyethylene tubing is available, but regular heavy duty polyethylene tubing weighted with ½ inch by 20 foot reinforcing rod placed end to end works well and is more cost-effective. The cost of one ¾ hp aeration unit is approximately $1,150.00, and the cost of operation of one ¾ hp unit is about $30.00 to $50.00 per month in electricity.

Ceramic diffusers are available which can be placed at the ends of the air lines to create smaller bubbles and thereby increase the aerators efficiency. However, the diffusers are a maintenance problem in that the micropores become clogged, and satisfactory results have been obtained simply by capping the ends of the air lines and drilling several 1/8 inch holes into the last several feet of tubing.

One advantage to a compressed air system is that once the system has been installed, relatively little maintenance is required beyond the erection of an open water barricade in early winter and its removal each spring. The system needs to be turned on before freeze-up to check for problems and to blow water out of the air lines. The air line valves must be shut immediately after the compressors are turned off to keep water out of the air lines during the freeze-up period.

It is recommended that the carbon vanes in the air compressor be replaced about every nine months of operation. A vane set costs about $85.00. Other possible maintenance concerns are muskrats *Ondatra zibethica* chewing holes in the air lines that then need repair and boat anchors catching and moving air lines that then need to be reset. If reinforcing rods are used to weigh down the air lines, they should be placed end to end to keep the air lines flat on the bottom.

Design, Installation and Operation of a Surface Aspirating Aeration System. Surface aspirating aeration systems are currently (2005) in use on four area lakes (Table 1). Each aerator unit consists of an aerator floating on a molded polyethylene pontoon. The aerator consists of an electric motor (2 or 3 hp) attached to an adjustable hollow shaft that angles into the water (Figure 3). The shaft drives a propeller/diffuser that draws air through intake holes above the water surface and shoots a stream of air through the shaft into the water. Underwater power cable and mooring cable are necessary, and the open water must be surrounded by a barricade. The cost of one 2 hp unit with 200 feet of under water power cable is about $1,350.00. Operating cost is estimated at $120.00 to $180.00 per month in electricity for one 3 hp unit.

A significant difference between the surface aspirating aeration system and the compressed air system is that the compressed air system is permanently installed at the site, while the aspirating system must be installed each winter and removed each spring. Therefore, the aspirating systems are considerably more labor intensive, and may require Department of Natural Resources (DNR) assistance for installation and removal. On the plus side, the aspirating systems are portable and ideal for emergency aeration situations.

We received a copy of the email below from Lake Halsey notes.

DATE: January 31, 2003

TO: Dave Neuswanger

FROM: Greg Rublee, Skip Sommerfeldt, Tim Risch

SUBJECT: **Winter Aeration Barricading Guidelines**

Section 167.26 of the Wisconsin Statutes requires that any person removing ice from navigable or public waters shall place and maintain a barricade around the margin of the open hole(s). The barricade shall consist of uprights spaced every 25 feet or less, connected by a continuous rope, cord or similar material placed 3 ½ feet above the surface of the ice. The connecting rope, cord or similar material shall have reflectorized ribbon or tape attached to it, so as to be highly visible, and shall be of sufficient strength to permit retrieval of the barricade following melting of the ice. Any person erecting such barricade shall remove the barricade and all parts thereof from the ice or water immediately after the ice has melted. Persons barricading ice holes in the manner specified shall not be liable for damages suffered by persons who enter within the barricaded area.

In fulfilling the barricade requirements around the ice holes created annually by our lake aeration systems, we have developed barricade installation methods and safety guidelines which work well for us. The following information is what we currently utilize on our lake aeration applications.

- **Safety Equipment for Personnel:**
  - Floatation vest or coat
  - Ice bar/chisel to check ice
  - Cellular phone in vehicle
  - 4" hand or power ice auger
  - Floatable hand held ice picks
  - Rope life line secured to shore
  - Extra change of clothes
  - Throwable life preserver/cushion

- **Safety Precautions:**
  - At least a 2 person crew
  - Stay away from edge of hole
  - Do not risk marginal ice conditions
  - Observe ice quality variations
  - Wear floatation coat or vest
  - Post warning signs at access points
  - Minimum of 4" ice to support you and posts
  - Person checking ice is secured to tied off rope
  - Drill holes near and off shore to check ice
  - Check ice with chisel on initial perimeter walk
  - Carry ice picks with you at all times
  - Mail barricade reminder letter to cooperators

- **Aerator Start-Up (2 Options):**
  1. Start aerator in late fall before ice up and keep running until ice out.
     - Prevents water-filled diffuser lines from freezing up at water/shoreline interface.
     - Provides a better opportunity for underpowered aeration systems (some solar units) to get a head start in opening holes and maintaining them after ice up.
     - Must mark aeration hole sites with reflective hazard buoys during late open water to warn people during the transition period of ice formation until the ice is thick enough to install a barricade.

2. Start aerator after ice up when dissolved oxygen values approach dangerous levels.
   - Must be able to locate air diffuser lines in order to drill holes above the diffuser to allow holes to open up in the ice.
   - Locate diffuser lines using one of these methods:
     - -Mark ends of diffuser lines in late fall with buoys and let them freeze in.
     - -Measure the known length of the aeration lines from shore using pre-designated diffuser line compass readings for directional bearings.
     - -Use GPS coordinates (margin of error may be too high).
   - Can install the barricade around the diffuser lines once they're located.

Barricade Equipment:

-Extruded fiberglass composite posts; 5 ft. long; 1"diameter; foam filled; 1/4" hole drilled 2" from top; with two 4"-6" wide strips of reflective tape around top third of post.
-Reflective rope (3M reflective filament wound into nylon sheath of 4mm diameter rope).
-4" hand ice auger
-Power auger with a 20"auger extension modified to hold a 1 1/8"diameter drill bit.
-Anchors w/ regular rope (anchors are old window weights that fit down a 4"diam. hole).
-Wire zinc-plated coil tension safety pins (.091"diam. & 1 3/4" long - fits in post hole to support the reflective rope).

- **Barricade Layout:**

-Use enough posts and reflective rope to stay out at least 50 feet from edge of hole.
-Must increase barricade perimeter distance to allow for hole expansion on some aeration sites due to historical susceptibility with warming air temps, wind direction/fetch or currents on flowages.
-One person walks barricade perimeter while secured to tied off rope and watched by the other crew member. Always check ice ahead of you with ice bar as you proceed.

- **Barricade Installation:**

-Drill a 1 1/8" diameter hole with modified power auger every 25 feet around perimeter.
-Do not drill all the way through the ice (preferably 3-4" deep post hole in ice).
-Place a 1" diameter fiberglass composite pole in each post hole.
-Insert coil tension safety pin (rope fasteners) in hole at top of each post.
-Drape reflective rope over open pins on each pole, then fasten shut (rope slides through).
-Pull rope tight and tie off where you started.
-Drill 4" holes with hand auger at 4 "corners" of the barricade. Drop tethered anchor down each hole and fasten to top of nearest barricade post, allowing for easy boat retrieval of the barricade at ice out (keeps barricade from washing up and tangling on shoreline debris).
-Can also post warning signs around outside of barricade and at access points around waterbody (boat landings, etc.)