PROGRESS IN LAKE MANAGEMENT

- What we learned in 2021
- What is needed in 2022
- Vision for the long-term

Lake Advocates ~ Scientifically Based Lake Restoration, Management & Protection

Harry Gibbons & Robert Plotnikoff

AGENDA

Part I: Overview of Management

Part II: Future Potential Projects

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Part I: Overview of Management

Aquatic Plant Survey Results

Lake Limerick

- June/October Plant Surveys
- Benthic Macroinvertebrate Survey

Lake Leprechaun

- June/October Plant Surveys

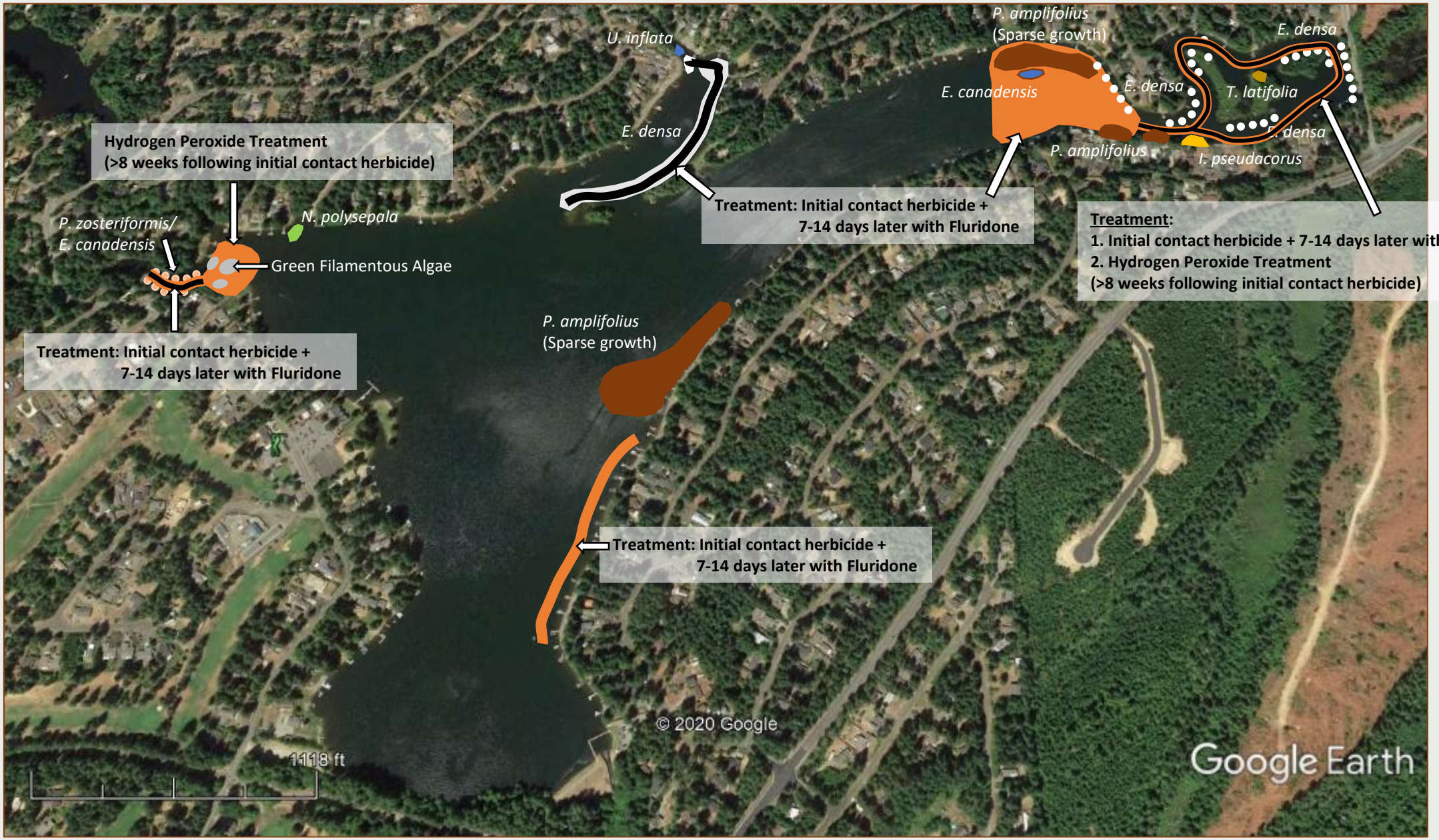
Lake Limerick general observations

- Water quality fairly good
- Sedimentation is accelerating
- Plant control was successful

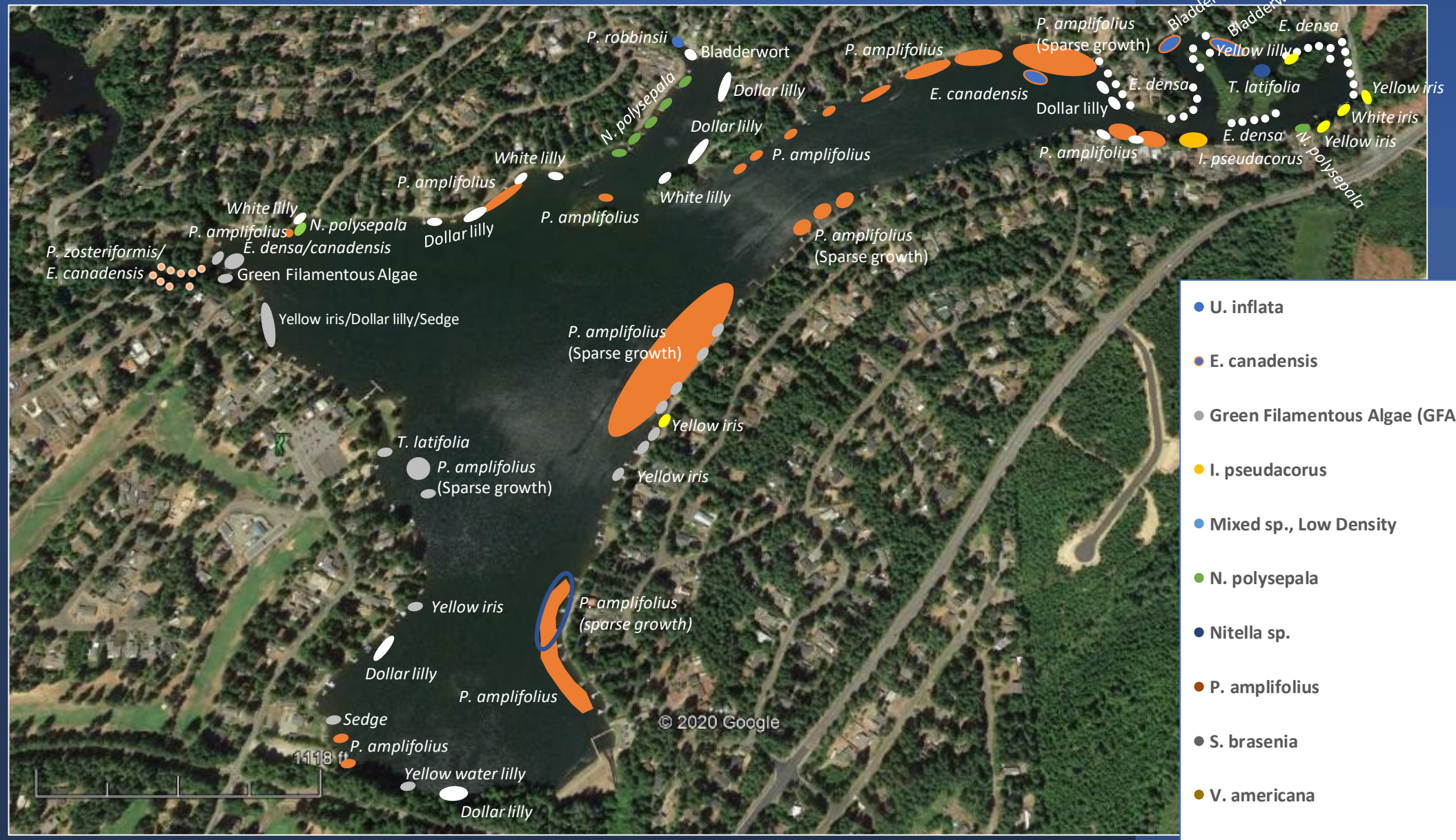
Lake Leprechaun general observations

- Dramatic improvement in plant control/organics

Lake Limerick Proposed Aquatic Plant Treatment for 2021

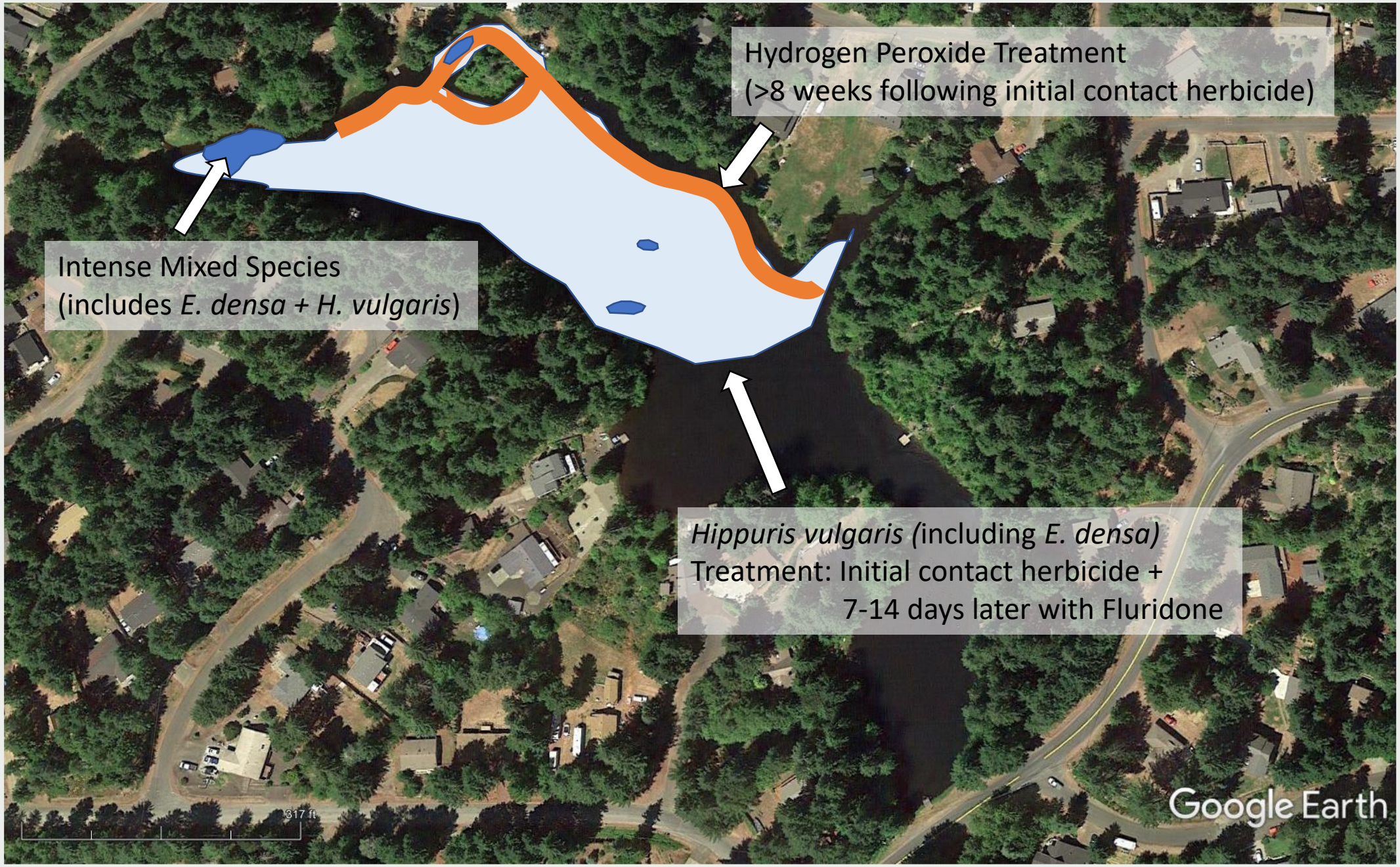


Aquatic Plant Survey (June & October 2021)



- U. inflata
- E. canadensis
- Green Filamentous Algae (GFA)
- I. pseudacorus
- Mixed sp., Low Density
- N. polysepala
- Nitella sp.
- P. amplifolius
- S. brasenia
- V. americana
- T. latifolia

Lake Leprechaun Proposed Aquatic Plant Treatment for 2021



Aquatic Plant Survey (June & October 2021)

Part I:

Overview of Management

Annual Report 2021

1. Expected Completion Date
2. Dredging Permit Requirements Completion

Future Plant Management

1. Plant Treatment Spring 2022/Summer 2022
2. Re-establishment of water quality monitoring

Part II:

Future Potential Projects

Water Monitoring

Weed Harvester

Past Lake Dredging

Transect measurements (pre-/post- conditions)

How to determine future dredging

Lake Leprechaun Dredging

Cranberry Creek Sediment Pond

Bird Sanctuary

Part II:

Future Potential Projects

Water Monitoring

1. Training volunteers
2. Frequency of sampling
3. Chain of Custody (Quality Data Collection)

Weed Harvester

1. Will a permit be required to use one?
2. Considerations for purchasing a weed harvester.
3. Expectations for plant management.
4. Other issues not identified.

Part II:

Future Potential Projects

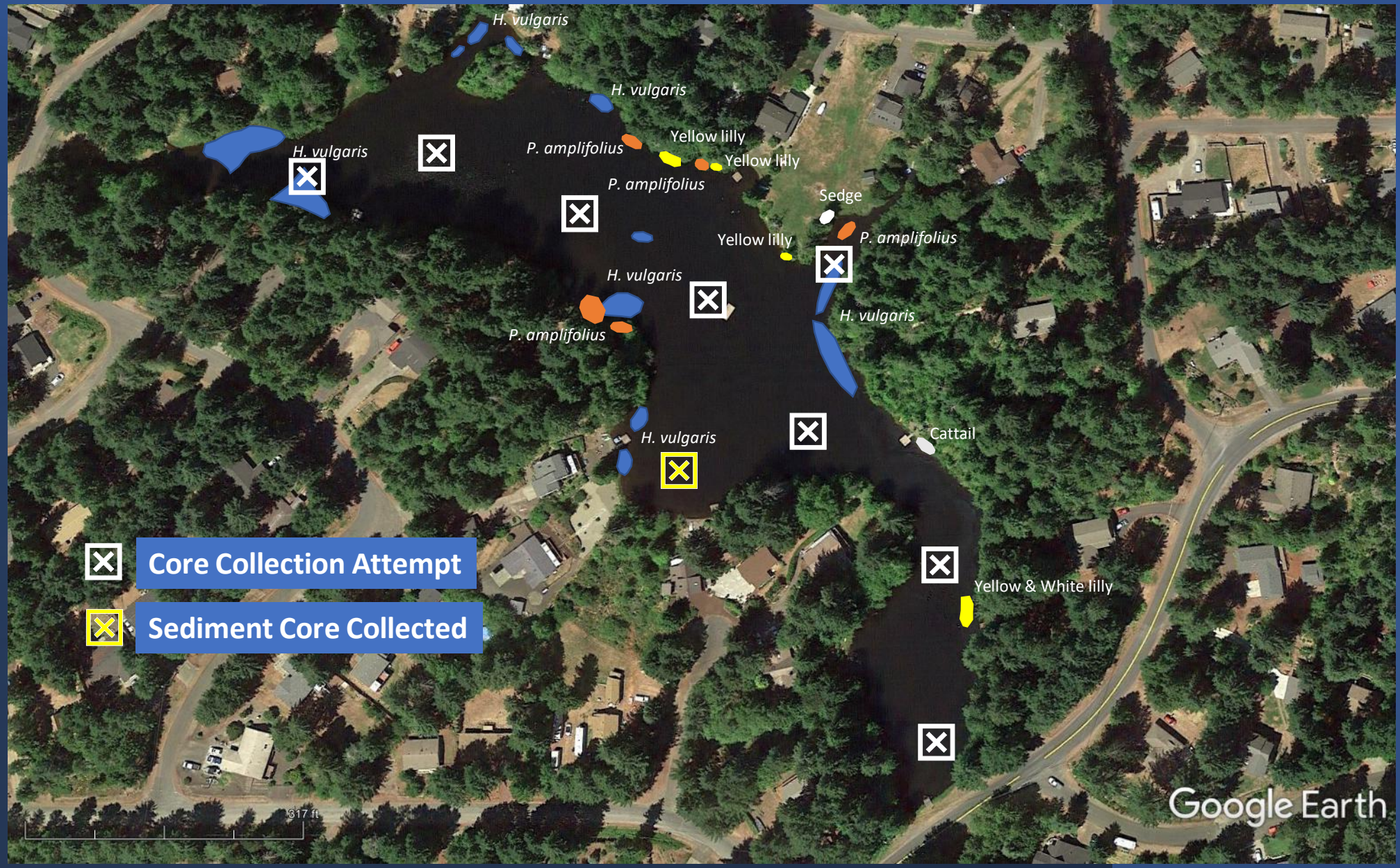
Lake Limerick Dredging

1. Rapid sedimentation in bay areas
2. Organic enrichment and sedimentation build-up in deepest area
   - *a.* Transect Measurements (compare of pre-/post-)
   - *b.* Planning for future dredging

Lake Leprechaun Dredging

1. Sediment core samples
   - *a.* Most areas of bottom are sandy/gravelly (previously observed as mucky/organics)
   - *b.* Single location had a mucky bottom
   - *c.* Sandy/gravelly composition indicates groundwater interaction

Sediment Core Collection Attempts (October 15, 2021)



Part II: Future Potential Projects

Cranberry Creek Sediment

1. Feasibility study
2. Design considerations for a sediment pond
3. Footprint near the stream
4. Timeline for implementation

Bird Sanctuary

1. The issues defined
2. Next steps
3. Timing for action

Lake Advocates / LLCC Lake Dam Committee
20 December 2021 Working Team Meeting Minutes

Lake Advocates; Study Session
December 20, 2021
Presenters: Harry Gibbons and Robert Plotnikoff
Attendees: Dorthy Powter, Debbie Moore, Maureen/Steve Glenn, Tamra I, Mandy Paradise, Dennis Muretta, Ashlin Ingalls/Bob Heisleman, Steve Saylor, Roger Milliman, Tim Reber, Teddy Lovgren, Connie Wong, D. Landsvertk, Dean Dyson, Katherin Genseon, Robert Garvy, Rictcher, Bob Heislman

Presenters did not record the meeting. Instead, Mandy Paradise volunteered to record notes and LA presenters reviewed for accuracy. Meeting start time was: 7:02 pm

Presentation Summary:
1. What we learned in 2021
2. What is needed in 2022
3. Vision for the long-term

Part one overview of management:
- Limerick: Plant surveys done in June/October and Benthic Macroinvertebrate
- Leprechaun: June/October plan surveys
- Analysis is not yet complete

The conditions of the lake are taking on the conditions of lake aging.
- Habitat stress and aesthetic value,
- Based on years of observing by Lake Advocates (no data sources provided).

Lake Advocate's data and the anticipated surveys are not yet available.
- Estimated due date was requested. The known delivery date of benthic monitoring data was February 3, 2022 and has been incorporated into the annual report.
- The annual report will be available for LLCC review the end of February 2022.

Survey Findings (Preliminary):
1. Water quality is good (positive outcome)
2. Sedimentation is accelerated
3. Plant control was successful (positive outcome)
4. Lake Leprechaun condition: dramatic improvement in plant control (positive outcome)

Treatment areas took place in several locations at Lake Limerick, *see PowerPoint presentation.*
- Density of weed growth was reduced by the treatments (positive outcome)
- Treatment types applied on two different dates, a second following the initial treatment to have maximum benefit of weed/algae control
- Lily growth has been greatly mitigated following the 2021 treatment schedule
- Pond weed, a native plant, is present and expected to occur in the lake

Goals are to mitigate the invasive species of weeds/lilies, and foster healthy levels of native species:
- Notable, is that pondweed is sparsely growing and not dense.
- Treatment has knocked back invasive weed growth as expected (positive outcome)
- Patches of non-native weeds exist, but this is not problematic (positive outcome)

Leprechaun Overview:

- Lake Leprechaun is a more productive lake when it comes to weeds
- The 2021 aquatic plant herbicide application suggested a more aggressive approach taken to mitigate weed growth
- The 2021 treatment was significant with respect to the size of Lake Leprechaun
- The hydrogen peroxide treatment was highly effective and potentially mitigated for warmer climate conditions during the 2021 growing season (positive outcome)
- The October 2021 survey showed very little plant presence but showed a greater area of bare sediment during the sediment coring work. Organic materials were low to not present based on sediment core attempts throughout the length of the lake.
- Native lily growth in middle of lake was an indicator of depth reduction (sedimentation over time)

Annual Report by Lake Advocates

- Annual Draft report will be presented to LLCC by end of February 2022.
- The report will provide trend and comparison data including suggested aquatic plant herbicide treatment and results from the summer and fall surveys.
- Periodic and staggered treatment cycles have proven effective.

Looking Ahead - *Spring/Summer 2022 Treatment:*

1. Survival of aquatic plants will be examined based on prevailing environmental conditions and considering past herbicide applications. **Late April/ early May may be the next decision-point for treatment as that will be the window of time that reveals the most information.** Based on strategies we've taken with treatment, anticipating continuing a similar protocol of staggered aquatic plant herbicide applications in 2022.
2. **Some plants in the lakes are valuable (native aquatic plants) and necessary to maintain fisheries**. These plants mitigate for nuisance algae growth and harmful algal blooms (HABs). Lake Limerick hasn't experienced HABs like other local lakes (e.g., Mason Lake). The goal is to maintain balance of native weed growth to maintain other scenarios resulting in degradation of lake health. These measures serve as preventative measures and maintain lake health. Maintaining native plants promotes a healthy lake ecosystem and acts to discourage invasive weed presence and excessive algae growth.

Part II: Future Potential Projects

Water Quality Monitoring

Desiring to see lake chemistry throughout the year

- Recording methods and approaches for measures is critical
- Data-loggers in use
- Training volunteers, frequency of sampling, and chain of custody (quality data collection)
- *Quality Assurance Monitoring Plan* was referenced (data/plan needed) - **this is recommended**. One hasn't occurred in "years" and is something to consider doing again.

- Roger (CAM) commented: a plan is ready to launch using IEH Labs. We anticipate the Lake-Dam Committee will bring this recommendation forth to the Board for financial approval and that the Quality Assurance Monitoring Plan will proceed.
- The Managing scientist at IEH has been working in conjunction with LA staff since 1985. LA has had influence on hiring of technical staff at IEH. This lab has also been a focal point for establishing low-level nutrient analysis and metals analysis for several agencies in the Northwest and in western Canada.

Q. Do we have data on thalweg?

A: Reports containing data regarding pre-and post-dredging was sent to M. Paradise upon request. Specific questions were addressed by indicating report section and page along with an interpretation of the results.

Weed harvester

- HPA permit will be **required** to use/operate a weed harvester. Further review of requirements by Washington Department of Fish and Wildlife and Department of Natural resources is necessary.
- Harvester is more likely to create an imbalance in lake plant management and potentially lead to a worsening weed problem. Some weeds re-seed themselves from cuttings following weed-harvesting.
- Over-harvesting weeds or improperly harvesting weeds can lead to algae blooms and proliferation of other lake-health issues
- Harvesters used on these lakes are anticipated to worsen water quality and not improve it versus current proposed and implemented treatment strategies.
- Estimated 100-200k for purchasing and maintenance of a weed harvester
- LA has worked with Aquatic Ecosystems (foremost and best aquatic plant harvesters) since 1980. This strategy for plant harvesting can be effective in situations where appropriate but is not recommended in the case of Lake Limerick and Lake Leprechaun.
- Lake Advocates stated that weed harvesters can lead to worsening lake conditions in environments like Lake Limerick and Leprechaun that have similar conditions.
- Large-scale harvesting of plants will trap small fish in the overburden and impact the existing habitat for raising salmon. Likely to experience resistance from **Fish and Wildlife** and **Tribes**.

- *Alternative method for weed mitigation proposed by Lake Advocates*: Hiring a diver to selectively remove nuisance aquatic plants and is a more **effective** mitigation strategy and more cost-effective in place of purchasing a harvester.

Past dredging

- Cranberry Cove sediments/nutrients coming into the lake from Cranberry Creek appear to cause substantial inflow of sedimentation. Past dredging removed approximately 3

feet of soft sediment in locations and appears to have returned. Current conditions need to be mapped to verify effectiveness of past dredging.
- King's Cove had some minimal return of sediments.
- Organic enrichment appears to be slowly increasing in Lake Limerick.
- Lake Advocates stated the following is necessary information for guiding future dredging activity: *How fast is the lake refilling (and identify the sources), how does this mediate weed growth, and what are the options to implement alternate solutions to dredging.*
- Data describing sedimentation in the lake and current bathymetry is not available and could be a future investment: Description and comparison from three points in time: prior, immediately after, and post dredge conditions. The previous strategy used data from longitudinal transects were determined in Cranberry Cove and near Cranberry Creek to determine how sediment is transported and the rate of sedimentation.
- How effective is dredging without some control in place to reduce sediment inflow is a question.
- Need to revisit the transects (data points) and depths, compare past- and current conditions; using sonar to measure bathymetry and to describe sediment deposition patterns. This work could be planned for future consideration.

Q. Have we previously mapped bathymetry in Lake Limerick?

A. Lake Limerick has two past sonar projects that were completed Bathymetric measurements using sonar technology was recently completed in detail in King's Cove and Cranberry Cove.
   a. Recent bathymetric mapping would be useful to know how sedimentation patterns have progressed in the Coves and in the Lake.
   b. Lake Limerick bathymetry was mapped using BioBase® in 2016 by Tetra Tech.

Q. Was Lake Limerick water level fluctuation was considered during past bathymetric mapping?

A. Yes.

Leprechaun dredging

- Muck on the bottom of the lake is minimal throughout the mid-lake area. Gravel is dominant in these areas based on sediment core collection attempts. One location in Lake Leprechaun was found to have soft-bottom sediments and a core was collected (see map).
- It appears that dredging in Lake Leprechaun will not have an effect on plant management in the lake based on recent sediment core collection attempts. Dredging would be focused on inlets, coves, and shorelines where soft bottom would enable establishment of invasive aquatic plants.
- *NOTE: cost and timeline of this was not discussed at the study session*

Q. Leprechaun only had one location with a mucky bottom?

A. Sediment Core sampling was attempted throughout the lake; see PowerPoint map for locations.
B. Hard bottom was prolific, no mucky bottom. Muck bottom was found in one, singular location (see yellow marker in the PowerPoint map).
C. Recent sedimentation has occurred nearer to select banks.

D. No need to collect core samples where known soft-sediments exists along shorelines. Soft sediments are located near inlets and bays of the lake where increased sedimentation is visually evident. Sediment core data would be used to determine how deep to dredge and if whole-lake dredging would need to occur.

Q. Is there a clay liner that maintains surface water in Lake Leprechaun? Did the core samples indicate a clay liner exists?

A. A clay liner may exist beneath the hard pan sediment but was not able to be sampled with the soft-bottom sediment core technique.

Q. Is there a glacially influenced sea l inLake Leprechaun?

A. The cores showed that the basin is very solid and has a glacial seal. This condition was unexpected given previous plant growth in the lake
B. With culverts at Lake Leprechaun inflow, speculating that that plant growth has occurred with transport of nutrient-laden sediment. Tim's maintenance in plant removal has helped to mitigate excessive growth near that inflow.

Q. Is a glacial seal the same thing as hardpan?

A. Yes. It's composed of clay and gravel mix that forms an impenetrable seal to surface water.

Q. **Surprising finding there is a lack of measurable organic material at the bottom of Lake Leprechaun. Does this mean is necessary?**

A. Dredging of the main-basin of leprechaun doesn't appear necessary as there is little to no soft-bottom material to remove.

Q. **Because hardpan is so close to the surface, is this a problem when it comes to dredging? (Lake Leprechaun)**

A. No. However, soft sand that is transported into the lake from points of inflow can easily be trapped at the source.

Q. How much to lower Lake Leprechaun if dredging were to proceed?

A. Lower the lake level by 3-4 feet

Q. What type of permitting needed for dredge

A. A permit is the next step needed. Even though not a hydraulic dredge, the same process to obtain a permit (e.g., Lake Limerick dredging) is necessary.
B. A new permit is needed each time a dredging project is proposed.
C. No ability to have an ongoing dredging permit. No "continuous permit" is ever granted.

Q. What is the next step needed regarding dredging Lake Leprechaun?

A. The same steps, contact with regulatory agencies and Tribe and documentation is necessary as that for Lake Limerick.

Q. What about the tailings/removal of dredged materials?

A. Dredged material can be composted or taken to a landfill (following testing of the soils for contaminants), or potentially used by a local recipient as backfill.
B. Cost for transportation: the longer distance, the greater the cost. Costs can be high depending on distance of the landfill.

C. Analysis of the dredged soils needs to occur. Composition would be evaluated and that would determine location and dumping regulations. Original dredge material was previously moved to Kennedy Creek landfill with the dredging company's dump truck.

Q. Will this impact fish? Drawing down the lake? (Lake Leprechaun dredging)

A. The fish may need to be netted and isolated and moved (called fish exclusion).
B. Further investigation needs to ensure no salmon are in the lake.
C. Further consultation with Department of Fish and Wildlife is necessary.

Cranberry Creek Sediment Pond

Cranberry Creek is a source of sediment inflow to Lake Limerick. To prevent sediment passing through Cranberry Creek to Lake Limerick, a feasibility study has been proposed by the Lake-Dam committee.

- A study involving sediment transport is needed to confirm rate and build-up, if a nearby sediment pond could trap the transported sediment, if there is nearby space available for a sediment pond, and if transported sediment needs to be filtered and/or treated for chemical contaminants.
    - The Department of Ecology and Washington Department of Natural Resources will need to be involved.
- A study would be needed to determine how sediment would need to be trapped and treated by chemical and/or mechanical means.
- Cost balance and cost-effectiveness needs to be completed:
- Possible to also consider a "mutual benefit of building a sediment facility and zones that create both fishery and waterfowl habitat further upstream in the Cranberry Creek drainage in collaboration with land owned by other owners and not LLCC.
- A Feasibility study will investigate options and cost-effectiveness in comparison with dredging.
    - A review of alternatives, costs, and benefits would occur.
    - Concept exploration is the first step and includes potential locations for a sediment control structure.
- *NOTE: cost and timeline of this was not discussed at the study session*

Q. What do we need to kick off the feasibility study for the sediment pond/facility concept?

A. Understanding that it will take engineers and paying for external contractors.
B. It will not be cheap.
C. LA would provide oversight of this process. We would provide QA/QC of the products and development of goals/alternatives relative to the cost effectivness analysis. This element would require external contractors of which LA could provide recommendations for cost effectiveness and qualifications.

Q. We have a reserve study with budget numbers reflecting a cost estimate of the sediment pond concept, did Lake Advocates provide these cost estimates?

A. Low to high ranges were provided by Harry and Rob (no indication of a formal bid and only estimates were discussed). Next steps would be to understand the volume of

chemical composition of transported sediment then implement a Feasibility Study to begin constructing a cost estimate.

B. A Feasibility study will take time and refine the cost estimates

Q. What is your take on nutrient inflow? If Cranberry creek sediment flow was mitigated, what impact might that have given other sources of nutrients like septic run-off, lawn care related nutrients, and other sources contributing to weed growth?

A. Water quality monitoring will help .
B. Sediment reduction would be determined through a feasibility study. A sediment retention pond cost and effectiveness would be developed with current sediment delivery as the design condition. Alternatives to a simple pond would be evaluated with the feasibility study.
C. A holistic approach is needed to solve these issues. Septic systems, lawn care, and other chemicals provide nutrients that promote weed growth - all must be mitigated to have lasting, consistent outcomes for the lake.

Bird Sanctuary

- To manage plants and algae in ths area of Lake Limerick, continue the treatments
- Use diver dredging or hand-pulling
- How septics and lawn management is handled near that area will be critical.

Q. Lake Advocates stated the islands in the bird sanctuary have expanded in size? What data can we look at that shows us the growth?

A. The bird sanctuary area has had aquatic plant mapping since the mid 1990's and the edges of the island have expanded into the open water. The maps are in the aquatic plant management plans including the Integrated Aquatic Plant Management Plan.
B. *Comment by committee member*: Two islands in Bird Sanctuary - used to be able to pull the boat into one of the coves but can no longer get the boat into the cove due to substantial weed growth. Have been cutting yellow iris seed pods but need to physically remove the plants (roots and all).

Overview of Project Needs for Both Lakes

Q. We've talked about several projects that need to be done, and it's a long list. What are the chief contributors to the nutrients coming into the lake? Are septic systems a source for nutrients andwhat needs to be addressed? What are the priorities and in what order should each be addressed?

A. "Not a linear answer."
B. Spottiness of the pondweed over time may help us map and be aware the hotspots.
C. Outreach to homeowners regarding landscaping and septic management needs to be addressed.
D. It is not yet determined if Cranberry Creek sediment load is something we need to address after right away. Bird sanctuary has some restraints and needs attention too.
E. Ongoing vegetation management will be required.

F. Lake Leprechaun has one major source of inflow and an on-going need for plant management.
G. Septic systems may be a contributing issue to high nutrients and aquatic plant growth, fertilizers and chemicals, any sources of nitrogen and other elements that promote growth of aquatic plants or proliferation of algae.
H. Maintenance of aquatic plant community and water quality is at a point that needs to be increased and maintained over time to avoid beneficial use reductions and accelerating management costs in the short- and long term for both lakes.

Next Steps:
Regarding Lake Leprechaun dredging: Tim Reber (LD committee member) intends to call Teddy (LD committee Chair), and Lake Advocates (Harry and Rob) for future planning. Sediment Core analysis results will be used to inform this process.