Environment

Yukon Energy Corporation

Southern Lakes Enhanced Storage Concept Aquatic and Terrestrial Effects Workshop

Prepared by:

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Project Number:

60237818

Date:

February, 2012

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February 29, 2012

Travis Ritchie
Manager: Environment, Assessment & Licensing
Yukon Energy Corporation
#2 Miles Canyon Road
Whitehorse, Yukon
Y1A 6S7

Dear Travis:

Project No: 60237818 Task 3.6.4

Regarding: Southern Lakes Enhanced Storage Concept Aquatic and Terrestrial Effects Workshop Report

AECOM is please to provide our summary of the Aquatic and Terrestrial Effects Workshop that was held at the Marsh Lake Fire Hall on Saturday February 4th, 2012. Appended to this report are the minutes of the meeting, the list of attendees, a copy of the workshop agenda and presentations.

Sincerely,
AECOM Canada Ltd.

Heather Onsorge
Socio-Economic Specialist
Heather.Onsorge@aecom.com

EH/HO:ba
Encl. Meeting minutes
Attendance list
Workshop agenda
Copy of presentations

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Appendices

Overview

The Aquatic and Terrestrial Effects Workshop was hosted by Yukon Energy Corporation (YEC) on Saturday, February 4th, 2012 from 10:00 am to 4:30 pm at the Marsh Lake Fire Hall. A total of 18 people attended the workshop including residents from a number of subdivisions in the Southern Lakes area, plus representatives from Ducks Unlimited Canada (DUC), Department of Fisheries and Oceans Canada (DFO), the Yukon Environmental and Socio-economic Assessment Board (YESAB) and Environment Yukon. Seven representatives from YEC, AECOM and Ardea Biological Consulting were present to deliver presentations, participate in discussions and address questions. Lunch and snacks were provided by YEC throughout the workshop.

1. Workshop goals and objectives

The goal of the Aquatic and Terrestrial Effects Workshop was to provide information about the potential effects on aquatic and terrestrial environments around the Southern Lakes resulting from Yukon Energy's Marsh Lake Fall-Winter Storage Concept. Detailed information presented at the workshop included:

- Southern Lakes Enhanced Storage Concept presentation
  - Overview of current operations and conditions
  - Overview of proposed changes to water license
- Overview of fish and fish habitat fundamentals
- Summary of aquatic studies conducted to date on the Southern Lakes
- Presentation and discussion on findings from recent aquatic investigations, and discussion of potential effects to aquatic Valued Ecosystem Components (VECs)
- Overview of wildlife investigations and vegetation mapping
- Presentation on wetland and wildlife ecology fundamentals
- Presentation and discussion on findings from recent wildlife and wetland ecology investigations, and discussion of potential effects to terrestrial VECs

Workshop attendees were given the opportunity to ask questions, voice concerns and provide feedback throughout the workshop. These questions, comments and concerns are captured in the meeting minutes appended to this report in Appendix A. A detailed list of workshop attendees and workshop agenda are also included in Appendix A.

2. Workshop material and presented information

The following documents/handouts were made available at the workshop:

- Workshop agenda
- The Big Picture Newsletter
- Posters of discipline studies undertaken to date

Seven presentations were delivered throughout the workshop by Forest Pearson, Jennifer Sarchuk and Don Toews of AECOM, and Laurence Turney of Ardea Biological Consulting. Copies of the presentations are appended to Appendix B.

Presentations delivered are as follows:

- Southern Lakes Fall-Winter Storage Concept:

  This presentation provided an overview of the current conditions for the Southern Lakes (Marsh, Tagish and Bennett Lakes), as well as an overview of proposed changes to Yukon Energy's water license for the Lewes Control Structure.

- Fish and Fish Habitat Fundamentals:

  The purpose of this presentation was to provide an introduction to fish and fish habitat fundamentals so attendees would have a better understanding of the existing conditions and the potential effects to fish and fish habitat as a result of changes to the current operating regime.

- Overview of Aquatic Studies:

  This presentation provided an overview of the aquatic studies completed to date. The presentation described the scope of studies completed to date and some of the preliminary results.

- Preliminary Effects Assessment – Fish and Fish Habitat:

  The purpose of this presentation was to provide an overview of the potential effects of the project on the identified VECs: wetlands, freshwater fish and Chinook salmon.

- Scope of the Investigations (Terrestrial):

  This presentation provided an overview of the terrestrial studies (wetland and wildlife ecology) completed to date. The presentation described the scope of studies completed to date and some of the preliminary results.

- Wetland and Wildlife Ecology 101:

  The purpose of this presentation was to provide an introduction to wetland and wildlife ecology so attendees would have a better understanding of the existing conditions and the potential effects to wetlands and wildlife as a result of changes to the current operating regime.

- Preliminary Effects Assessment – Wetland and Wildlife:

  The purpose of this presentation was to provide an overview of the potential effects of the project on the identified wetland and wildlife VECs.

3. Participant questions and discussion

Participants were invited to discuss, ask questions and seek additional information throughout and following the presentations. The questions and comments provided during the workshop will be used to gain a better understanding of the socio-economic effects for Yukon Energy's proposed Marsh Lake Fall-Winter Storage Concept.

4. Workshop outcomes

The following is a summary of the major outcomes identified by workshop participants through discussions:

- Participants were genuinely interested and actively involved in the workshop by asking questions and providing feedback relating to fish biology and life history of key species. Overall, participants gained a good appreciation of key biological factors in the study area.

- Some participants had considerable local knowledge to contribute to the discussions regarding aquatic and fish and fish habitat baseline studies conducted. There were a number of questions on the status of fish stocks within the study area. Furthermore, the instream flow studies methods and results were relatively new to most of the audience. Overall, participants gained a good overview of the extensive aquatic and fish and fish habitat studies undertaken.

- Key issues, including wetland connectivity, instream flows on the Yukon River, and lake trout spawning/incubation requirements, generated a lot of discussion and interest. Participants engaged especially on the potential effects to lake trout spawning/incubation and wetland connectivity. The presentation series flowed logically; starting with a discussion on basic fish biology, progressing to the study results, and concluding with a discussion of potential project impacts on the three key areas. This tied everything together nicely for participants, enabling a clearer understanding of the potential effects.

- Participants recognized that the scope of terrestrial studies was large and that the detailed work that was completed on selected areas within the study area would allow for extrapolation to the larger area.

- Participants gained an understanding of the dynamic nature of the southern lakes system and how wetland vegetation communities and wildlife use patterns, have adapted to the changes in water levels over the years. It is this adaptability which makes impact predictions challenging.

- Participants were able to appreciate that there is a large variability between years within the system, and that the vegetation communities and wildlife use patterns are resilient to this variability, creating challenges to being able to predict changes in vegetation communities and wildlife use.

- Participants attended the full day workshop on a Saturday from 10:00 to 4:30 and remained engaged throughout the day. This active participation serves to emphasize their interest in the workshops, the presentation materials, and the discussions that followed each.

Appendix A

Meeting Minutes, Attendance Record and Agenda

Yukon Energy's Aquatic & Terrestrial Effects Workshop

Saturday, February 4, 2012 (10:00 am – 4:00pm)
Marsh Lake Fire Hall

Agenda

1. **Meet and Greet** …….. (10 mins)
   Lead: YEC and AECOM

2. **Workshop Overview** ……..…… (10 mins)
   Lead: Travis Ritchie, YEC and Heather Onsorge, AECOM
   - Introductions
   - Review workshop schedule
   - Workshop goals and objectives

3. **Southern Lakes Fall-Winter Storage Concept** ……..…….. (30 mins)
   Lead: Forest Pearson, AECOM
   - Concept Presentation
     - Overview of current conditions
     - Overview of proposed changes
   - Discussion / question period

4. **Fish and Fish Habitat Fundamentals**……..…… (45 mins)
   Lead: Jennifer Sarchuk and Don Toews, AECOM
   - Local Study Area (LSA)
   - Freshwater fish
   - Chinook
   - Wetlands
   - Discussion / question period

< Break >

5. **Overview of Aquatic Studies** ……..…….. (45 mins)
   Lead: Jennifer Sarchuk and Don Toews, AECOM
   - Aquatic studies conducted to date – including instream flow, wetland assessments, lake ecology, freshwater fish studies and lake trout spawning
   - Discussion/question period

6. **Preliminary Effects Assessment - Fish and Fish Habitat** …..... (60 mins)
   Lead: Jennifer Sarchuk and Don Toews, AECOM
   - Value Ecosystem Components
   - Effects to Chinook
   - Effects to Freshwater Fish
   - Effects to Wetlands
   - Discussion / question period

< Lunch >

7. Scope of the Investigations……..…(30 mins)

Lead: Laurence Turney, Ardea Biological Consulting Ltd.

- Planning for the Investigations and Understanding the Issues
- Selecting Species Groups and Areas
- Conducting the Investigations
- Results of the Investigations

8. Wetland and Wildlife Ecology 101……..…(60 mins)

Lead: Laurence Turney, Ardea Biological Consulting Ltd.

- Marsh Lake Wetland Dynamics
- Biology of Selected Wildlife Species
- Amphibians
- Waterfowl
- Riparian Birds
- Aquatic Mammals
- Terrestrial Mammals

< Break >

9. Preliminary Effects Assessment - Wetland and Wildlife……..…(60 mins)

Lead: Laurence Turney, Ardea Biological Consulting Ltd.

- Hypotheses of Effects / Linkage diagrams
- Effects Assessment Assumptions and Methods
- Preliminary Findings and Next Steps

10. Wrap Up ……..…… (10 mins)

Lead: Travis Ritchie, YEC

- What's next for Yukon Energy
- Door prizes

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Minutes of Meeting

Date of Meeting	February 4, 2012	Start Time	10:00 am	Project Number	60237818.3.6.4
Project Name	Marsh Lake Fall-Winter Storage Concept				
Location	Marsh Lake Fire Hall				
Regarding	Marsh Lake Aquatic and Terrestrial Effects Workshop				
Attendees	Travis Ritchie (YEC); Heather Onsorge, Forest Pearson, Jennifer Sarchuk, Don Toews and Emilie Herdes (AECOM); Laurence Turney (Ardea Biological Consulting); Residents from Southern Lakes area (see attached for list of attendees).				
Minutes Prepared By	Emilie Herdes				

PLEASE NOTE: If this report does not agree with your records of the meeting, or if there are any omissions, please advise, otherwise we will assume the contents to be correct.

Intent of meeting

The intent of this meeting was to provide residents of the Southern Lakes with detailed information on Yukon Energy Corporation's (YEC) aquatic and terrestrial data collection programs, analysis and modelling that has been completed to date for the Marsh Lake Fall-Winter Storage Concept. The workshop was also an opportunity for YEC to provide residents with an update on the Marsh Lake Fall-Winter Storage Concept as well as an opportunity for residents to ask questions and provide feedback.

The following is an outline of the meeting, beginning with introductory statements made by the organizers, including YEC and AECOM representatives.

The following documents were made available at the meeting:

1. Workshop agenda;
2. The Big Picture newsletter; and
3. Handout posters of discipline studies undertaken to date.

Copies of the presentations, agenda and list of attendees are appended.

Workshop Overview

Travis Ritchie thanked everyone for coming to the aquatic and terrestrial effects workshop. He presented the objectives of the workshop, to share information on ecological data collected to date for the Southern Lakes Enhanced Storage Concept (a.k.a. the Marsh Lake Fall-Winter Storage Concept). Previous workshops covered groundwater and erosion effects. He explained that this series of workshops are designed to provide an overview of the project and to explore specific impacts of the Marsh Lake Fall-Winter Storage Concept, and to make sure that YEC is asking and answering the right questions.

Heather Onsorge introduced the AECOM and Ardea Biological Consulting representatives and briefly went over the workshop agenda. She noted that there is a lot of material to cover and asked that questions be saved for the end of each presentation if possible.

Presentation #1: Southern Lakes Enhanced Storage Concept

Forest Pearson presented an overview of current conditions and of the changes to the management regime at Lewes Dam proposed in the project. He explained the hydraulic connection between the Southern Lakes (Marsh Lake, Bennett Lake and Tagish Lake). He noted that it has recently been discovered that the watershed is dominated by snowmelt more than glacial melt and that in low water years, the gates close early to bring water levels up to the regulated FSL. Many attendees had seen the presentation at other effects workshop. Forest ended the presentation by bringing everyone's attention to the environmental benefits of the project, including displacing 1.9 million litres of diesel fuel and reducing greenhouse gas emissions. A few questions were asked throughout the presentation and are included in the Q&A section below.

Discussion / Question Period

1. **D. Gibbon** – Asked if the proposed FSL would bring the water level in Tagish Lake up to the same elevation as the Atlin Lake (*re: Southern Lakes in Cross-Section*) and if it could cause a backwater effect in the Atlin River.

   Forest Pearson – Pointed out the elevation difference between Tagish Lake and Atlin Lake. He explained that the water level drops over 10 m in the Atlin River, and that hydraulic engineers have studied the system and have determined that a backwater effect was not possible.

2. **R. Lewis** – Asked how much of a damming effect Lewes Dam has when all the gates are open.

   Forest Pearson – Said he was not sure about this but that he thought the damming effect was equivalent to about one foot of water.

   J. Dabbs – Mentioned she heard, in 2007, that it was equivalent to about 6 inches of water.

Presentation #2: Fish and Fish Habitat Fundamentals

Jennifer Sarchuk and **Don Toews** provided a presentation on fish and fish habitat fundamentals. They gave an overview of fish life cycles (arctic grayling and lake trout) and emphasized that spawning is the most sensitive life history phase for fish and spawning habitat is generally the most limited and most sensitive. Lake trout were identified as a species that could potentially be impacted by winter drawdown because of their limited spawning habitat and the timing of spawning (fall) where incubating eggs would be exposed to the full effect of overwinter drawdown. They discussed the importance of wetlands and Chinook salmon migration. Some questions were asked throughout the presentation and are included in the discussion / question period section below.

Discussion / Question Period

1. **K. Barr** – Asked when lake trout spawning occurs in Bennett Lake (compared to Tagish Lake and Marsh Lake).

   Don Toews– Explained that there is very little data on lake trout spawning in Bennett Lake. He added that spawning timing is driven by water temperature, which is why lake trout spawn later in Tagish Lake than in Marsh Lake.

2. **R. Lewis** – Asked at what depth lake trout typically spawn.

   Jennifer Sarchuk – Lake trout typically spawn at 1 to 3 m depth.

   Don Toews– Explained that wave action cleans the sediments at the spawning grounds, and that there is not much wave action below 3 m depth. Lake trout need clean coarse substrate so their eggs can fall in the spaces between cobbles and rocks and be sheltered from predators.

3. **P. Dabbs** – Asked when lake trout cease to spawn, if they only start spawning at 9 or 10 years.

   Don Toews – Explained that lake trout never really stop spawning.

4. **K. Barr** – Asked whether Chinook are currently found in the same areas as historically.

   Don Toews – Explained that the majority of Chinook go up M'Clintock into Michie Creek to spawn, and that this has always been where the majority of Chinook were found historically, although some may have been observed elsewhere in the system at times. e.g. in the Tagish River during the 1940's to 1960's and in Atlin Lake during the 1940's

5. **A. Middler** – Asked how the fish ladder determines the age of Chinook passing through and whether they are from a hatchery or not.

   Don Toews – Explained that the hatchery fish are tagged (small clip off fin) and nose tagged with a coded wire to allow for determination of age.

6. **P. Dabbs** – Asked what the ratio of male to female is for Chinook in this system.

   Don Toews – Explained that the ratio changes from year to year. Typically, 3-5 year old Chinook returning to the fish ladder are males and the older fish are females which have built up sufficient body mass to produce eggs.

7. **P. Savoie** – Asked whether there is any existing data showing that the system needs a higher number of female Chinook.

   Don Toews/Jennifer Sarchuk – Reproductive capacity is determined by the numbers of females and the eggs that deposit in spawning habitat so low or declining female:male ratios and abundance in older larger fish (which have more eggs) experienced in recent years are not good

8. **R. Taylor** – Asked why there weren't any studies on pike under the Freshwater Fish section of the presentation.

   Jennifer Sarchuk/Don Toews – Explained that pike were looked as part of the wetland studies, and that a potential impact of the project on pike would be an access issue in the spring as pike spawn and rear in wetlands. Pike were looked at as part of the wetland ecosystem instead of individually as a species.

9. **P. Savoie** – Asked if any data exists on effects of increasing a FSL on lake trout spawning.

   Jennifer Sarchuk – Suggested parking the question until the effects assessment presentation.

10. **P. Dabbs**– Asked if any studies have been conducted on adaptability of fish to changes in their spawning habitat.

    Don Toews – Explained that there have been studies done in Ontario, but not in systems similar to the ones we have here (i.e. with high sedimentation from glaciers in some lakes, to which fish populations seem to have adapted).

11. **P. Savoie** – Commented that spawning occurs below the dam since the dam was built, but that there is no historical evidence of spawning below the dam.

Presentation #3: Overview of Aquatic Studies

Jennifer Sarchuk and **Don Toews** presented an overview of the baseline aquatic studies conducted to date including instream flow, wetland assessments, lake ecology, freshwater fish studies and lake trout spawning. They gave an overview of preliminary results of the studies and explained how the key aquatic concerns were identified throughout the studies of the past two years. Several questions were asked throughout the presentation and are captured in the discussion / question period section below.

Discussion / Question Period

1. **J. Dabbs** – Asked why the studies for the project are limited to upstream of the Takhini River confluence.

   Forest Pearson – Explained that the Takhini River is such a major inflow of water that it is difficult to measure any effects of the project downstream of the confluence.

2. **D. Fulmer** – Asked whether the Yukon River flows (in m^3/s) presented as part of the wetland connectivity studies can be presented as sill elevations (at which wetlands become disconnected from the river).

   Jennifer Sarchuk – Explained that the elevations are available and that she will get back to her with them.

3. **P. Dabbs** – Asked to specify which guidelines the presentation refers to (*re: water quality samples met all guidelines*).

   Jennifer Sarchuk – Explained that the guidelines referred to are the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life.

4. **A. Middler** – Asked whether any studies will be completed in the wetlands this year, since last year the fish were already moving out of the wetlands and data could not be collected as planned (as per presentation).

   Jennifer Sarchuk – Answered that AECOM and YEC will try to collect the data this year, if possible.

5. **P. Dabbs** – Asked whether any differences exist between current studies' results and previous studies with regard to water quality.

   Don Toews – Explained that there were no differences with previous studies' results with regard to water quality in the lakes.

6. **R. Lewis** – Asked about the methods used to catch/sample fish for the studies.

Jennifer Sarchuk – Explained that electrofishing and minnow trapping were used, and both are non-destructive methods.

7. **P. Dabbs** – Asked what "bathymetry" means.

   Jennifer Sarchuk – Explained that bathymetry means depth mapping of the bed of the lake or water body.

8. **D. Fulmer** – Asked if a list of historical studies has been compiled and whether it is available to the public.

   Jennifer Sarchuk – Said that a bibliography of historical studies has been compiled.

   Travis Ritchie – Agreed that it can be made available to the public.

9. **K. Barr** – Commented that the First Nations traditional knowledge protocol should be considered when releasing information.

   Travis Ritchie – Agreed that care will be taken so that information that needs to be kept confidential will not be released.

Presentation #4: Preliminary Effects Assessment – Fish and Fish Habitat

Jennifer Sarchuk and **Don Toews** presented an overview of the preliminary findings of the aquatic studies. They discussed the potential effects of the project on the identified VECs: Chinook, freshwater fish and wetlands. A number of questions were asked throughout the presentation and are captured in the discussion / question period section below.

Discussion / Question Period

1. **A. Middler** – Asked whether dam gate closure dates change from year to year, and whether a change is proposed under the project.

   Forest Pearson – Explained that the date for gate closure does change from year to year depending on water levels. The historical average for gate closure is the first week of September, but under the proposed project, it would be August 15th.

2. **J. Dabbs** – Asked why the line on the graph (flow) is higher in the spring and winter for the proposed project vs. current conditions.

   Jennifer Sarchuk – Explained that the line represents flow (and not water level), and that it is higher under the proposed project because when the additional water stored in fall is released in winter, flows will be higher at this time of the year than they have been historically.

3. **R. Lewis** – Asked whether similar analysis as that done on the Yukon River Chinook was done for Chinook in the lakes.

   Jennifer Sarchuk – Explained that Chinook only spawn in the river.

4. **L. Turney**– Asked if there is a limit for the optimal range for Chinook rearing, as there is for spawning.

Jennifer Sarchuk – Explained that very high flows are not optimal for rearing, and there is an upper limit to the optimal range.

5. **P. Savoie** – Commented that he was not convinced that overharvesting of lake trout in Marsh Lake is the probable cause for the smaller populations found in the lake today, and that he thinks populations may never have been higher

   Don Toews – Explained that archived photos and discussions with "old-timers" show that populations were higher prior to the 1950s.

   P. Savoie – Added that lake trout are sensitive to habitat change, and the Whitehorse dam caused a drastic habitat change when is was built in 1959. He disagrees with the assumption that overharvesting is the likely cause for population decline in Marsh Lake.

6. **P. Dabbs** – Asked whether major fish studies conducted on Atlin Lake lake trout populations can be used to understand what happened in Marsh Lake. *(He was under the impression that lake trout population in Atlin Lake had declined in past years.)*

   Don Toews – Said he thinks Atlin Lake has a very healthy lake trout population with low harvest pressure for such a big lake.

7. **R. Taylor** – Asked whether lake trout move between Atlin Lake and Graham Inlet.

   Don Toews – Explained that genetic studies show that fish have moved between Tagish Lake and Atlin Lake. There is also lots of movement between Marsh Lake and Tagish Lake as evidenced by the angling fishery at the Tagish bridge.

8. **A. Middler** – Asked whether the 20-year old fish study data for the Southern Lakes is still considered the baseline.

   Don Toews – Said that yes, it is still considered baseline.

9. **J. Dabbs** – Asked what would happen to lake trout eggs with the additional drawdown in spring. She mentioned that last spring, for example, the water was very slow to come back up.

   Travis Ritchie – Explained that lake trout hatch before the ice is off and can swim to deeper areas.

10. **A. Middler** – Asked whether the LSL is and will be reached every year.

    Travis Ritchie – Explained that yes, the LSL has to be reached to generate the maximum amount of power.

11. **P. Dabbs** – Asked about drawdown in unmanaged reservoirs (i.e. Teslin and Atlin Lakes) and whether it could be compared to managed reservoirs.

    Don Toews – Explained that these unmanaged reservoirs do approach the maximum drawdown level for the Marsh Tagish system naturally. He confirmed that unmanaged and managed reservoirs have not be compared in terms of effects of drawdown.

12. **A. Middler** – Asked whether there were any anticipated impacts of erosion on fish.

    Forest Pearson – Explained that AECOM has studied the issue and suggested going over this issue with her later.

Presentation #5: Scope of the Investigations (Terrestrial)

Laurence Turney presented an overview of the baseline terrestrial investigations conducted to date including waterfowl and mammal aerial surveys and vegetation mapping from air photos and on-site observation. He provided an overview of methods and preliminary results of the studies and explained how the key species groups and areas were identified throughout the studies of the past two years.

Discussion / Question Period

1. **A. Middler** – Asked how a waterfowl breeding survey conducted on a single afternoon can be used to come to the conclusion that there is no breeding of waterfowl in the Lewes Marsh area.

   Laurence Turney – Explained that limited evidence of breeding waterfowl was found during the surveys, but that doesn't mean there are no breeding waterfowl there and that further elaboration would be provided in the following presentation.

Presentation #6: Wetland and Wildlife Ecology 101

Laurence Turney provided a presentation on wetland and wildlife ecology fundamentals. He gave an overview of Marsh Lake wetland dynamics and on the biology of selected wildlife species including amphibians, waterfowl, aquatic mammals and terrestrial mammals. He described some of the adaptations of wildlife to wetland dynamics. A few questions were asked throughout the presentation and are included in the discussion / question period section below.

Discussion / Question Period

1. **F. Pearson** – Asked if the levying of shorelines occurs more along rivers or lakes.

   Laurence Turney – Explained that levying occurs along both rivers and lakes.

2. **D. Fulmer** – Asked whether waterfowl whose nest is destroyed would lay again.

   Laurence Turney – Explained that only some species would lay again.

   J. Kenyon (DUC) – Gave the example of mallards.

3. **D. Fulmer** – Asked if ice collapsing on beaver lodges could become a risk with the increase drawdown.

   Laurence Turney – Said that is could possibly be an issue, and that susceptibility of lodges would be determined by the elevation of the entrance related to drawdowns and configuration of entrance and bottom.

Presentation #7: Preliminary Effects Assessment – Wetland and Wildlife

Laurence Turney presented an overview of the preliminary findings of the terrestrial studies. He discussed the assumptions that were made and the limitations of the data being analyzed. He described the effects assessment methods and described the next steps in the process. A number of questions were asked throughout the presentation and are captured in the discussion / question period section below.

Discussion / Question Period

1. **D. Fulmer** – Asked how much the flooded area in wetlands would increase under the proposed FSL.

   Forest Pearson – Explained that the extent of flooded area changes throughout the year (along with water level) and reminded everyone that the proposed FSL is within the natural range of the lake. Wetlands are relatively flat though, and a little bit of water goes a long way.

2. **P. Dabbs** – Asked what the effects of anticipated changes in vegetation will be on mammals and waterfowl. A major concern around Tagish is migratory birds, especially swans feeding in the spring.

   Laurence Turney – Explained that Ardea is working on getting more information to be able to answer the question, such as information on what swans are eating to determine if it will be available at higher a water level.

3. **J. Kenyon (DUC)** – Noted that the change in water level is proposed for late in the growing season and the impact on plant communities (i.e. moving up in elevation) will depend on germination periods and the timing of life phases.

   Laurence Turney – Agreed that more information is needed on this topic.

4. **M. Reddoch** – Noted that in 2007, the swans had a hard time getting to food (because of deep water due to the flood). She suggested contacting Dave Mossop for information.

   Laurence Turney – Said that this was a good observation and agreed to follow-up with Dave Mossop.

5. **J. Dabbs** – Asked how resilient pondweed is to changes in water depth.

   Laurence Turney – Explained that pondweed is a generic name for under water plants. He said he wasn't sure how resilient it would be changes in depth.

6. **A. Middler** – Asked what will happen to swans in the fall with a decrease in available forage due to increased vegetation inundation.

   Laurence Turney – Agreed that this was something that needs to be looked into.

7. **D. Fulmer** – Asked about swan fall migration through the Nisutlin Delta.

   Laurence Turney – Agreed to look into it.

   J. Kenyon (DUC) – Noted that this is a completely different water regime.

8. **J. Kenyon (DUC)** – Asked whether the assumption is that there will not be increased ice cover on the lakes as a result of the proposed FSL.

   Travis Ritchie – Explained that ice thickness is a function of temperature, not of water level.

   J. Kenyon (DUC) – Asked about the possible effects of upwelling warmer water (like Tagish Lake, which stays open year-round in some areas).

Forest Pearson – speculated that the area at the outlet of Marsh Lake maybe marginally larger as there would be relatively higher flows leaving the lake in winter months, thereby bringing more warm deeper water to surface.

9. **K. Barr** – Noted that it would be interesting to find out what happened to beaver populations after the 2007 flood.

   Laurence Turney/Travis Ritchie – Suggested that trappers or First Nations who have used the area for a long time might know.

10. **K. Barr** – Noted that muskrat used to be trapped in the area, but not since the dam was built.

    Laurence Turney – Explained that there might be some connection to how and/or when water leaves the system. He said we are looking into the question.

Wrap Up

Travis Ritchie concluded the workshop by thanking everyone again for attending the workshop. He reminded everyone that the project is at the preliminary effects assessment stage. He described the next steps for YEC: 2012 will be spent doing more analysis and filling in any gaps in the studies. He stated that YEC will be back to talk to residents about what they've learned and to answer more questions. YEC is now focused on finding out more about the impacts of the proposed project and finding ways to mitigate them. When there will be a better understanding of this. YEC will be back to engage residents, probably in late fall 2012. Door prizes were handed out.

	Action
Provide wetland sill elevations (re: wetland connectivity) to D. Fulmer	Laurence
Provide bibliography of historical studies to D. Fulmer	Don/Jen
Lake trout overharvesting in Marsh Lake issue – P. Savoie	Jen/Don/Forest
Impacts of erosion on fish – A. Middler	Jen/Don
Contact Dave Mossop for information on swan studies from 2007 – M. Reddoch	Laurence
Look into effects of 2007 flood on beaver populations and follow up on muskrat population levels – K. Barr	Laurence

Marsh Lake Fall-Winter Storage Concept
Aquatic/Terrestrial Effects Workshop

YUKON ENERGY

AECOM

Date: February 4, 2012
Time: 10:00am to 4:00pm
Location: Marsh Lake Fire Hall

Contact Information				
Name	**Phone Number**	**Email**	**Community / Organization**	**May we contact you if we have questions relating to this workshop? Yes or No**
ROB LEWIS	667-7670	ramal64@gmail.com	Tagish	yes
RICH MARTIN	633-5804	Richmar@klondiker.com	Tagish	yes
Randy Taylor	399-4478	rtaylor@northwestel.net	Tagish	yes
Mary Reddoch	660-4307	amreddoch@gmail.com	OLD CONSTABULARY	YES
PAUL & JUDY DABBS	399-3047	dabbs@northwestel.net.	TAGISH	YES.
Kevin Barr	821 4443	Kevinbarr57@hotmail.com	Mount Lorne Southern Lakes MLA	YES
Ed Lishman	8213204	jelishman@gmail	Carcross	Yes
Dorothy Gibbon	821-3204	got it already	Carcross	Yes.
PEARL/SAVOIE				YES.
Anne Middler	399-4979	ycsenergycoordinator@gmail.com	YCS/Tagish	yes.

Contact Information				
Name	Phone Number	Email	Community / Organization	May we contact you if we have questions relating to this workshop? Yes or No
Scott Herron	393-7935	scott.herron@ec.gc.ca	Environment Canada	Yes-
Deb Fulmes	660-5611	deborah.fulmes@gmail.com	N. McClintock	Yes
John Ryder	667-5093	john.ryder@gov.yk.ca	Environment Yukon	Yes.
Jamie Kenyon	668-3824	j_kenyon@ducks.ca	Ducks Unlimited	Yes
Lisa Ericksson	633-2600	cardinal@northwestel.net		Yes
Ken Eby	633-2600	" "		Yes
Jennifer Anthony	456-3201		YESAB	No

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Appendix B

Workshop Presentations

Southern Lakes Enhanced Storage Concept

February 2012

YUKON ENERGY

Overview

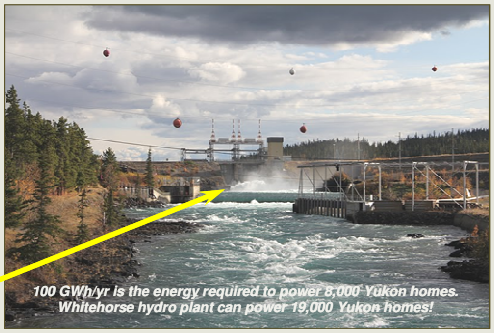
This presentation provides an overview of the Southern Lakes Enhanced Storage Concept. This concept generally consists of amending Yukon Energy's water license for regulating water levels in Marsh Lake (and Tagish & Bennett Lakes) during fall and winter months.

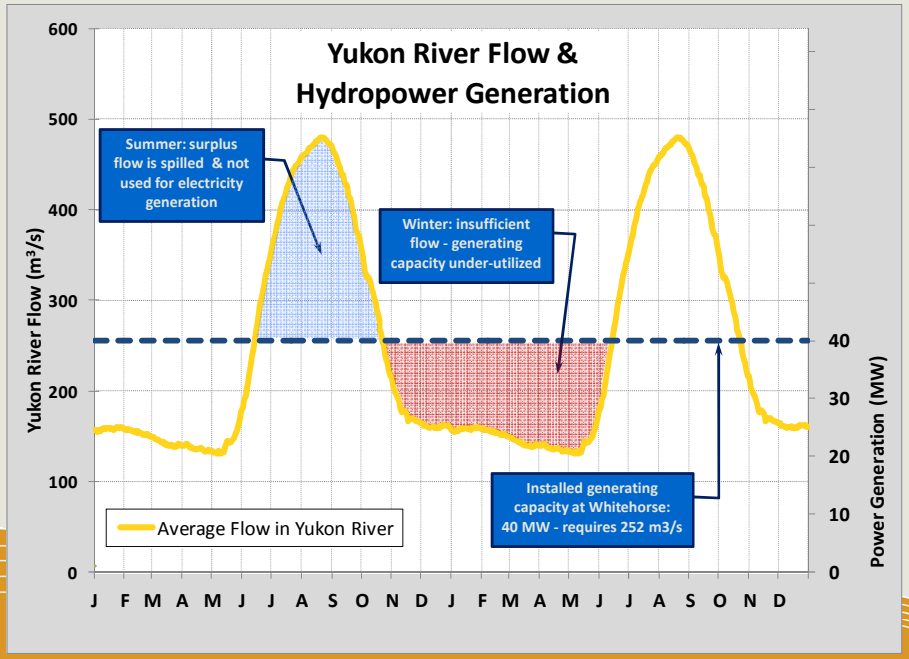
Presentation Overview

1. Existing Conditions
2. Proposed Change

Producing Electricity at Whitehorse Rapids

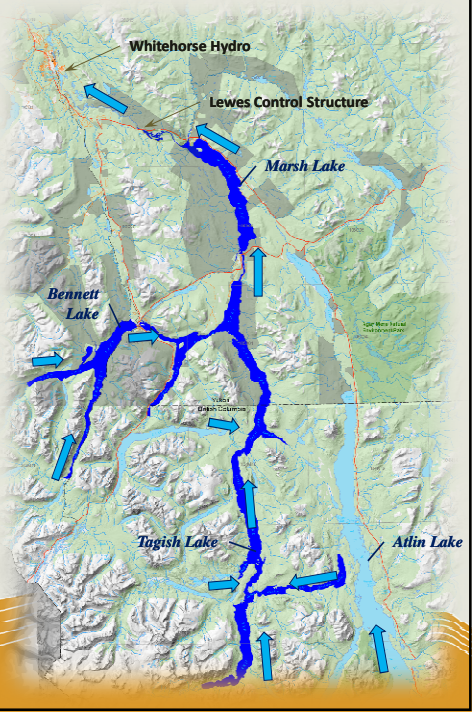
- Built in 1958, Whitehorse Rapids Hydroelectric Generating Station is the Yukon's largest renewable energy facility.
- Hydropower is by far the most sustainable & resilient of all renewable energy technologies.
- Whitehorse currently produces 240 GWh/yr, or 60% of the Yukon's renewable energy.
- Whitehorse has an installed generating capacity of 40MW, but in winter months there is only enough water flow to produce 25 MW on average.
- In summer months, there is excess water, which is "spilled"



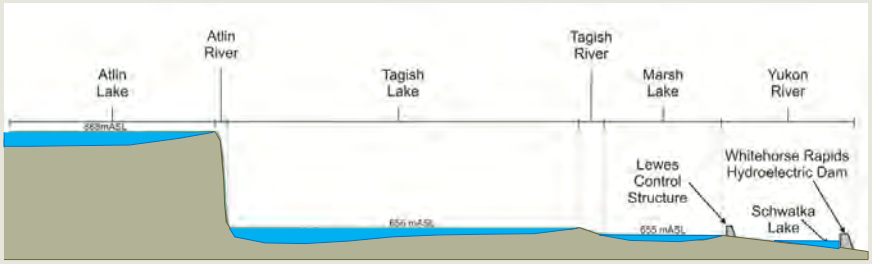


Water for Whitehorse Hydro comes from the Southern Lakes watershed

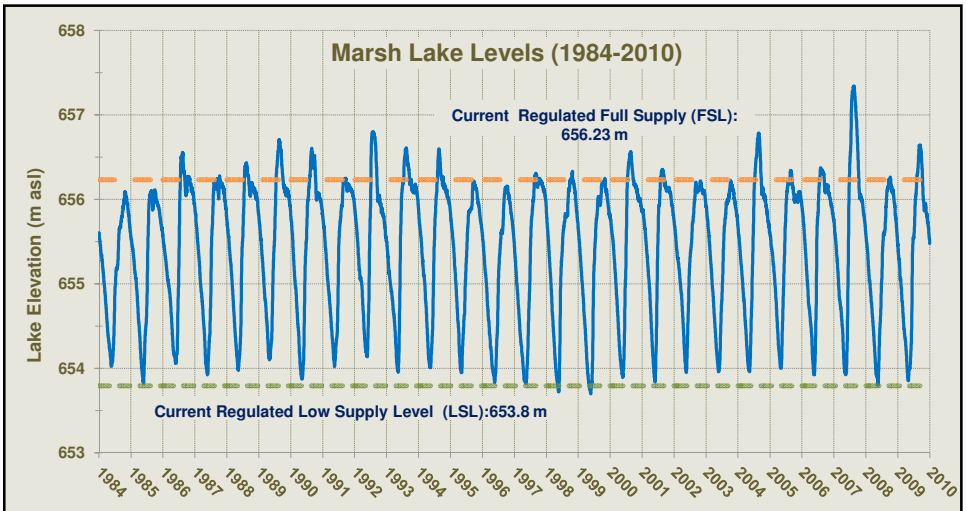
- Marsh, Tagish & Bennett Lakes are hydraulically connected.
- This means managing the outlet of Marsh Lake affects Tagish and Bennett Lakes, allowing storage of water in those lakes as well.
- Water "stored" in the Southern Lakes is used for generating energy in the winter, when we need it the most.
- Flow & lake levels are largely controlled by snow and glacier melt.
  - Warmer years ➔ higher lake levels;
  - Cold years ➔ lower lake levels.



The Southern Lakes in Cross-Section



- Water levels in Marsh, Tagish & Bennett Lakes are affected by Lewes River Control Structure
- For 7 months of the year (mid-August to mid-February), Marsh, Tagish & Bennett effectively act as one lake.
- Atlin, Tutshi and the other Southern Lakes are NOT affected by control of Marsh Lake levels because they are at higher elevations (their connecting rivers have rapids or waterfalls!)



- On average, Marsh Lake levels are lowest in mid-May and peak in mid-August.
- Lake levels fluctuate between elevation 653.7 and 657.34 m above sea level (ASL) – 3.64 m (12 feet)
- 25% of years, peak lake level in Marsh Lake reach 656.6 m ASL or higher.
- Yukon Energy's current water license allows for regulation of the lake between **656.23** and **653.8** m ASL (Full and Low Supply Levels respectively). 2.43 m (8 feet)

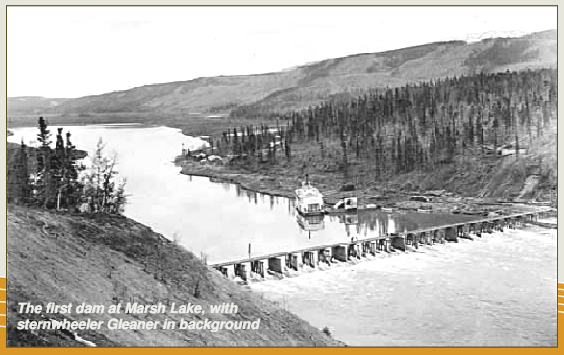
What does Lewes Control Structure Do?

- It regulates outflow from Marsh Lake during fall and winter.
- After August 15th, gates can be lowered to reduce flow in the river. Later in the winter, gates are raised to let more water out of the lake.
- Gates must remain open from May 15th to August 15th
- This structure effectively "stores" water in the Southern Lakes for use in the winter to generate hydropower at Whitehorse.

Lewes Control Structure in late winter with 12 gates closed

History of Lewes Control Structure

- Original wooden dam built in 1922 by British Yukon Navigation Co. (now White Pass) to hold water back until the spring to "flush" ice out of Lake Laberge for early-season steamship navigation on the Yukon River.
- Marsh Lake has been regulated for almost 90 years. Over the period of record, Marsh Lake has fluctuated within the same range.
- Dam rebuilt in the 1950s when Whitehorse hydro built.
- Current steel dam built in 1975. Innovative "sheet-pile" design



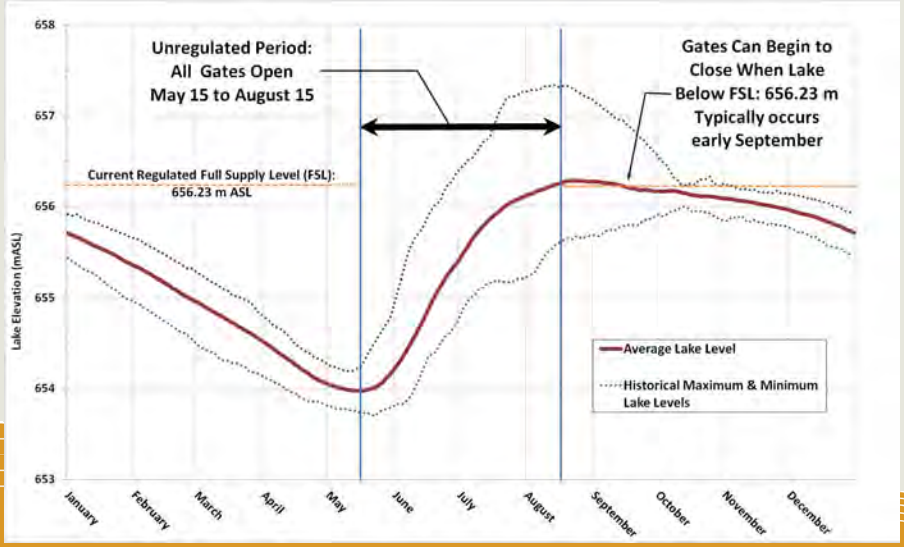
The first dam at Marsh Lake, with sternwheeler Gleaner in background

How is Marsh Lake Regulated?

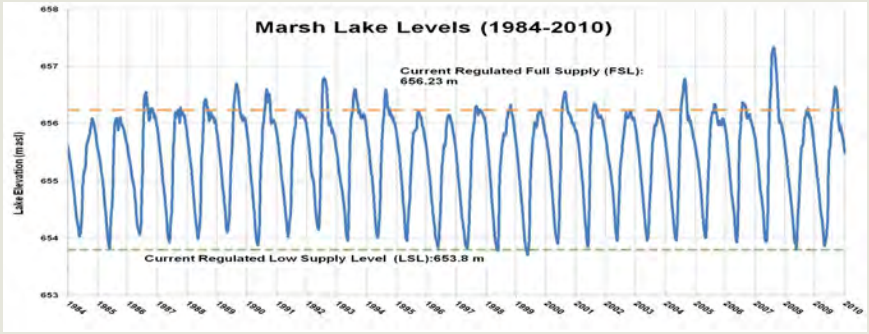
- Marsh Lake is regulated according to Yukon Energy's water licence HY99-010
- License to be renewed in 2025 (14 years left in the current license).
- Conditions in the licence state that:
  - Structure must be fully open (no restriction to flow) from May 15th until lake levels recede to elevation 656.23 m ASL, or August 15th whichever comes later.
  - Gates cannot be closed until lake levels drop to "Full Supply Level" of 656.23 m ASL.
  - On average, gates start to be lowered in early September.
  - On low lake level years (such as 2011), gates start to be lowered on August 15th to raise the lake to (or near) the Full Supply Level

Lewes Control Structure in summer with all gates open.

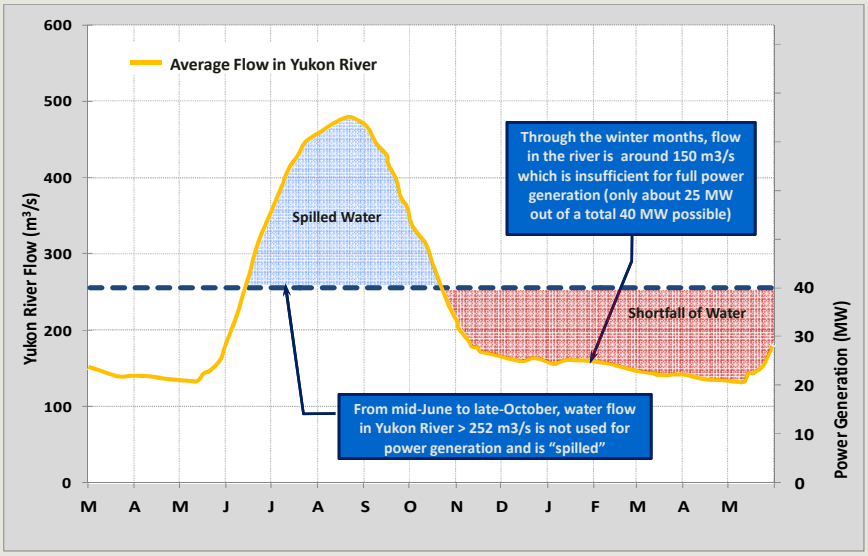
How is Marsh Lake Regulated?



Any questions about how Marsh Lake is currently managed?

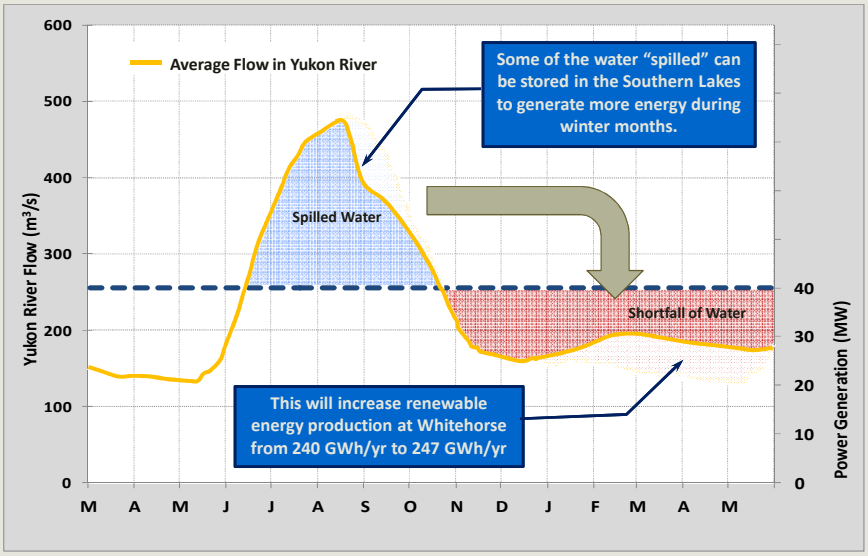


How can more hydropower be generated at Whitehorse?



Southern Lakes Enhanced Storage – Proposed Change

How can more hydropower be generated at Whitehorse?

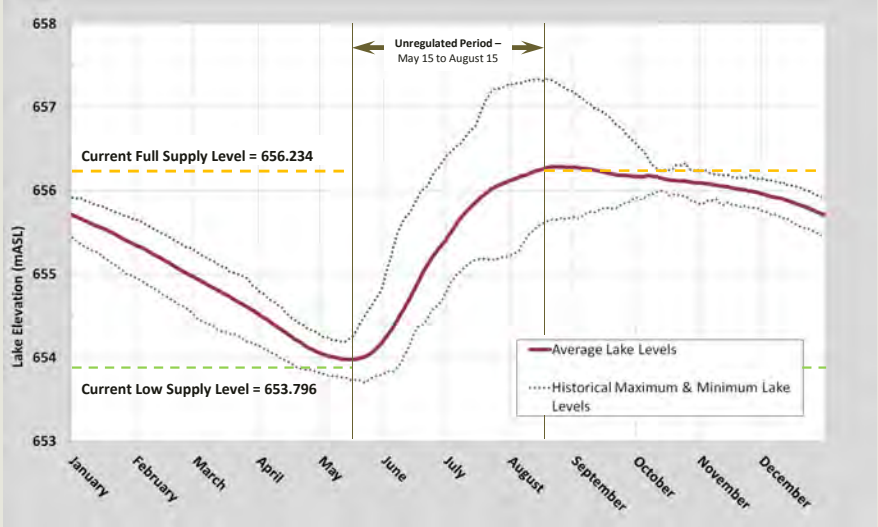


Southern Lakes Enhanced Storage – Proposed Change

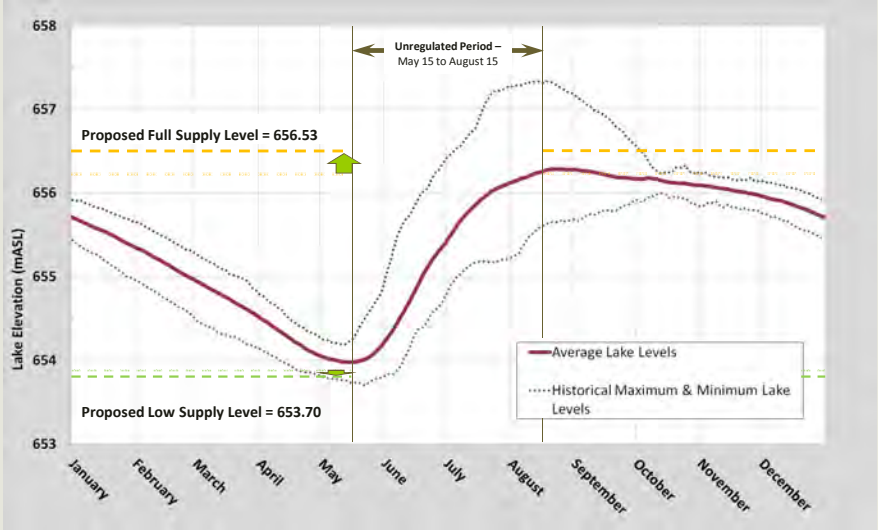
Summary of proposed changes to water licence :

- Increase regulated full supply level (FSL) by 0.3 m from 656.234 to 656.53 m ASL
- Lower low supply level (LSL) by 0.1 m from 653.796 to 653.70
- Gate closure rules may not need to change, but there may be environmental benefits to manage flows by adjusting gate closure rules.

Overview of proposed change to Marsh Lake water levels

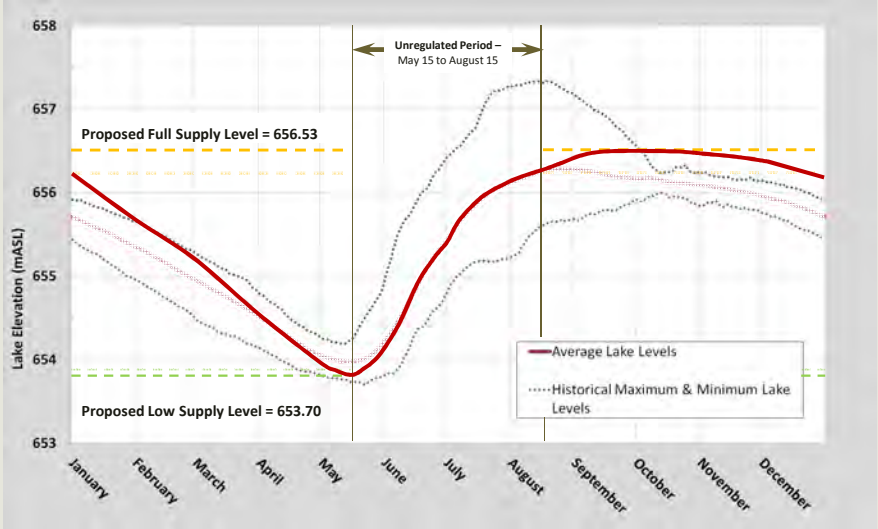


Overview of proposed change to Marsh Lake water levels



Southern Lakes Enhanced Storage – Proposed Change

Effect of proposed change on average Marsh Lake levels



Southern Lakes Enhanced Storage – Proposed Change

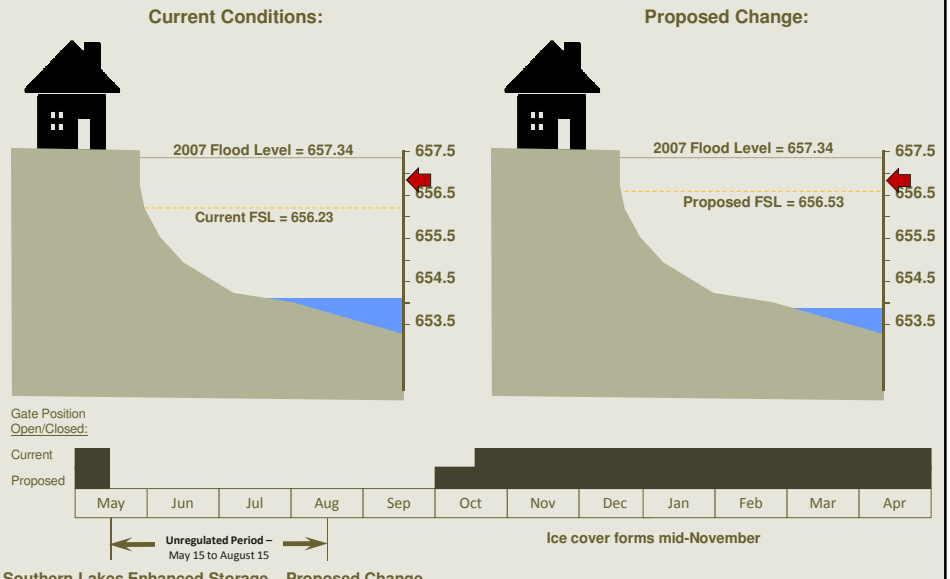
Illustration of proposed change in high water year

2004/05 selected as representative year for illustration purposes – peak lake level: 656.79 m

Southern Lakes Enhanced Storage – Proposed Change

Illustration of proposed change in high water year

2004/05 selected as representative year for illustration purposes – peak lake level: 656.79 m



Southern Lakes Enhanced Storage – Proposed Change

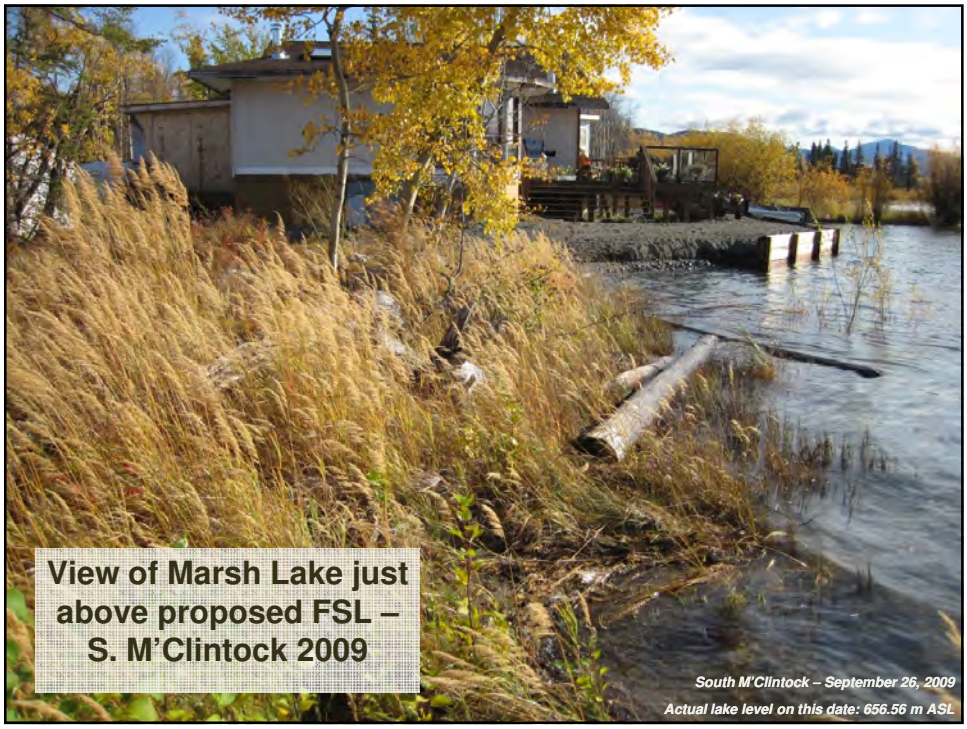

View of Marsh Lake just above proposed FSL – S. M'Clintock 2009
South M'Clintock – September 26, 2009
Actual lake level on this date: 656.56 m ASL


Illustration of Current Full Supply Level
Army Beach – October 22, 2010
Actual lake level on this date: 656.17 m ASL
Illustrated lake level: 656.23 m ASL (Current FSL)


Illustration of Proposed
Full Supply Level
Illustrated lake level: 656.53 m ASL (Proposed FSL)

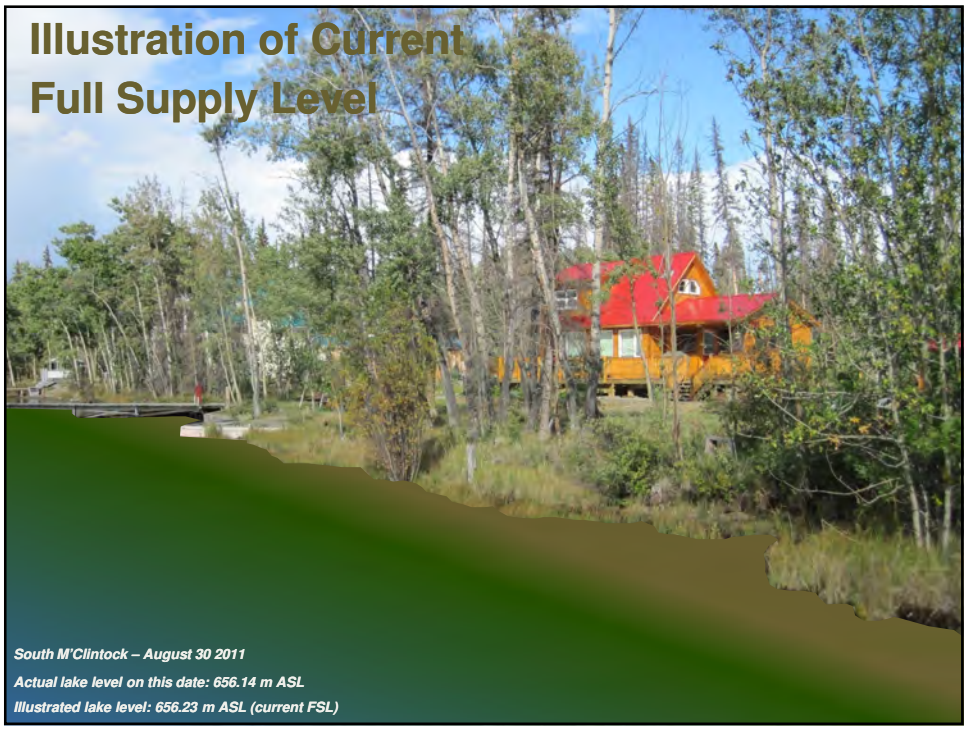


Illustration of Current
Full Supply Level
South M'Clintock – August 30 2011
Actual lake level on this date: 656.14 m ASL
Illustrated lake level: 656.23 m ASL (current FSL)

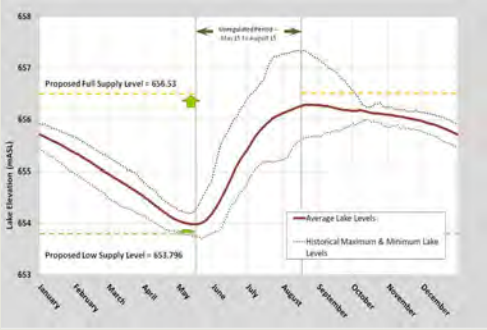
Illustration of Proposed Full Supply Level

Illustrated lake level: 656.53 m ASL (Proposed FSL)

Scope of Proposed Changes to Lewes Control Structure Water Licence

- Increase regulated full supply level by 0.3 m
- Lower low supply level by 0.1 m
- No change to gate closure dates necessary, but may be optimal.

- Water level changes extend to Marsh, Tagish & Bennett Lakes during the regulated period
- Water level changes in mid-August through March in most years.
- No change to water levels from June to mid-August



Questions?

Southern Lakes Enhanced Storage Concept: Workshop Series

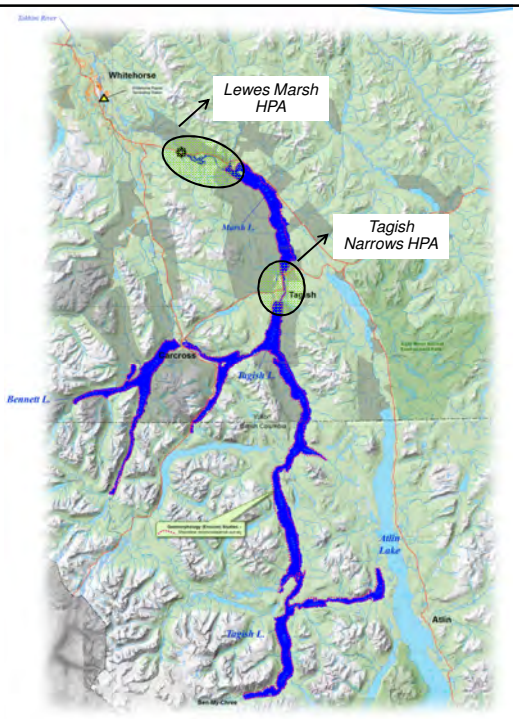
Aquatics – Fish and Fish Habitat Fundamentals

January 2012

Outline

- **Overview of the Project Concept**
- **Fish and Fish Habitat Fundamentals**
- **Studies Conducted**
- **Preliminary Assessment of Effects to Fish and Fish Habitat**

We are here



Study Map of Southern Lakes

Local Study Area

The Local Study Area (LSA) consists of Marsh, Tagish and Bennett Lakes and the Yukon River from Lewes Dam to the Takhini River.

Yukon River

Marsh Lake

Bennett Lake

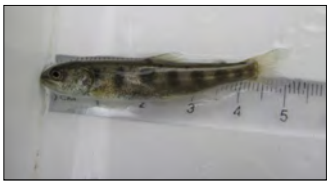
Tagish Lake (and includes Nares Lake)

Fish and Fish Habitat Fundamentals

Focus on :

- Freshwater Fish
- Chinook
- Wetlands

**Spawning and Rearing as habitat requirements are usually the most sensitive and limiting.*



Freshwater Fish Species in Study Area

Fish Species	
Lake Trout	Broad Whitefish
Arctic Grayling	Lake Chub
Round Whitefish	Burbot
Lake Whitefish	Northern Pike
Least Cisco	Longnose Sucker
Inconnu	Slimy Sculpin

Spawning Periods of Fish Species

Family	Common Name	Spawning Period and Habitat
Salmonidae – Salmon, Trout, Grayling, Whitefish	Lake Trout	Fall Lake cobble
	Arctic Grayling	Spring Streams
	Round Whitefish	Late Fall In lakes near stream outlets
	Lake Whitefish	Late Fall In lakes near stream outlets
	Least Cisco	Fall Lakes
	Inconnu	Fall
	Broad Whitefish	Fall Rivers

Lake Trout

Arctic Grayling

Inconnu

Freshwater Fish in Study Area

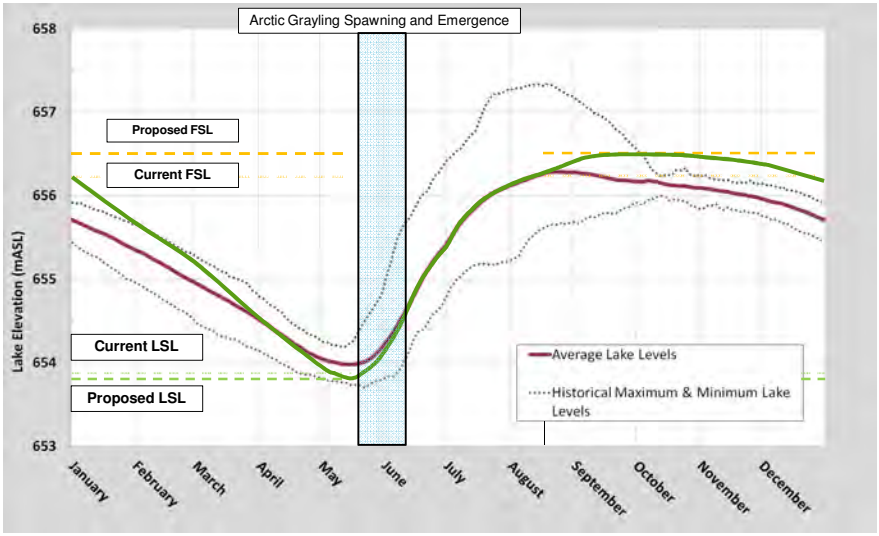
Family	Common Name	Spawning Period and Habitat
Cyprinidae – Chub	Lake Chub	Spring Lake & streams
Percidae – Perches	Slimy Sculpin	Spring Lake & stream
Gadidae – Cod	Burbot	Late Winter Deep lake reefs
Esocidae – Pikes	Northern Pike	Early Spring Wetlands & Marshes
Catostomidae - Suckers	Longnose Sucker	Early Summer Streams

Burbot

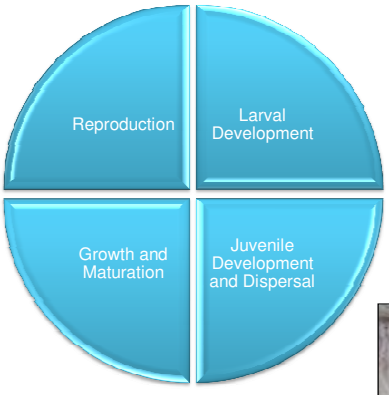
Lake Whitefish

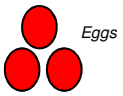
Northern Pike

Arctic Grayling – Spring Spawners



Spring Spawners –Arctic Grayling





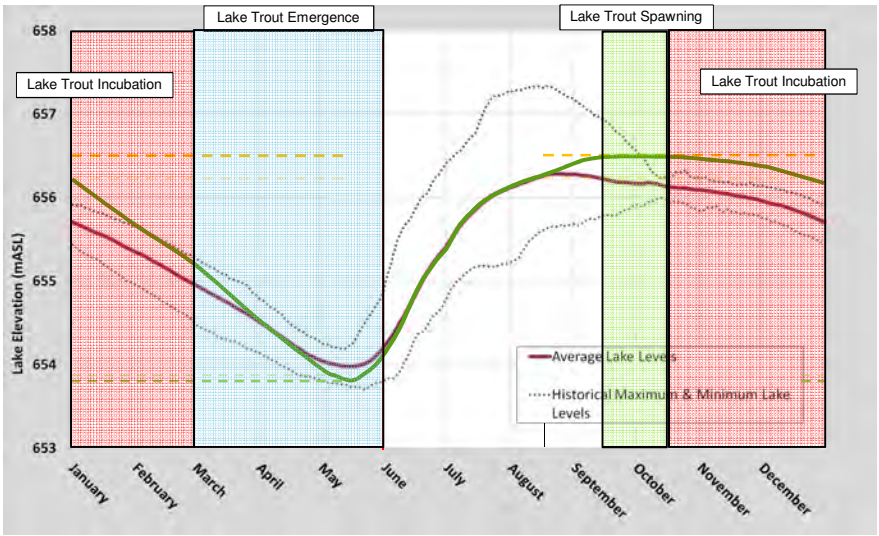
Arctic Grayling Life Cycle Summary

- Spawning
  - Spawning timing: mid May to early June
  - Spawning habitat: small gravelly tributary streams

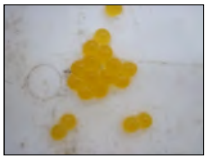
- Larval Development
  - Emergence timing : June
  - Optimal incubation temperature: 6 -10ºC
- Juvenile Development and Dispersal
  - Emergent feed on zooplankton the switch to larval insects (caddisflies, mayflies, etc.)
  - Extremely rapid growth rate the first year
  - Tolerate of low DO concentrations (1.4 mg/L)

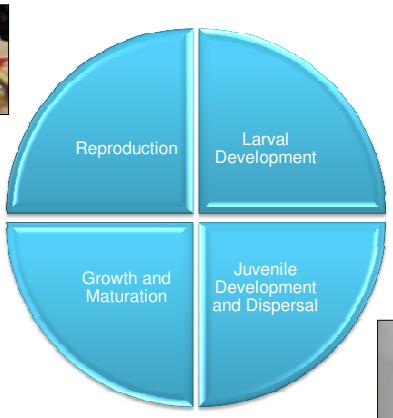
- Growth and Maturation
  - Reach sexual maturity between 4-6 years and live 9-10 years in the Yukon
  - Habitat – stream and lake residence
  - Slow growth

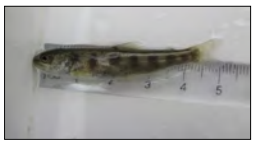
Lake Trout – Fall Spawners



Fall Spawners – Lake Trout







Lake Trout Life Cycle Summary

- Spawning
  - Preferred spawning temperature: 9-10°C
  - Typical spawning depth: 1-3 m in the Yukon
  - Preferred spawning substrate: cobble/rubble

- Larval Development
  - Incubation: September to March (may be longer in the Yukon)
  - Hatching: April to May

- Juvenile Development and Dispersal
  - Temporary inshore residence period: June/July
  - Disperse to offshore and deeper habitats: August/September
  - Primary food: benthic or planktonic invertebrates

- Growth and Maturation
  - Maturity between 9-12 in Yukon
  - Northern populations of LT growth and maturity is slow

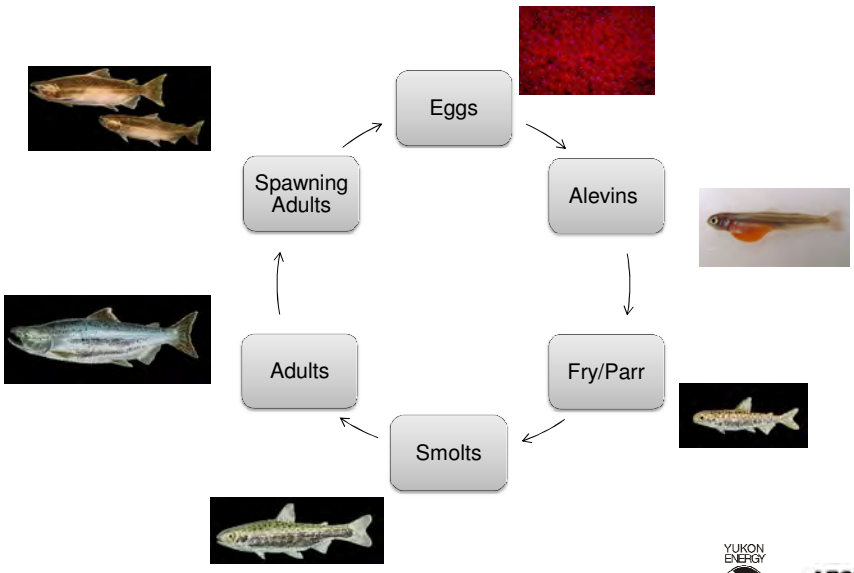
Why Lake Trout?

- Why focus on Lake Trout ?
  - Lake trout are important recreationally and culturally in the Southern Lakes.
  - Based on literature, LT have the potential to be impacted by winter drawdown.
  - Spawning habitat for LT varies from 1-3 m in depth based on literature and research in the Yukon.
  - Incubation success may be affected by the proposed project.

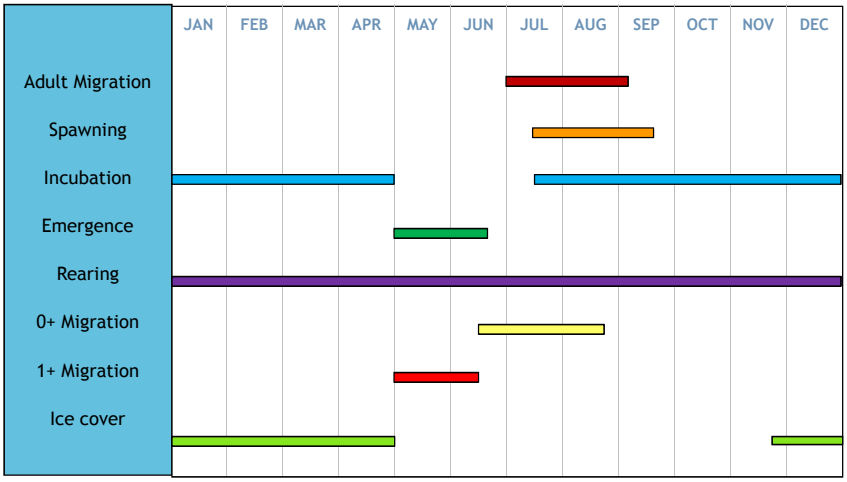
LT are well equipped to survive demanding and dynamic environments. They are a large and long-lived fish that produce large, well-provisioned eggs.

Chinook Salmon

Chinook Salmon Life Cycle

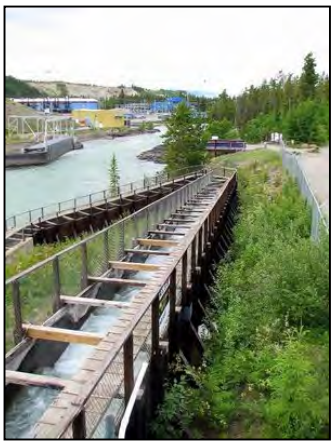


General Timeline of Chinook Salmon Life History for the Upper Yukon River

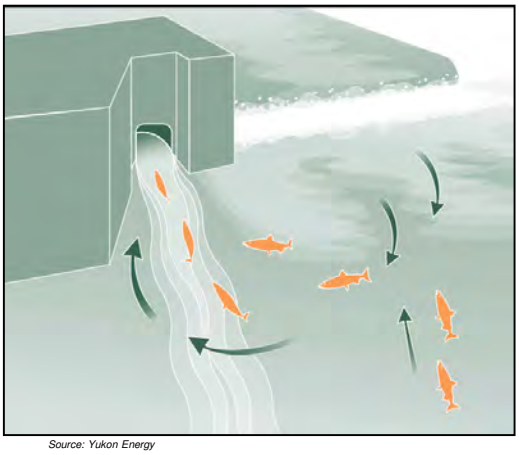


Whitehorse Fishway

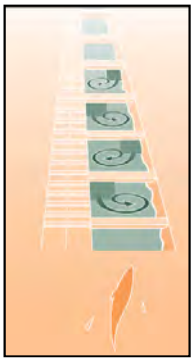
- Whitehorse Fishway was built in 1959 after the completion of Phase 1 of the Whitehorse Dam
- Longest wooden fish ladder in the world at 366 m
- Built in a series of steps that span over more than 15 m from the Yukon River to Schwatka Lake



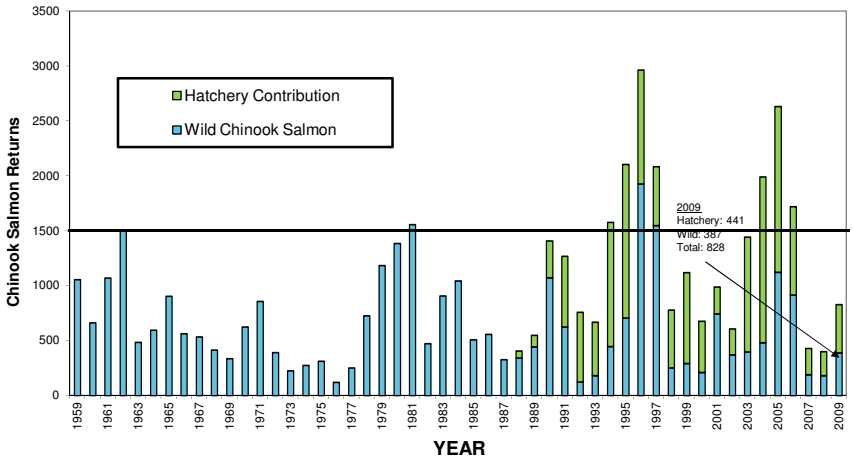
Whitehorse Fishway



Source: Yukon Energy



Whitehorse Rapids Fishway Chinook Salmon Returns 1959-2009



Why Chinook Salmon?

- Yukon River Chinook salmon are a highly managed migratory species of international importance (Yukon River Salmon Agreement)
- Chinook salmon are culturally, recreationally and commercially important.
- Yukon River is one of the most northerly and the longest of the major Chinook spawning rivers.
- Long migration.

Why are Wetlands Important?

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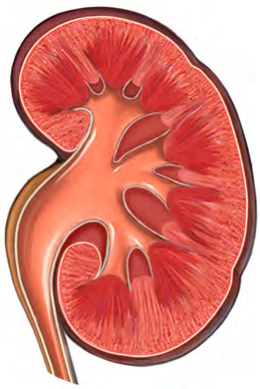


Kidney

Importance of Wetlands to Fish

- Most biologically diverse, productive and important life support systems
- Functionality:
  - absorb and filter sediments, pollutants, and excess nutrients;
  - recharge groundwater;
  - maintain stream flows;
  - control runoff;
  - store flood waters;
  - reduce erosion;
  - stabilize shorelines; and
  - help regulate atmospheric gases and climate cycles
- Some fish species (especially northern pike) reproduce and spend all or some of their life cycle in wetlands.

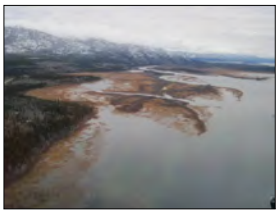
Importance of Wetlands to Fish in Yukon

- Yukon lakes are cold, deep and ice covered for 6-7 months.
- Wetlands start warming and become ice free 3-4 weeks before lakes.
- Productivity of fish food organisms starts to increase with warming of water.
- Many species of fish fry have no yolk sac or food reserves and must start feeding soon after hatching.
- Wetlands and river estuaries provide important rearing habitat to these species e.g. whitefish, grayling.

Lewes Marsh Wetlands

- Lewes Marsh is designated as a Habitat Protection Area in the Kwanlin Dün First Nation Final Agreement .
- The Management Plan for this area has yet to be developed.
- 20 km^2 area that includes Swan Haven and protects important migratory bird habitat.
- These areas are important biologically and culturally.

Open Water, March 24, 2010



Lewes Marsh, October 14, 2011

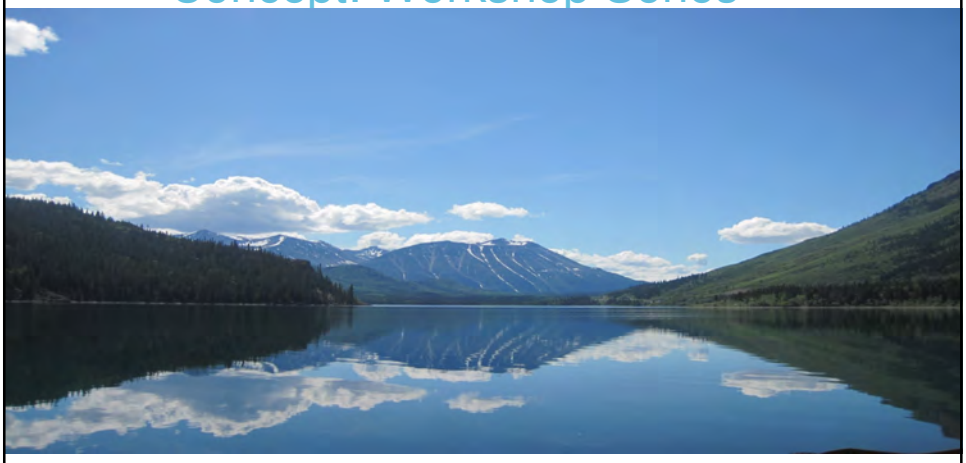
Tagish Narrows

- Tagish Narrows is also designated as a Habitat Protection Area in the Carcross Tagish First Nation Final Agreement.
- The Management Plan for this area has yet to be developed.
- 4.5 km^2 area is important spring staging area for waterfowl.
- These areas are important biologically and culturally.

Open Water, Marsh 24, 2010

Questions

Southern Lakes Enhanced Storage Concept: Workshop Series



Aquatics – Studies Conducted

January 2012

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Outline

- **Overview of the Project Concept**
- **Fish and Fish Habitat Fundamentals**
- **Studies Conducted**

We are here

- **Preliminary Assessment of Effects to Fish and Fish Habitat**

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Key Aquatic Concerns

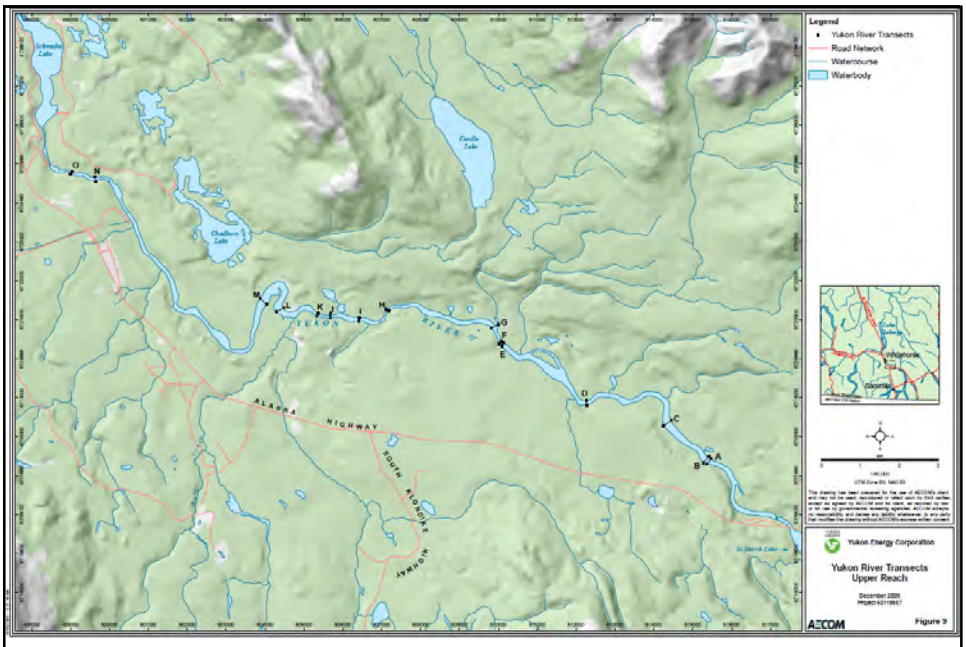
1. Changes in Yukon River flows – lower average flows in fall and higher flows in winter may affect Chinook salmon migration, spawning, incubation and/or rearing.
2. Lake Trout Spawning – increased overwinter drawdown may affect incubation success on Marsh, Tagish and Bennett Lakes
3. Wetlands - the effects of higher fall water levels and lower spring levels on connectivity and productivity

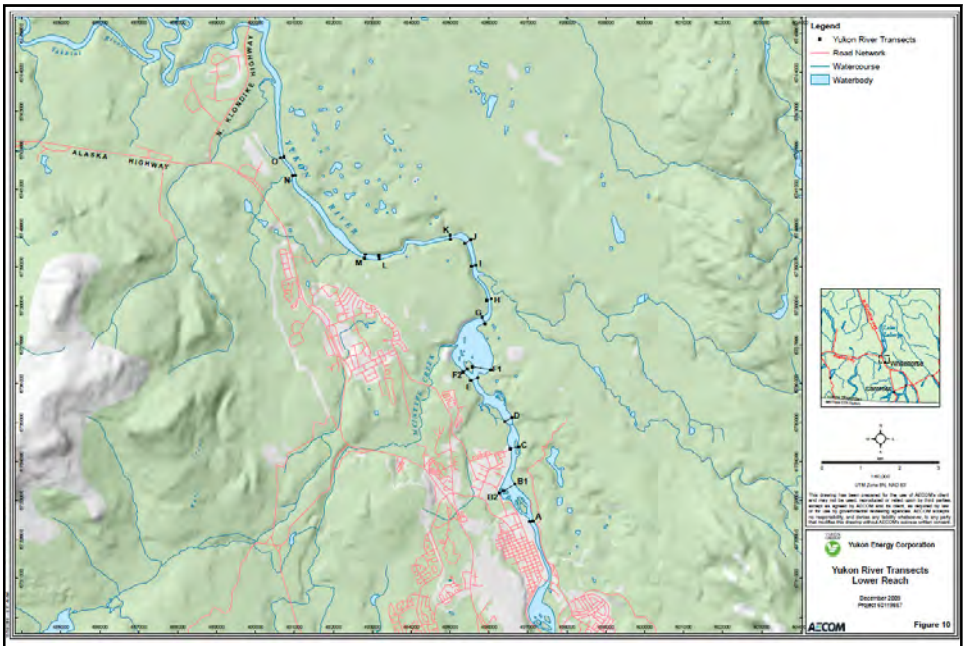
Southern Lakes Baseline Studies

2009 Studies	2010 Studies	2011 Studies		
Instream Flow Studies	Wetland Connectivity	Spring Open Water Review	Freshwater Fish Survey of Tributaries off Marsh, Tagish and Bennett Lakes	Bathymetry of Lewes Wetlands
	Wetland Assessment (3 Wetlands)	Further Studies on the Wetland Connectivity	LT Spawning Assessment on Marsh Lake	Fish Assessments in Wetlands
	Limnology and Aquatic Resource Sampling	Wetland Assessment (5 Wetlands)	Bathymetry of Known LT Spawning Locations on Tagish Lake	Physical Review of Yukon River Flows for Chinook Spawning
		Lewes Marsh Ice Surveys and Winter Benthic Invertebrate Sampling	LT Spawning Potential Locations based on Habitat – Bennett and some of Tagish Lake	Chinook Spawning - Local Knowledge and Literature Search

Instream Flow Studies

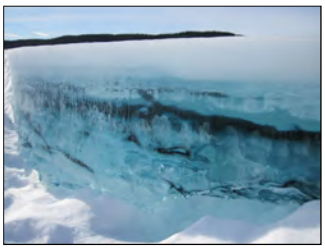
- **Objective:** To understand the potential effects of the proposed project on Chinook salmon migration, spawning, incubation and juvenile rearing.
- Conducted instream flow studies on the Yukon River - measured flows, surveyed water levels, characterized substrate.





Spring Open Water

- **Objective:** To identify areas that become ice free and warm up, becoming productive in early spring to provide food for fish, especially fry and juveniles, weeks before ice off on the main waterbodies.
- In 2010, Ardea Biological Consulting conducted surveys of the ice conditions in March, April and May in the study area.



Spring Open Water - Results

- Some key areas that were open during the March 2010 survey were:
  - North end of Marsh Lake and Lewes Marsh to M'Clintock;
  - A small portion near Judas Creek Marina;
  - Tagish River and the inlet of the River into Marsh Lake;
  - The east side of Nares Lake and at Carcross;
  - Atlin River and the outlet into Tagish Lake;
  - Graham Inlet had thin ice; and
  - Millhaven Bay on Bennett Lake

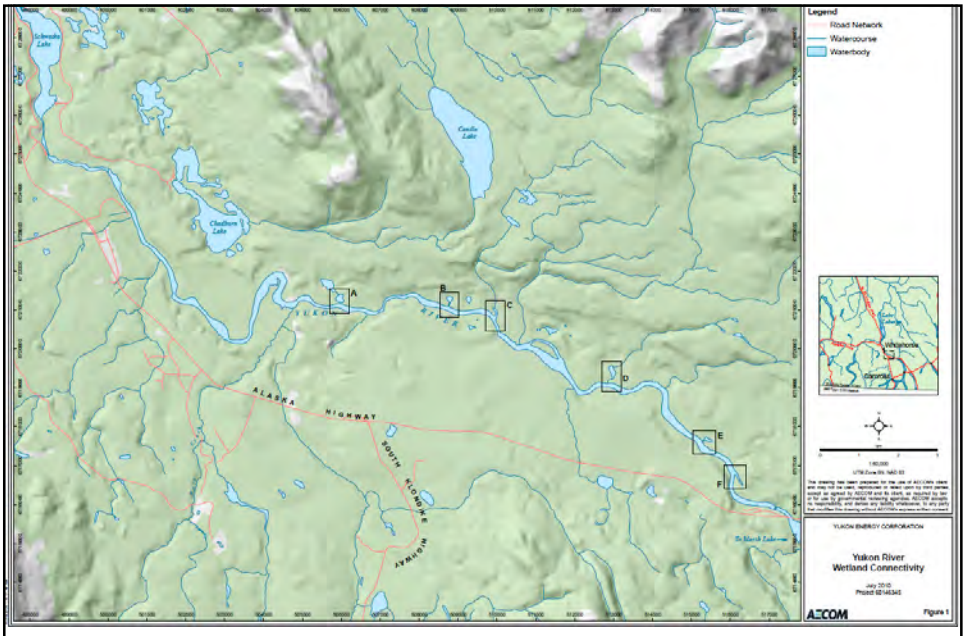
Carcross

Lewes Marsh

Connectivity of Wetlands off the Yukon River

- **Objective:** To determine at what Yukon River flows the wetlands are connected.
- 6 wetland sites were selected to study on the Yukon River (Lewes Reach) – Wetland A, B, C, D, E, and F.

Marsh D – Dry Connection



Yukon River Wetland Connectivity Sampling Locations

Wetland Connectivity – Preliminary Findings

Site	Connection
Marsh A	Never Connected
Marsh B	Disconnected below 71 m^3/s
Marsh C	Disconnected below 24 m^3/s
Marsh D	Only connected at high flows (above 477 m^3/s)
Marsh E	Disconnected below 42 m^3/s
Marsh F	Disconnected below 183 m^3/s

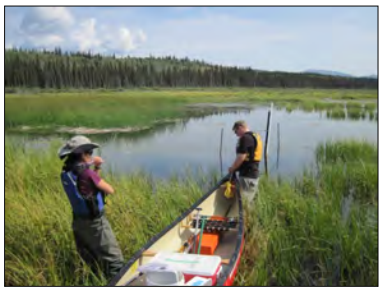
*Further work was conducted in 2011 and data will update these preliminary findings

Marsh & Tagish Lake Wetland Assessment

- **Objective:** To better understand the ecology of a representative sample of wetlands.
- Eight wetlands were chosen – 3 in Lewes Marsh, 2 in Nares, Tagish, Judas Creek and M'Clintock.
- The wetlands were sampled following "Preliminary Wetland Aquatic Biomonitoring Data Collection Manual" for sampling wetlands in the Yukon.
  - Sampling included: Benthic Invertebrates, Macro Invertebrates, Water Quality, Sediment, and Vegetation.

Marsh & Tagish Lake Wetland Assessment 2010 Locations

Three wetlands around Marsh Lake sampled.



Judas Creek Wetland

Tagish Wetland

M'Clintock Wetland

Wetland Assessment 2011 Locations

Three wetlands in Lewes Marsh and two wetlands in Nares Lake.

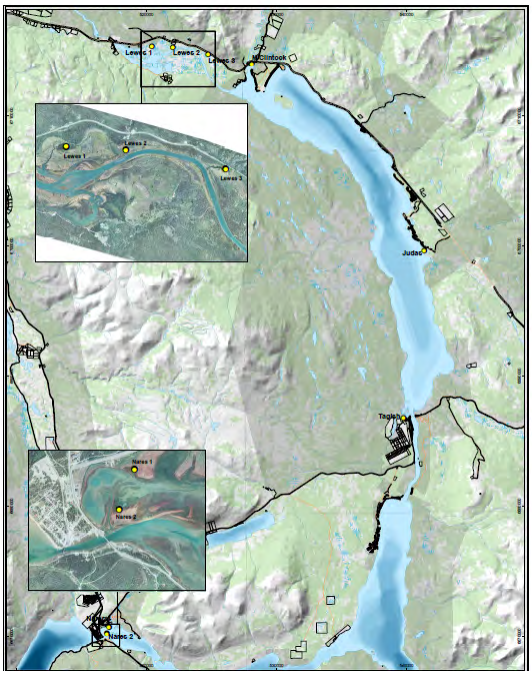
Lewes Marsh Wetland #3

Nares Wetland #1

Nares Wetland #2

Lewes Marsh Wetland #2

Lewes Marsh Wetland #1



Wetland Assessment Sampling Locations

Wetland Assessment – Results

•Results for Tagish, Judas and M'Clintock

•Water quality samples taken met all guidelines

•Sediment quality samples did not met guidelines for arsenic and chromium; however, these metals occur widely in the natural environment.

•Benthic Invertebrates:

-For the most part flies, midges, and mosquitoes dominated the communities in the wetlands.

-Judas Creek had the greater abundance of high quality fish food benthic invertebrates.

Fish Presence in Wetlands

•**Objective:** To understand fish use in representative sample of wetlands.

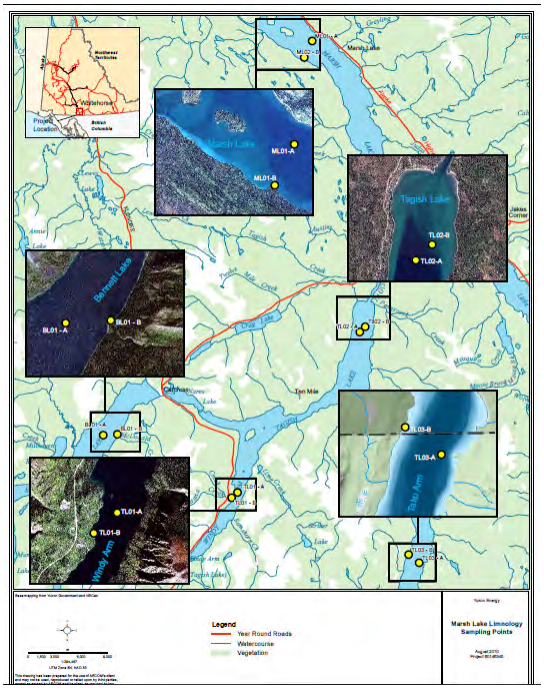
•**Results**: water temperatures in the wetlands in August appeared to be cooling; therefore, it was suspected that the fish may have moved out of the wetlands into areas of warmer water.

•Also, only a few northern pike, Arctic grayling, round whitefish and slimy sculpin were caught.

Lake Ecology

•**Objective**: To understand the ecology of the lakes.

Sampling	Equipment
Physical Limnology	YSI, Secchi disk
Water Quality	Kemmerer
Chlorophyll a	Kemmerer and then 45 um filter pump
Phytoplankton	Kemmerer
Zooplankton	Plankton Net (64um mesh)
Benthic Invertebrate	Ekman Dredge and 250um mesh sieve



Lake Ecology Sampling Locations

Lake Ecology- Results

•Marsh, Tagish and Bennett Lakes are classified as oligotrophic (deep and cold and unproductive) based on the low total nutrient concentrations, cold water and low algal abundance

•Water quality samples met guidelines.

•Diatoms (most common) dominated the phytoplankton (photosynthesizing organisms) community in all three lakes and Tagish Lake had the highest overall density of phytoplankton.

•Copepodes species(animal organisms) were abundant at the Tagish Lake sites, but not in Bennett and Marsh Lakes.

•For the most part flies, midges, and mosquitoes dominated the lakes.

Diatom

Dipteran

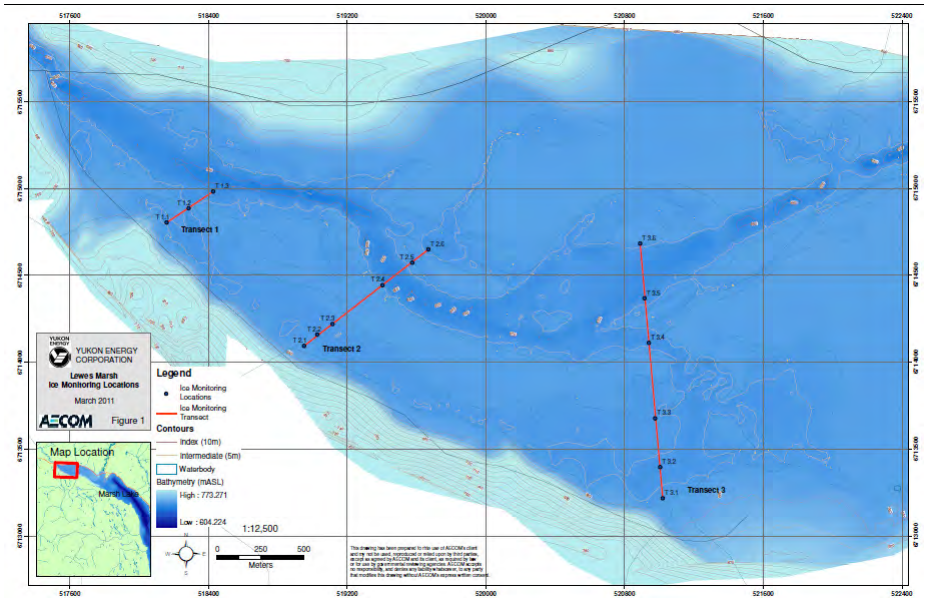
Copepod

Ice Surveys and Winter Benthic Sampling

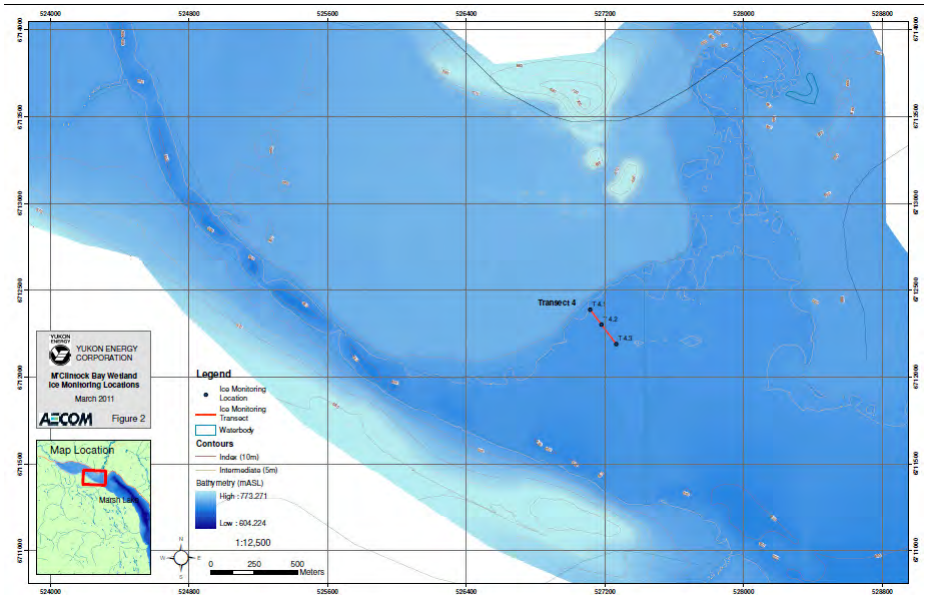
•**Objective:** To understand the benthic invertebrate community availability in the winter and which species may be presence in the spring to provide food for fish (and waterfowl) including looking at ice cover data.

•Data collected in March and April - ice data, temperature/DO profiles and characterize substrate/vegetation, and benthic invertebrate sampling.

Ice Surveys and Winter Benthic Sampling

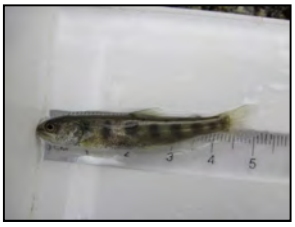


Ice Surveys and Winter Benthic Sampling



Freshwater Fish Surveys of Tributaries

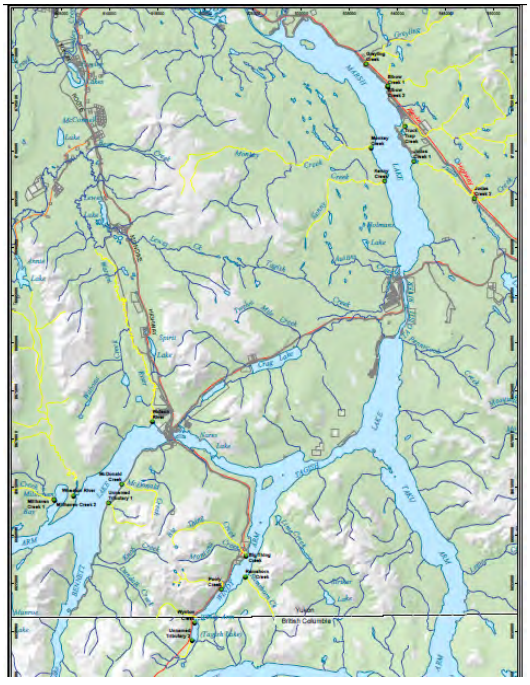
•**Objective:** To understand the fish species and habitat of tributaries around Marsh, Tagish, and Bennett Lakes.



•Slimy sculpin, Arctic grayling, round whitefish, pike, burbot were the most common species caught.

•No juvenile Chinook were caught.

•LT was caught in a few of the tributaries – this is unusual as LT are seldom found in streams.



Freshwater Fish Survey of Tributaries Sampling Locations

Freshwater Fish Surveys of Tributaries

Big Thing Creek

Wynton Creek

McDonald Creek

Watson River

Monkey Creek

Greyling Creek

Lake Trout Spawning Studies

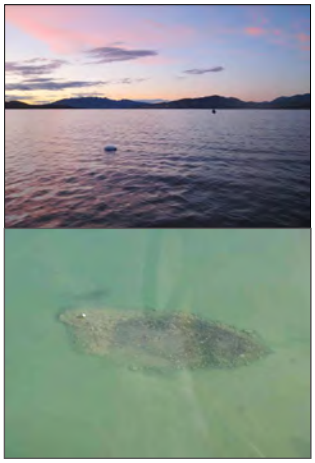
•**Objectives**: To better characterize LT spawning habitat in the southern lakes (Marsh, Tagish and Bennett Lakes).

•Criteria of potential lake trout spawning habitat (MacLean *et al.,* 1990) :

a) depth of <4 m;
b) within 15 m of shore;
c) >20 m from any inlet;
d) fetch of >0.5 km;
e) prevailing wind exposure;
f) clean coarse substrates 5.0 to 30.0 cm in size.

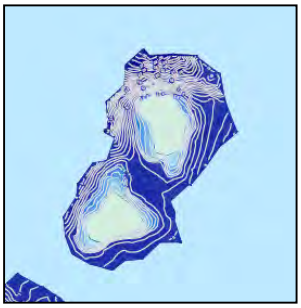
Lake Trout Spawning Studies – Marsh Lake

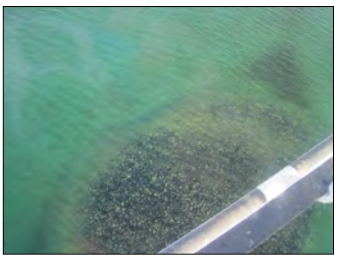
- Looked at 2 potential LT spawning locations on Marsh Lake.
- Gillnetting occurred at the 1 of the locations.
- Furthermore, it appears that LT spawning was already complete as only round whitefish were caught.
- Further follow up work may be considered.



Lake Trout Spawning Studies – Tagish Lake

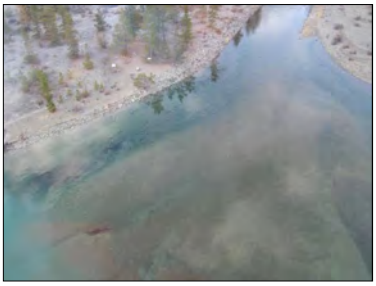
- Bathymetry was conducted at 4 known LT spawning locations.
- Helicopter flight was conducted over some parts of Tagish Lake to classify substrate for other potential locations of LT.





Lake Trout Spawning Studies – Bennett Lake

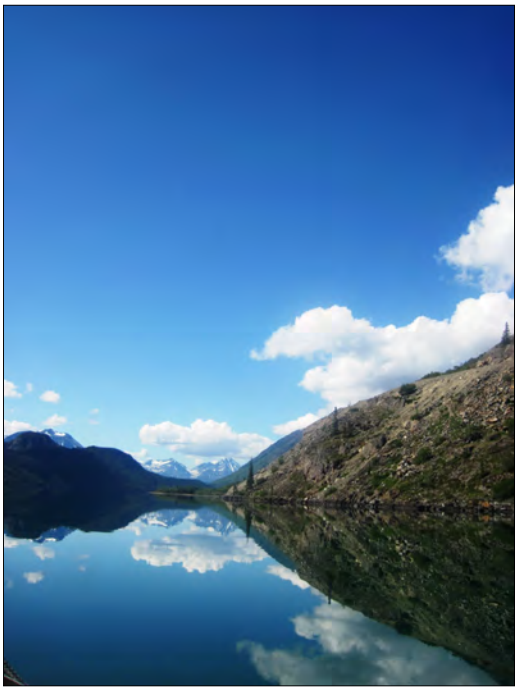
•A helicopter flight was conducted to classify substrate around Bennett Lake in relation to potential LT spawning.



Summary

Summary of Studies Conducted:

- •Instream Flow Studies;
- •Spring Open Water Review;
- •Wetland Connection off the Yukon River;
- •Wetland Assessments including Fish Sampling;
- •Lake Ecology Sampling;
- •Freshwater Fish Surveys of Tributaries;
- •Ice Surveys and Winter Benthic Invertebrate Sampling; and
- •Lake Trout Spawning Studies.



Questions?

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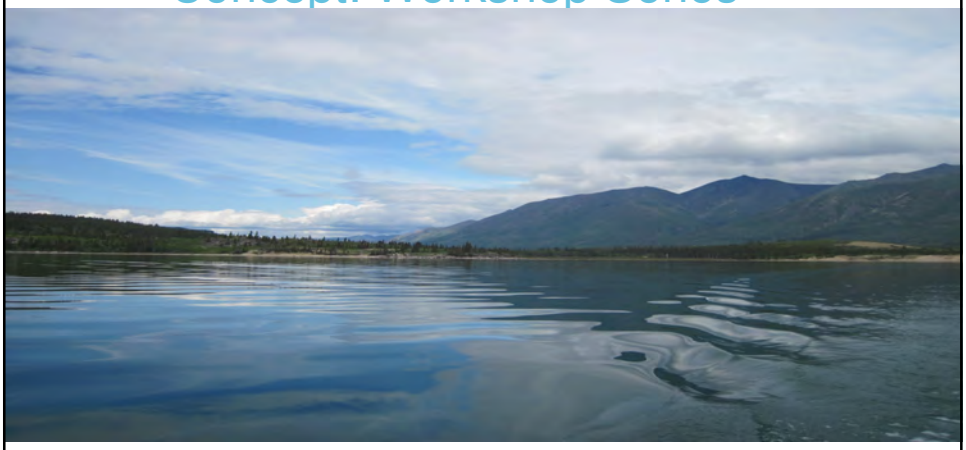
Southern Lakes Enhanced Storage Concept: Workshop Series



Aquatics – Preliminary Assessment of Effects to Fish and Fish Habitat

January 2012

Outline

- **Overview of the Project Concept**
- **Fish and Fish Habitat Fundamentals**
- **Studies Conducted**
- **Preliminary Assessment of Effects to Fish and Fish Habitat**

We are here

What is an Effects Assessment?

- An effects assessment is a identification of adverse environmental and socio-economic effects associated with a proposed project, and a determination of the likelihood and significance of adverse effects after mitigation.
- Effects assessments generally proceed as follows:
  - Identify the likely adverse affects associated with the proposed project.
  - Identify the Valued ecosystem and socio-economic components, and determine how those components might be affected by the project.
  - Determine if mitigation measures can reduce the effects of the projects.
- In the Yukon, projects are assessed by the Yukon Environmental Socio-Economic Assessment Board (YESAB).

Valued Ecosystem Components (VECs)

- Chinook Salmon Populations and Productivity
- Freshwater Fish Populations and Productivity (Lake Trout)
- Wetland Habitat

Why the Selection of these VEC's?

- Chinook and Lake Trout
  - Top of aquatic food chain
  - Most sensitive indicators of changes in the aquatic ecosystem potentially arising from the project
  - Cultural, recreational, and commercial importance
  - Legal requirement (ie. *Federal Fisheries Act*) to ensure no harm to fish and fish habitat
  - Fish are more likely than other aquatic ecosystem components to fulfill non-environmental criteria (some fish species have direct economic value)

Lake Trout in Tagish Lake (Graham Inlet)

- Wetland Habitat
  - Important habitat for fish based on the productivity
  - Critical time of year when fish utilize wetland habitat – Spring
  - Important habitat for northern pike and other species

Preliminary Identification of Effects

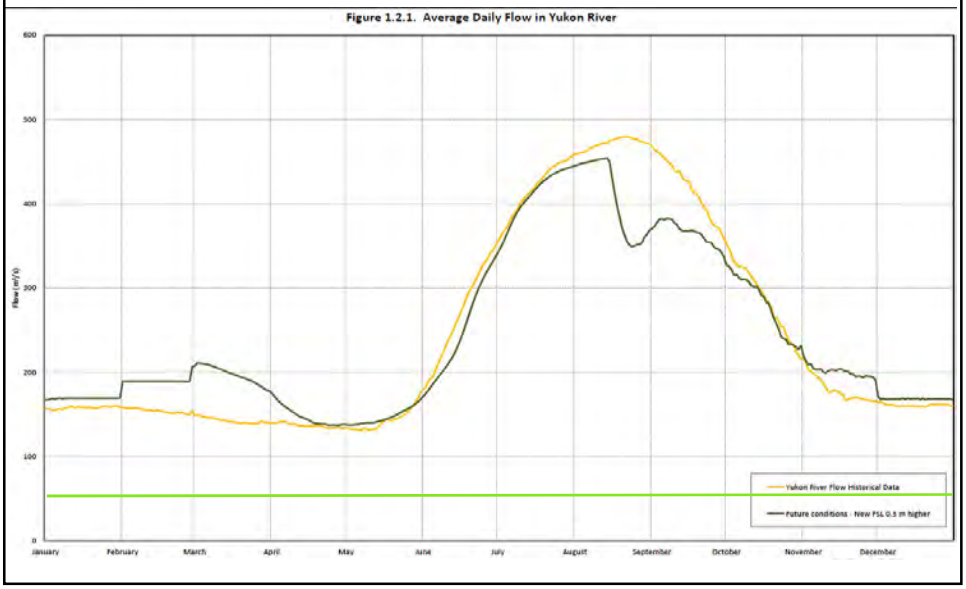
- **Chinook Salmon**
  - Potential changes in Yukon River flows could affect migration, spawning and/or incubation success on the Yukon River mainstem.
- **Freshwater Fish**
  - Increased winter drawdown may affect spawning and incubation success of fall lake spawning species like lake trout.
  - Delayed flooding of wetlands connected to Marsh Lake due to lower Low Supply Level (LSL).
- **Wetlands**
  - Potential delay in spring flooding may affect wetland productivity.

Preliminary Effects to Chinook Salmon

- **Chinook Salmon** – potential effects could include effects on migration, spawning, incubation success and/or juvenile rearing.

Chinook Salmon Migration

Pathway: Low flows in the Yukon River may affect migration of adult Chinook.



Chinook Salmon Migration

•Thompson Method (Thompson 1972) was used in conjunction with the Physical Habitat Simulation Model (PHABSIM) instream flow data to determine whether passage would be impeded at flows down to 50 m^3/s.

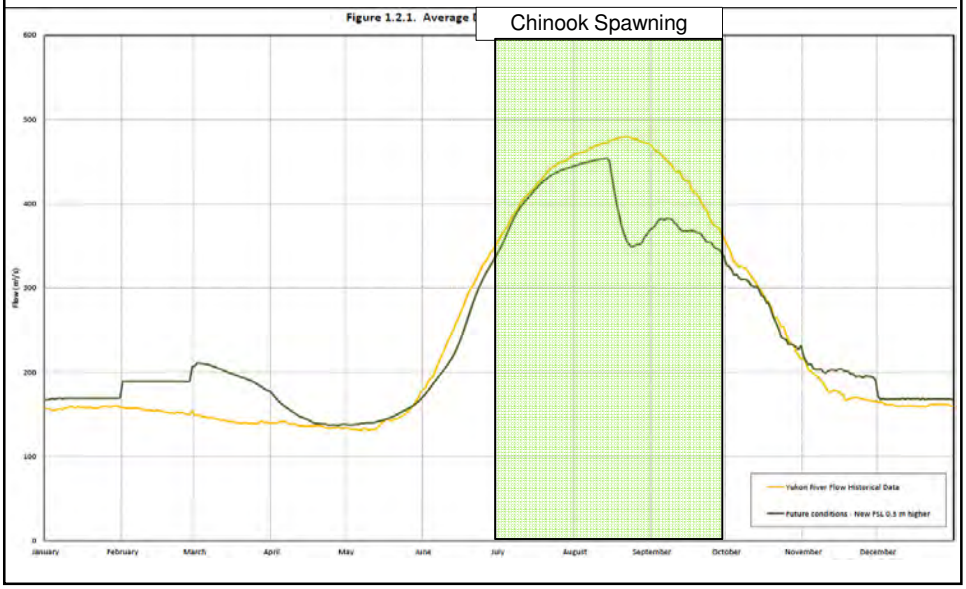
•50m^3/s was selected as YECs water license allows them to have flows of 83 m^3/s.

•Depths and velocities were simulated down to a low flow of 50 m^3/s at each transect that was sampled in the field.

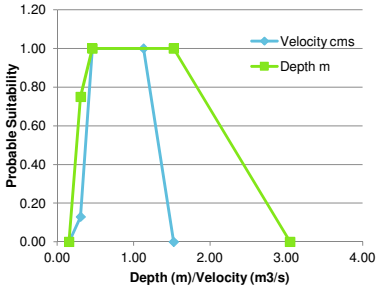
•Results: No low flow passage issues were detected by this analysis in either the Lewes or Takhini reaches.

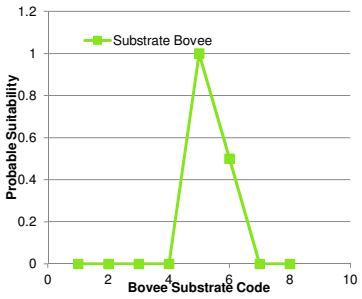
Chinook Salmon Spawning

Pathway: Reduced Yukon River flows during later summer/early fall (July 1-September 30), on average, may affect mainstem spawning habitat.



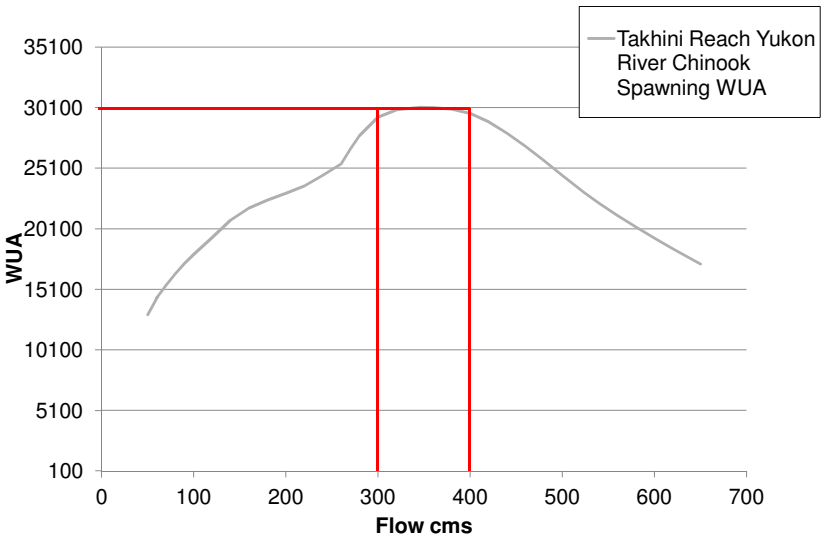
Chinook Spawning HSC Depth, Velocity and Substrate Curves





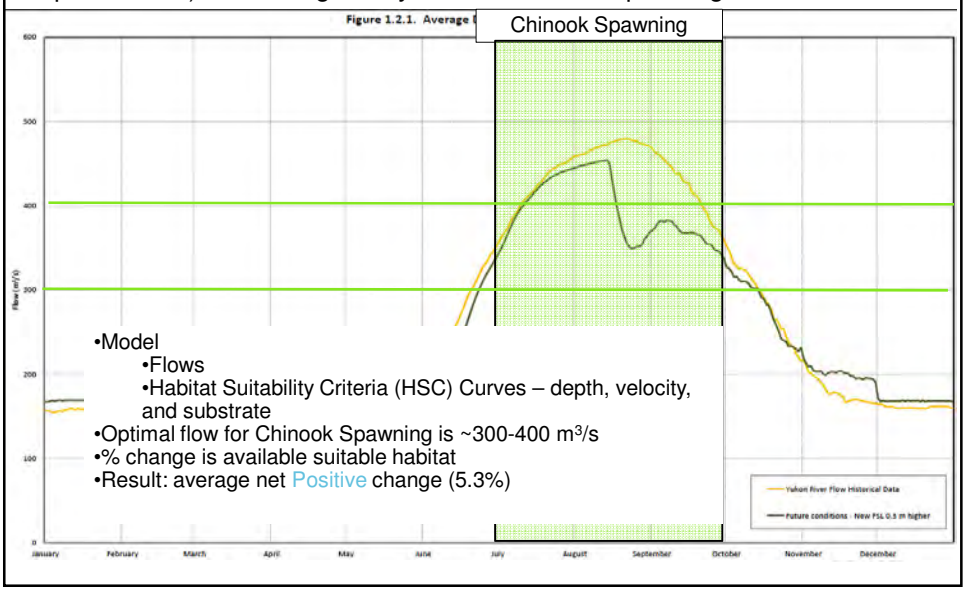
Bovee Code	Description	Size (cm)
4	Sand	0.005-0.25
5	Gravel	0.25-6
6	Cobble	6-25
7	Boulder	>25

Chinook Spawning WUA Takhini Reach Yukon River



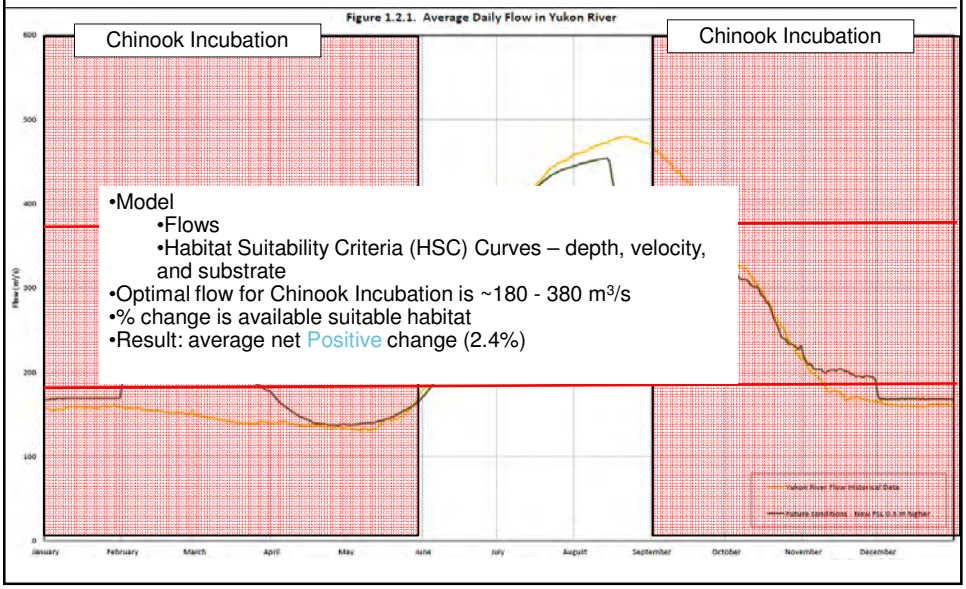
Chinook Salmon Spawning

Pathway: Reduced Yukon River flows during later summer/early fall (July 1-September 30), on average, may affect mainstem spawning habitat.



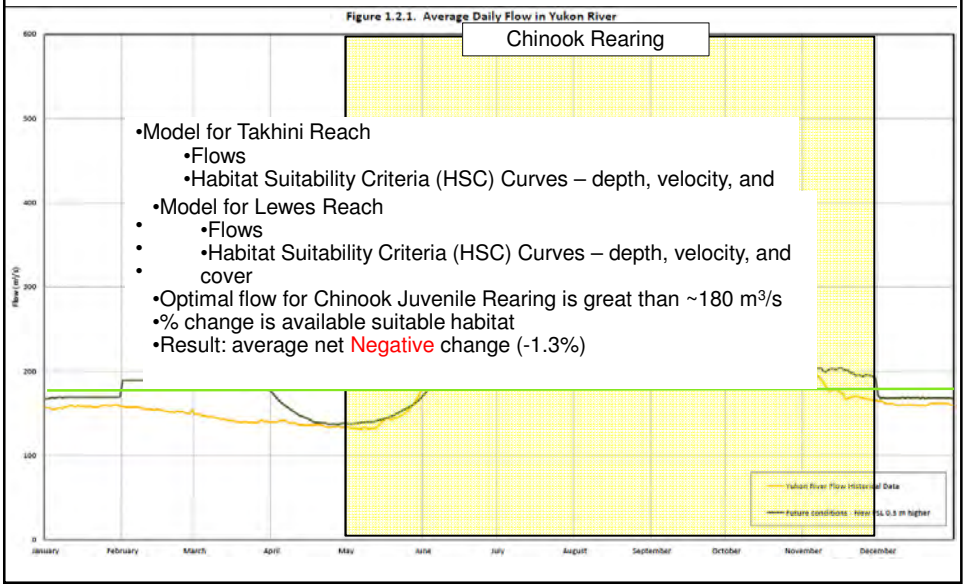
Chinook Salmon Incubation

- Pathway: Reduced Yukon River flows, may affect incubation success of Chinook along the Yukon River mainstem during September to May.



Juvenile Chinook Salmon Rearing

- Yukon River flows, on average, may affect juvenile rearing habitat.



Chinook – Migration, Spawning, Incubation Summary

- Chinook Adult Migration
  - No passage issues were detected.
- Chinook Spawning
  - Time Series analysis indicates that post-concept flows create little change in Chinook salmon spawning on average flow conditions.
- Chinook Incubation
  - Time Series analysis indicates that post-concept flows create more positive with negligible negative changes; therefore, incubation will not be an issue.

Habitat Time Series	Takhini Incubation		Takhini Spawning	
	Positive Change	Negative Change	Positive Change	Negative Change
Average % Change	5.4	-0.1	2.8	-0.4
Average Net % Change	**5.3**		**2.4**	

Chinook – Rearing Summary

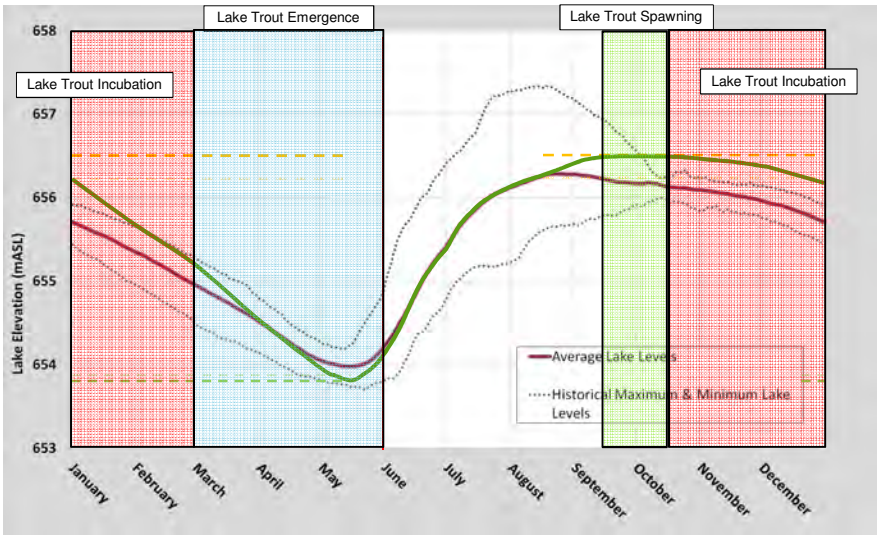
- Chinook Rearing
  - Most Chinook rearing is in tributaries and not in the mainstrem of the Yukon River (not a lot of cover).
  - Takhini Reach – Time Series analysis indicates that post-concept flows creates both positive and negative changes.
  - Lewes Reach – Time Series analysis indicates that post-concept flows creates more negative changes than positive changes.
  - Changes are very minor changes and are negligible.

Habitat Time Series	Lewes Juvenile		Takhini Juvenile	
	Positive Change	Negative change	Positive Change	Negative Change
Average % Change	0.4	-1.7	2.4	-1.4
Average Net % Change		**-1.3**	**1.0**	

Pathways of Effects to Lake Trout

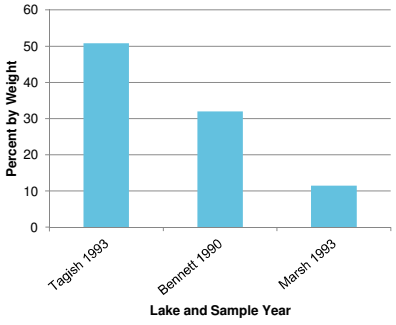
- *Pathway 1*: Increased winter drawdown on Marsh, Tagish and Bennett Lakes may affect LT incubation success.
- *Pathway 2*: Higher lake levels in fall may affect LT spawning habitat as a result of reduced wave action at depth which cleans spawning substrate.

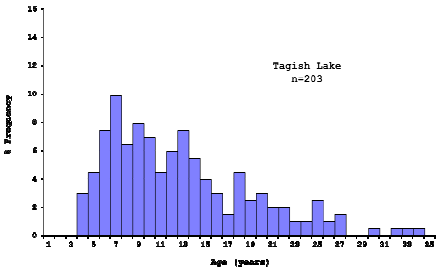
Lake Trout

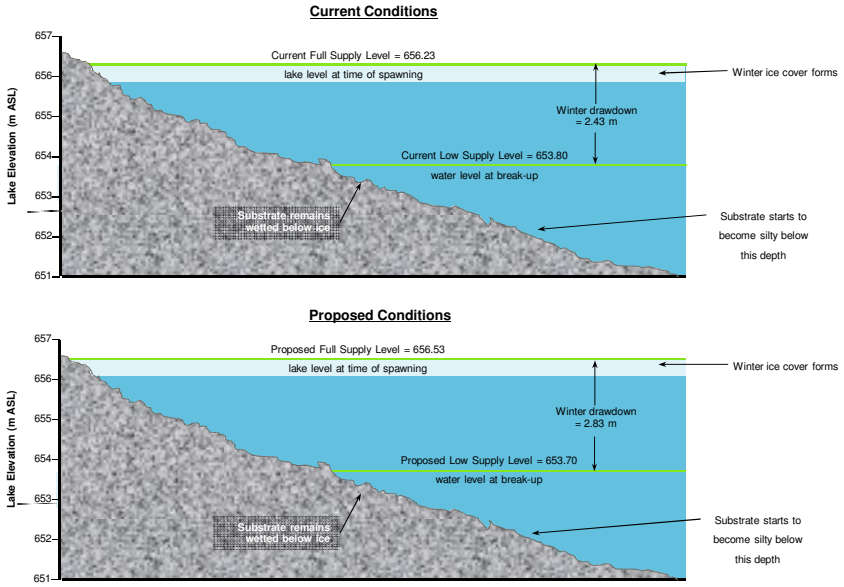


Status of Lake Trout Populations in the Southern Lakes

- Lake trout populations in Tagish and Bennett Lake are doing good – i.e. regular recruitment and no missing year classes and lots of older fish; however, lake trout populations in Marsh Lake are not abundant, largely due to overharvesting







Supporting Literature Regarding LT Population and Winter Drawdown

•Literature (Ontario) indicates that the acceptable winter drawdown range varies between 0.25 and 3.5 m, depending on the reservoir.

•**Preliminary Findings** -

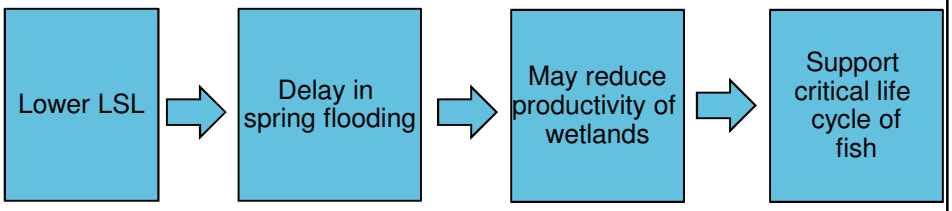
-LT have adapted to the managed system for a very long time (over 50 years).

-Under the current drawdown of 2.43 m LT populations are doing well in Tagish and Bennett Lakes; however, due to overharvesting Marsh Lake LT population is not abundant.

-With an additional 0.4 m drawdown, incubation success may be affected.

-Adaptive Management Plan may be a consideration for LT populations.

Effects to Wetlands



Question - What is the delay of the flooding of wetlands in the spring?

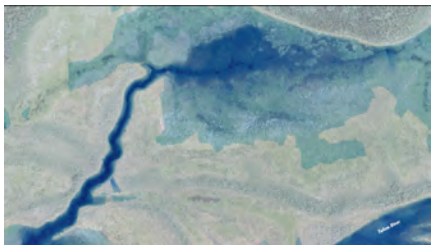
Assessed Effects:

- Wetland Assessment on representative wetlands – understanding of ecology of those wetlands
- Bathymetry of Lewes wetlands used to establish elevation when connections exist
- Compare current water levels with the proposed water levels

Lewes Marsh

Wetland #	Inlet Elevation	Pool Elevation
Lewes #1	<653.9 - 654.0	654.2 - 654.4
Lewes #2	653.9-654.0	653.4
Lewes #3	654	654.4 - 654.6

Lewes Wetland #1



Channel to Lewes Wetland #1

May 14, 2010

Lewes Wetland #2

Lewes Wetland #2

May 14, 2010

Lewes Wetland #3

July 19, 2011

Effects on the Wetlands - Results

Wetland	Inlet Wetting Date		Pool Flooding Date	
	Historical	Proposed	Historical	Proposed
Lewes #1	21-May	23-May	05-Jun	06-Jun
Lewes #2	21-May	23-May	Always flooded	Always flooded
Lewes #3	21-May	23-May	05-Jun	06-Jun

*Inlet natural range is between May 11-June 11.

- Conclusion - delays are very minimal in wetting of wetlands

Summary of Preliminary Effects Assessment

1. No significant project effects anticipated based on studies completed and data analysis to date.

2. Some outstanding questions and concerns regarding lake trout spawning depths and potential effects of drawdown on incubation success.

3. While an increased drawdown of up to 0.4 m is unlikely to cause significant adverse impacts to lake trout spawning success and recruitment, adaptive management may be considered.

Questions

Wildlife Studies within the Southern Lakes 2010-2011

February 2012

Wildlife and Wildlife Habitat Investigations 2010-2011

- Understanding the Project and Interactions with Wildlife and Habitats
- Planning the Scope and Types of Investigations
- Conducting the Investigations
- Results of the Investigations

Project Team

To complete the proposed studies an experienced team of technical and professional biologists and ecologists was assembled

We are all independent consultants who have worked together on many projects in the last 10 years

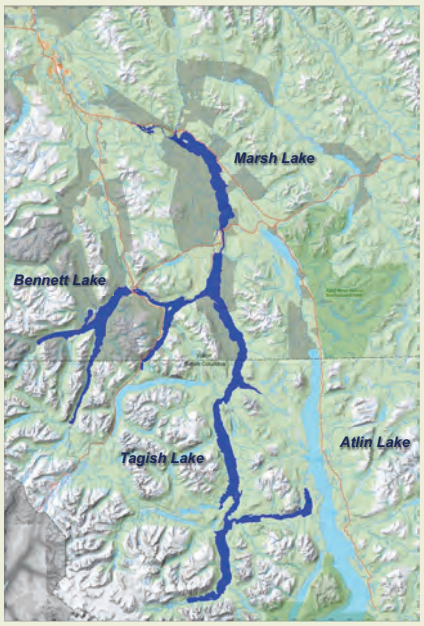
- Laurence Turney - terrestrial leader and wildlife ecologist with 20+ years of wildlife, wildlife habitat and vegetation community mapping experience in northern BC, Yukon, NWT, Nunavut
- Frank Doyle - wildlife biologist with over 20 years of experience working with birds in the Yukon and northern BC
- Patrick Williston - botanist, has worked for 14 years in BC, Yukon, Alberta and the NWT conducting vegetation and rare plant surveys
- Anne-Marie Roberts - wildlife, habitat and terrestrial biologist with 10+ years of work experience in wildlife habitat and vegetation community mapping in northern BC
- Anne Macleod - wildlife biologist who has worked on mammals and birds in northern BC since 2001
- Lis Rach - wildlife technologist, has worked in northern BC for over 6 years primarily on amphibians and wetlands

Understanding the Project and Interactions

Questions we asked ourselves

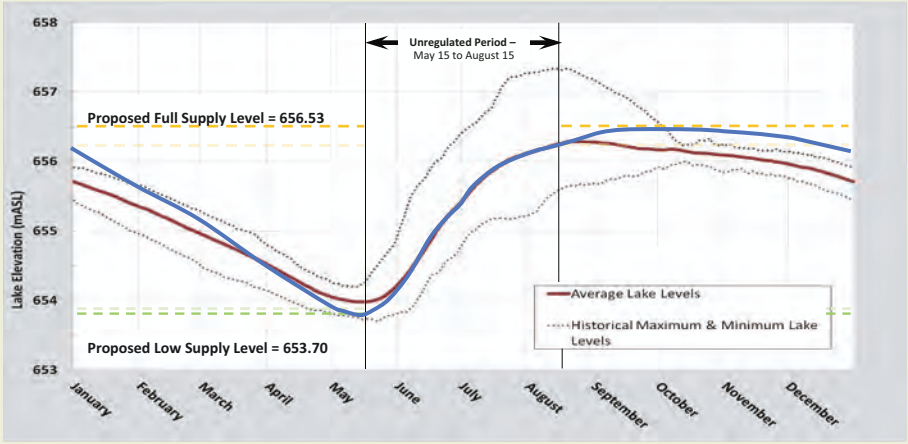
- What areas are important in the southern lakes for wildlife and to people?
- What wildlife species are important and how do they use the area?
- How was the project going to change water regimes and will that effect habitats and wildlife?

Understanding the Project and Interactions



- Started out by reviewing available information and mapping
- Large Study Area with a variety of wildlife species and habitats to understand
  - Marsh Lake (9,491 ha)
  - Tagish Lake (32,245 ha)
  - Bennett Lake (9,584 ha)
- System has been managed since 1922

Understanding the Project and Interactions



- Reviewed the existing and proposed water control regimes to understand where the changes would occur and what the potential magnitude could be
- It was noted that existing water levels were variable and that changes would occur due to new regime

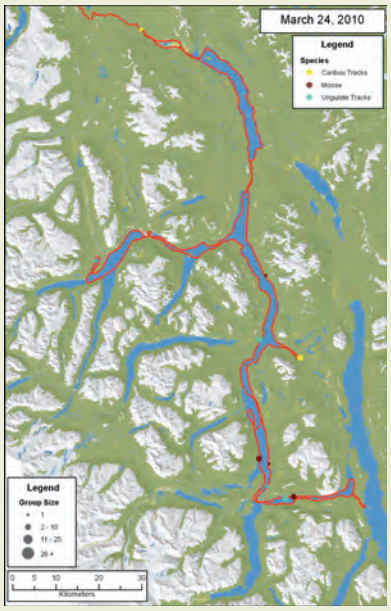
Understanding the Project and Interactions

- Wetlands Selected as Potential Study Areas due to their Important Ecological Role
  - Lewes Marsh is a large wetland complex with a variety of vegetation communities and use by waterfowl and wildlife
  - M'Clintock Bay important spring migration area for waterfowl and swans
  - Monkey Beach, south end of Marsh Lake and Nares Lake also identified as large wetland complexes with high wildlife values
  - Talaha Bay and outlet of Holman River in Bennett Lake also identified as potential wetland areas to study
- Wetlands also selected due to their use and enjoyment by the public

Understanding the Project and Interactions

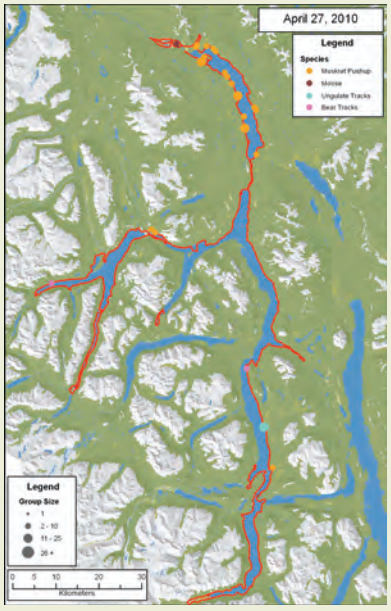
- Several Wildlife Species and Species Groups Identified for Assessment
  - Amphibians such as Wood Frog
  - Aquatic birds including ducks, swans, geese, shorebirds, gulls and terns
  - Aquatic mammals such as beaver and muskrat
  - Large mammals including moose, caribou, and bears

Conducting the Investigations - March

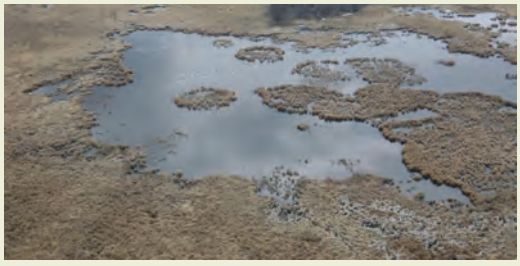


- March Aerial Survey
  - Very little open water, only 125 birds observed
  - 75 were a mixture of Common and Barrow's Goldeneye
  - 31 Swans observed (21 Lewes Marsh, 8 Tagish River, 2 Nares Marsh)
  - 7 moose observed bedded down
  - Several sets of ungulate tracks and some caribou tracks

Conducting the Investigations - April



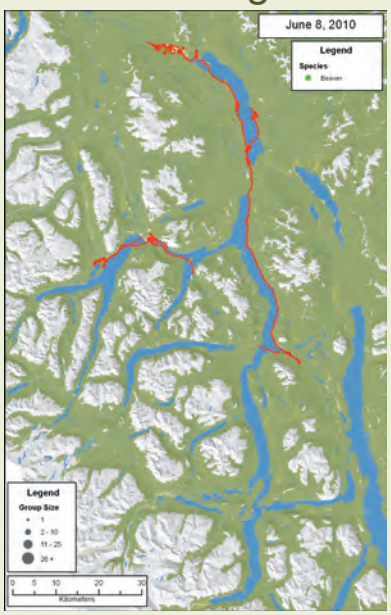
- April Aerial Survey
  - 1850 birds observed
  - 1601 waterfowl (including 501 American Widgeon, 163 swans)
  - Did not overfly mudflats of M'Clintock Bay to avoid disturbance
  - Birds concentrated in open water in lakes and adjacent wetlands
  - 102 muskrat pushups observed (86 within Marsh Lake)
  - 8 moose observed (7 in Lewes)
  - Bear tracks observed on Tagish and Bennett Lakes



Conducting the Investigations - May

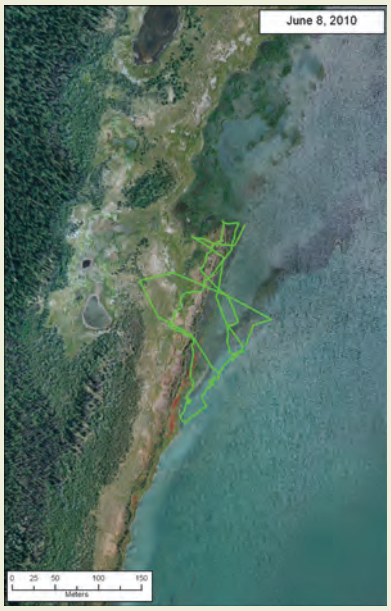
- May Aerial & Ground Surveys
  - 3651 birds observed
  - 2502 waterfowl (1937 dabblers – Widgeon, Teal, Mallard, Shoveler)
  - 600 shorebirds, 326 gulls, 150 longspurs feeding primarily on large mudflats along Marsh Lake shoreline
  - 5 caribou observed, as well as 5 moose
  - 2 grizzly bear observed feeding on south facing slopes
  - 11 beaver observed (10 in Lewes Marsh and Yukon River)

Conducting the Investigations - June



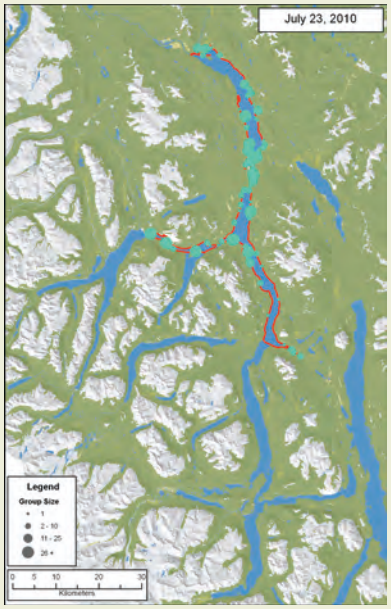
- June Aerial Survey
  - 1676 birds observed
  - 1463 waterfowl (904 dabblers – Mallard, Widgeon primarily)
  - 5 beaver observed in Lewes Marsh

Conducting the Investigations - June



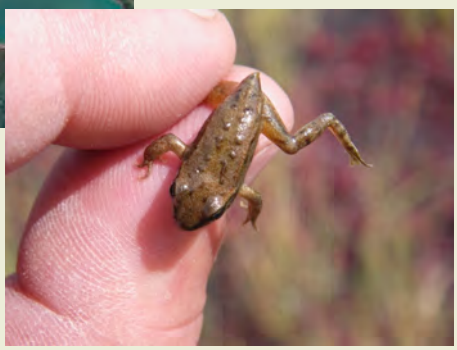
- June Ground Surveys
  - On the ground June 5 (Lewes), June 6 (Nares) and June 8 (6-Mile Wetland)
  - Used Thales GPS system to conduct detailed elevation mapping of wetland communities at Nares and Lewes
  - Primarily assessed vegetation communities, also took notes on wildlife observed and sign

Conducting the Investigations - July



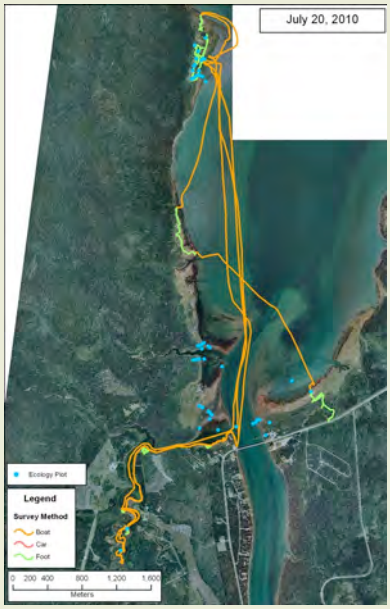
- July Aerial Survey
  - 1122 birds observed
  - 626 waterfowl (281 Canada Goose - [57 young] and 281 mergansers [38 young])
  - 386 gulls (Herring and Mew) and 72 Arctic Terns
  - One moose observed during survey at South end Marsh Lake

Conducting the Investigations - July



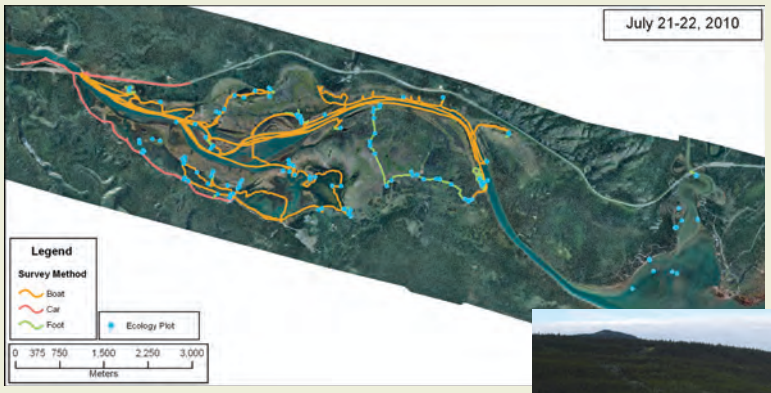
- July Ground Surveys – Nares Lake
  - Boat-based surveys for birds and amphibians
  - Vegetation community plots and rare plant surveys conducted
  - Many recently transformed wood frogs found providing important timing information on breeding

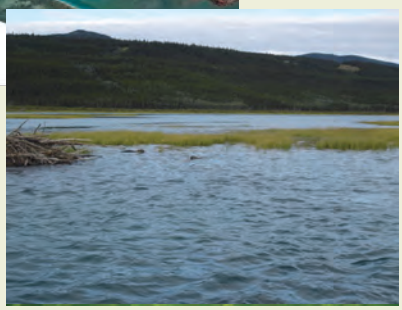
Conducting the Investigations - July



- July Ground Surveys – Tagish / 6 Mile
  - Boat and foot surveys to complete bird, amphibian, rare plant and vegetation mapping surveys
  - Wetland ponds provide breeding areas for small numbers of waterfowl and shorebirds

Conducting the Investigations - July





- July Ground Surveys – Lewes Marsh
  - Boat and foot surveys for wildlife and vegetation mapping
  - Effort made to sample the wide range of vegetation communities and habitats within this wetland complex

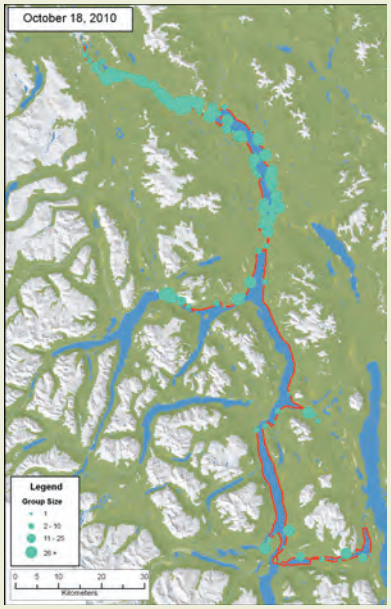
Conducting the Investigations - July

- July Ground Surveys – Monkey Beach
  - Foot based surveys only, concentrating on amphibians, birds and vegetation communities
  - Wood frog breeding area with many just transformed and still concentrated near ponds

Conducting the Investigations - September

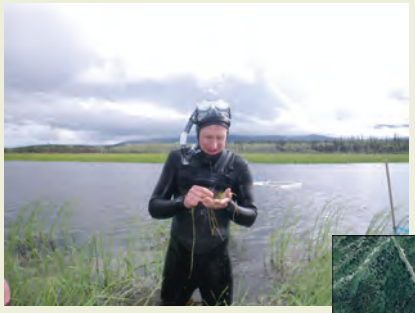
- September Aerial Survey
  - 1859 birds observed
  - 1836 waterfowl (786 diving ducks, 585 dabblers, 257 sea ducks and 196 mergansers)
  - A cow and calf moose observed in Lewes Marsh

Conducting the Investigations - October



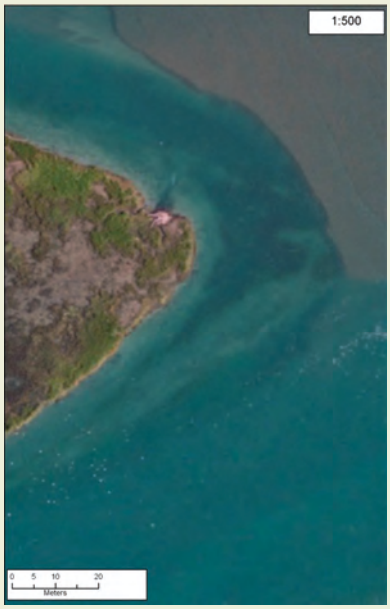
- October Aerial Survey
  - 4554 birds observed
  - 4527waterfowl (2904 sea ducks, 786 swans, 333 diving ducks, 290 dabbling ducks)
  - Swans primarily on Yukon River (117 juveniles observed)
  - No mammals observed

Conducting the Investigations – July 2011



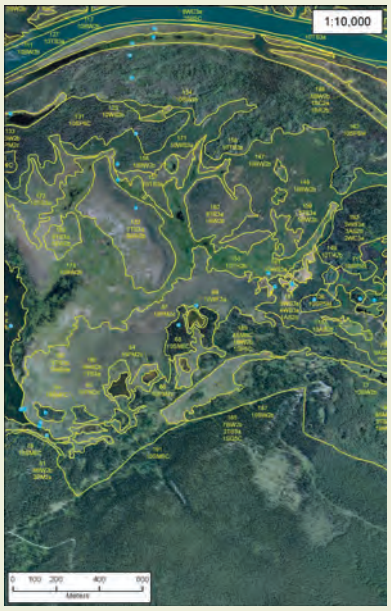
- Wetland Assessments
  - Five sites visited (3 in Lewes, 2 in Nares) to conduct vegetation surveys using the Canadian Aquatic Biomonitoring Network (CABIN) protocols for biological monitoring
  - Detailed vegetation surveys conducted including snorkel surveys of aquatic vegetation
  - Conducted quality assurance on wetland mapping

Conducting the Investigations – Air Photos



- Wetland Aerial Photography
  - Underhill Geomatics Ltd. contracted to obtain new 1:10,000 scale air-photos and complete the post-processing
  - Photos obtained July 8th, 2010 for Lewes, Tagish and Nares, Monkey Beach completed September 7th, 2010 due to problem with original flight line
  - Digital Orthophoto images created along with 1:10,000 contour mapping and Digital Elevation Model (DEM)
  - Orthophoto shows good detail at 1:1,000 and acceptable interpretation at 1:500 scales

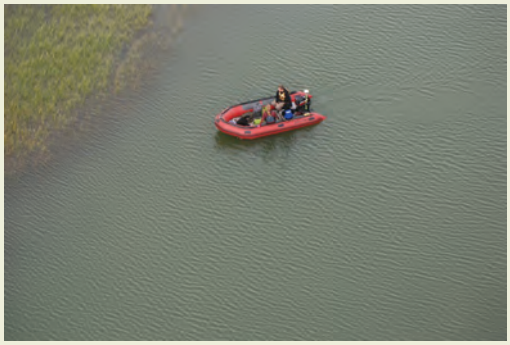
Conducting the Investigations – Mapping



- Wetland Vegetation Mapping
  - Air-photos digitized and used in ArcGIS with PurView and DEM to complete 3D mapping of wetland vegetation communities
  - Photo pairs are projected in 3D and mapper draws polygons around vegetation communities
  - Information from vegetation plots and site photos help determine vegetation communities

Conducting the Investigations – Water Depth

- Wetland Water Depth
  - Water Depth data collected late summer 2010 at high water point to access as much of area as possible using accurate GPS and depth sounder
  - ArcGIS used to create Triangulated Irregular Network (TIN) of bathymetry
  - TIN rasterized to create a surface for analysis
  - Contour mapping created



Results of the Investigations

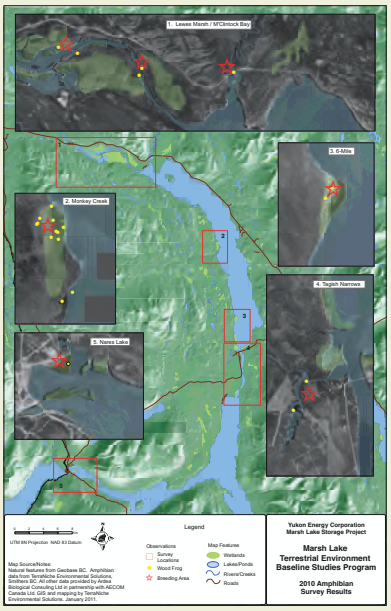
- Summary of Bird Observations
  - Waterfowl were most observed group, with peaks in observation during spring and fall migration
  - Breeding within the study area wetland habitats appears to be limited, based on observations and literature, although there are several gull and tern colonies on rocky islands within study area
  - 128 species are expected to use the study area, with 47 bird species listed under various conservation criteria

Results of the Investigations

- Summary of Mammal Observations
  - Limited number of moose, muskrat, beaver, caribou and grizzly bears observed, although sign for moose, beaver and muskrat relatively abundant within wetlands
  - Muskrat use of Marsh Lake margins through pushup surveys greater than that observed in Lewes Marsh, although evidence of use obtained from other surveys suggest pushup surveys may not be effective for Lewes Marsh due to under ice use

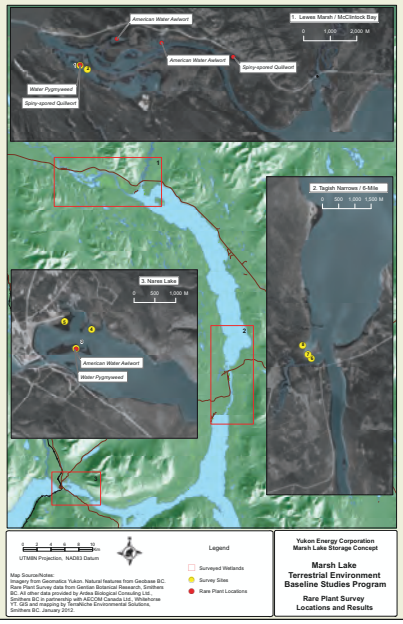
- Photo on left is area of Lewes in April with no pushups noted, but June ground surveys (right photo) indicated that muskrat were using the area, possibly taking advantage of under-ice voids, limiting the need to create pushups

Results of the Investigations



- Summary of Amphibian Observations
  - Breeding of wood frog was observed in all wetlands assessed, no other species were found
  - Only adults and juvenile wood frogs were observed, no egg masses or tadpoles found

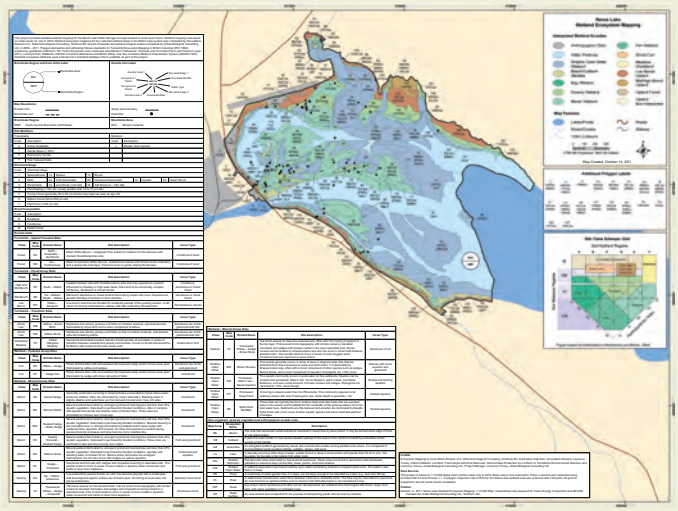
Results of the Investigations



- Summary of Rare Plant Observations
  - 3 rare plant species found in study area
    - American Water Awlwort
    - Spiny-spored Quillwort
    - Water Pygmyweed

Results of the Investigations

- Summary of Wetland Mapping
  - 4 areas completed, Lewes, Nares, Tagish/6 Mile and Monkey Beach
  - Example of Nares Lake shown below



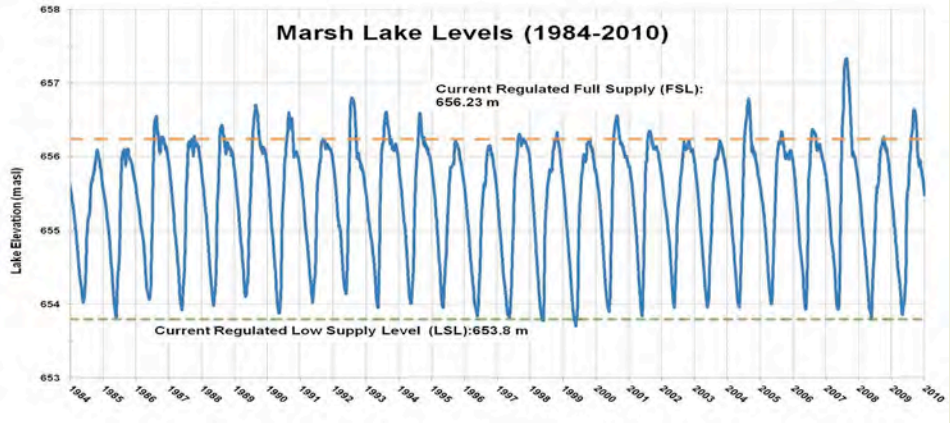
Wetlands and Wildlife101

February 2012

Wetlands and Wildlife 101

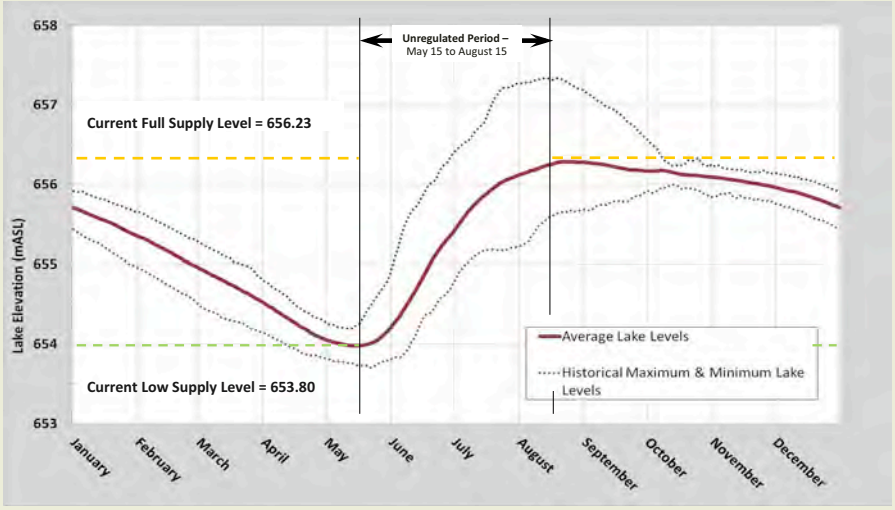
- Look at the Dynamics of Wetlands in Marsh and Tagish Lakes
- Look at how Vegetation Communities have developed
- Look at how Wildlife Species are using the study area

Dynamics of Wetlands in Marsh/Tagish Lakes

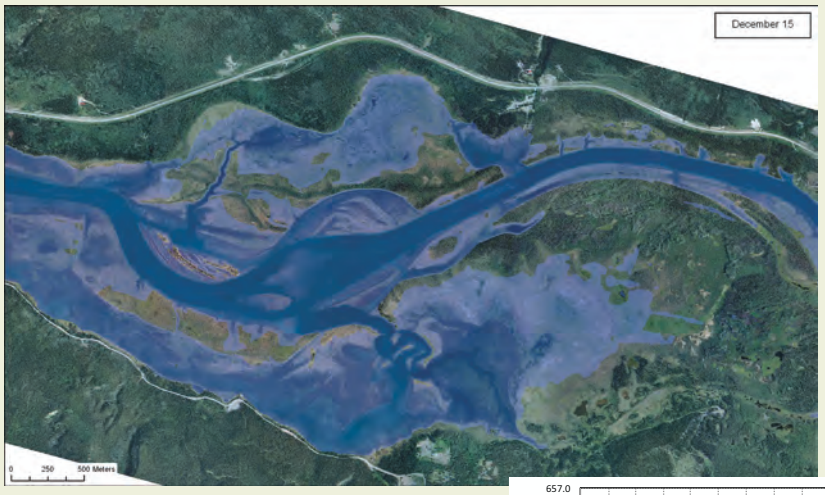


- Regular fluctuations within the system, with a range of 2.2 to 2.8 m on a yearly basis and an overall range of 3.6 m
- Variability between years on low and high levels, as well as in rate of fill and draining

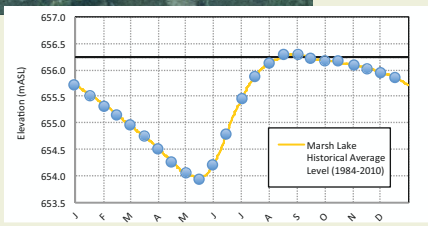
Dynamics of Wetlands in Marsh/Tagish Lakes



- Over an average year, the water level in Marsh Lake varies from 654 m to 656.3 m (2.4 m)
- There is a relatively slow decline in water levels from September to mid-May
- Quick refill of system from mid-May to mid-August

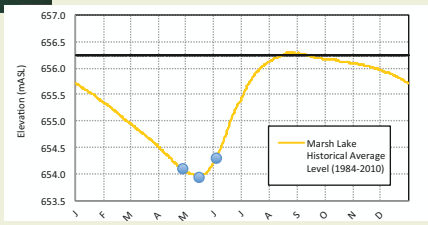


- Animation is of an average year and how water moves across Lewes Marsh from January to December



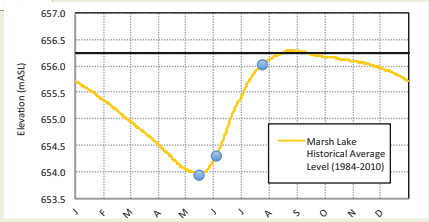
Dynamics of Wetlands in Marsh/Tagish Lakes

- Actual images from M'Clintock Bay from flights in 2010



Dynamics of Wetlands in Marsh/Tagish Lakes

- Actual images from Nares Lake from flights in 2010



Dynamics of Wetlands in Marsh/Tagish Lakes

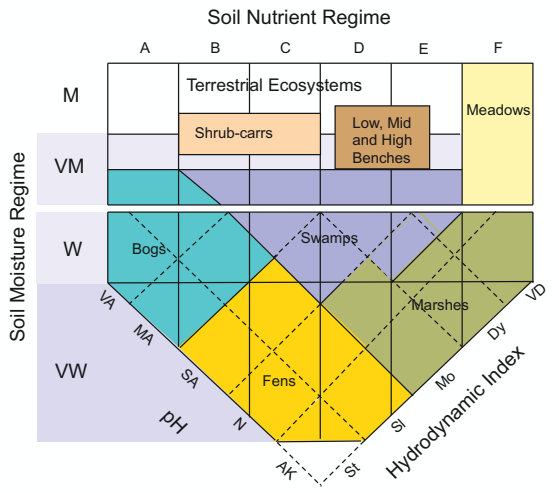
- Images from remote camera set to record images every 4 hours during daylight from early June to end of September

Vegetation Communities in Wetlands

Wetland Vegetation Communities develop through complex relationship of factors:

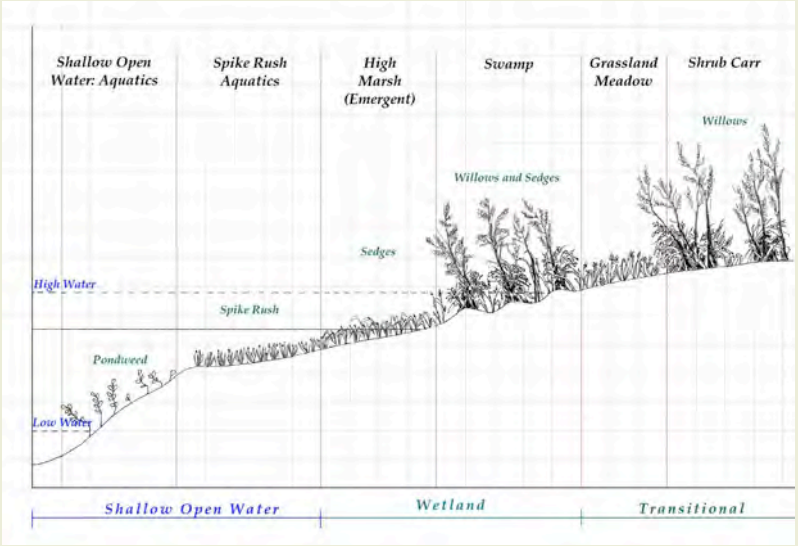
- Soil nutrients
- Soil moisture
- Acidity / alkalinity of soils
- Water movements through the soils
- Level, duration and timing of inundation

Vegetation Communities in Wetlands



- Edatopic grid that shows distribution of vegetation communities based on their relationship between soil nutrients, soil moisture, soil acidity (pH) and hydrodynamic index (water flows)

Vegetation Communities in Wetlands

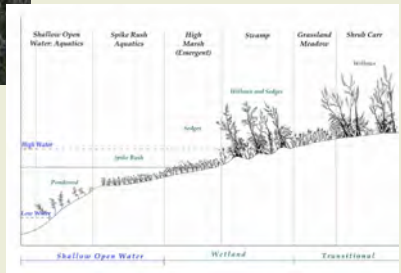


- Diagram outlining relationships of wetland vegetation communities along shallow sloped wetlands

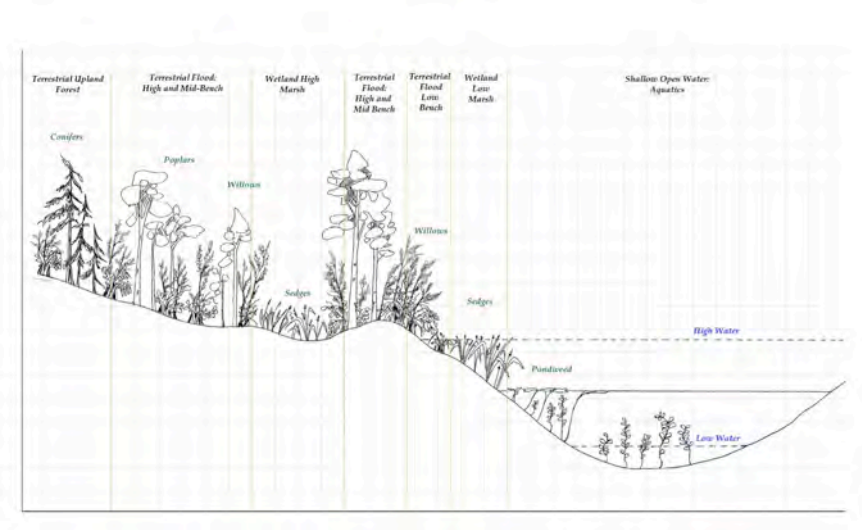
Vegetation Communities in Wetlands

Shallow slope wetland communities

- Spike rush and sedge communities prior to inundation (mid May)
- Aquatic, spike rush and sedge communities in early June
- Willow - sedge community
- Grassland community
- Shrub-carr community

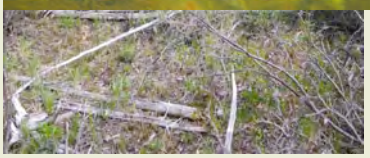


Vegetation Communities in Wetlands



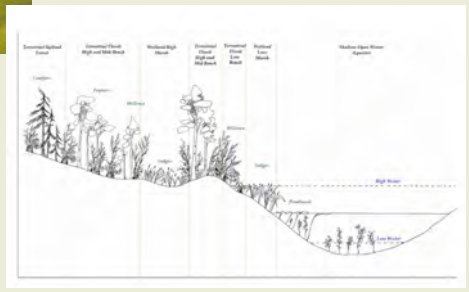
- Diagram outlining relationships of wetland vegetation communities in more complex topography such as historic beaches or river edges

Vegetation Communities in Wetlands

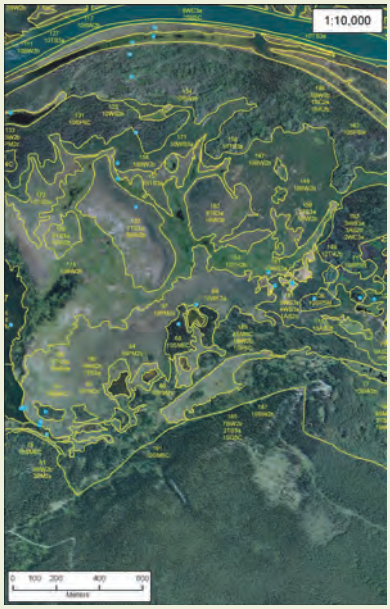


Complex Topography Communities

- Upland forest community
- High-bench riparian community
- Willow - sedge community
- Low-bench riparian community
- Wetland low marsh community
- Shallow open water aquatic community



Vegetation Communities in Wetlands



- Wetland mapping integrates the vegetation communities into polygons with up to 3 components, each component portrayed as a decile 1-10 (10 to 100% of polygon area)

Terrestrial – Transition Sites

Class	Map Code	Ecosite Name	Site Description	Cover Type
Shrub Carr	WB	Willow – Scrub Birch	Deciduous low shrubs, grasses and forbs on medium textured, well drained soils. Dominated by scrub birch and a minor component of willow.	Deciduous low shrub, graminoid and forb
Shrub Carr	WS	Willow Shrub	Deciduous low shrubs, grasses and forbs on fine to medium textured, well drained soils dominated by willow.	Deciduous low shrub, graminoid and forb
Grassland Meadow	TH	Tufted Hairgrass Meadow	Graminoid dominated meadow tolerant of brief periods of inundation in areas of transition between wetland and upland communities. Found on fluvial and lacustrine landforms with coarse to fine silty-sandy soils.	Graminoid or forb

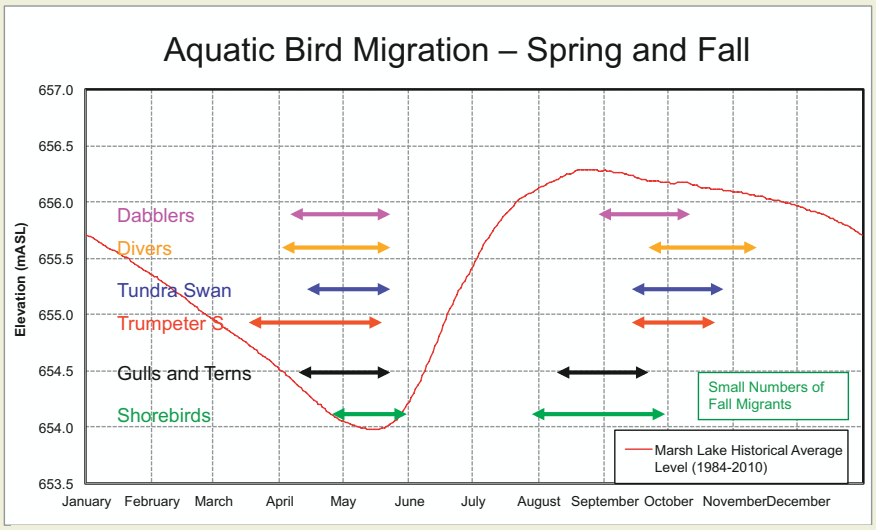
Wetland – Peatland Group Sites

Class	Map Code	Ecosite Name	Site Description	Cover Type
Fen	WF	Willow – Sedge	Poorly drained sites with accumulated decomposed sedge and/or brown moss peat. Dominated by willow and sedges.	Deciduous low shrub and graminoid
Fen	SF	Sedge Fen	Poorly drained sites with accumulated decomposed sedge and/or brown moss peat. Dominated by sedge with minor amounts of forbs.	Graminoid

Wetland – Mineral Group Sites

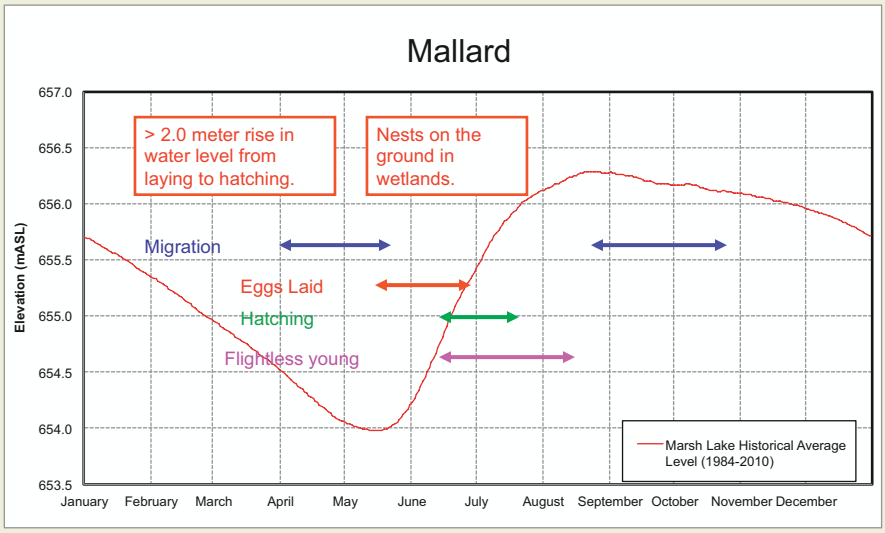
Class	Map Code	Ecosite Name	Site Description	Cover Type
Marsh	AS	Awned Sedge	Generally small sites occurring in small potholes surrounded by forest where water levels are shallow. Sites are dominated by *Carex atherodes*. Standing water is slightly alkaline and substrates are fine textured mineral soils. Very rich sites.	Graminoid
Marsh	BR	Bulrush Marsh	Mineral wetland dominated by emergent graminoid macrophytes and less than 25% aquatic vegetation. Saturated to permanently flooded conditions, often in complex with aquatic bed ponds and shallow water protected sites. These sites are dominated by *Scirpus* and *Cicuta spp.*	Graminoid
Marsh	BW	Beaked Sedge – Water Sedge	Mineral wetland dominated by emergent graminoid macrophytes and less than 25% aquatic vegetation. Saturated to permanently flooded conditions. Species diversity is low and plant cover is strongly dominated by beaked and/or water sedge with scattered forbs, aquatics, and mosses. On sites that experience surface drying, species diversity increases and sites become more meadow like.	Graminoid
Marsh	HS	Swamp Horsetail – Beaked Sedge	Mineral wetland dominated by emergent graminoid macrophytes and less than 25% aquatic vegetation. Saturated to permanently flooded conditions. These sites are restricted to lake and slow moving river edges.	Forb and graminoid
Marsh	MA	Manna Grass	Mineral wetland dominated by emergent graminoid macrophytes and less than 25% aquatic vegetation. Saturated to permanently flooded conditions, typically with standing water of at least 30 cm. Manna Grass dominates the emergent macrophytes but can also occur with sedges as well as aquatics.	Graminoid and aquatics
Marsh	SC	Sedge – Cinquefoil	Graminoid and forb site with sedges and cinquefoil occurring in saturated soils. This ecosite tends to occur in areas of more mobile or dynamic water movement and tends to have more exposure.	Forb and graminoid

Adaptations of Wildlife to Wetland Dynamics



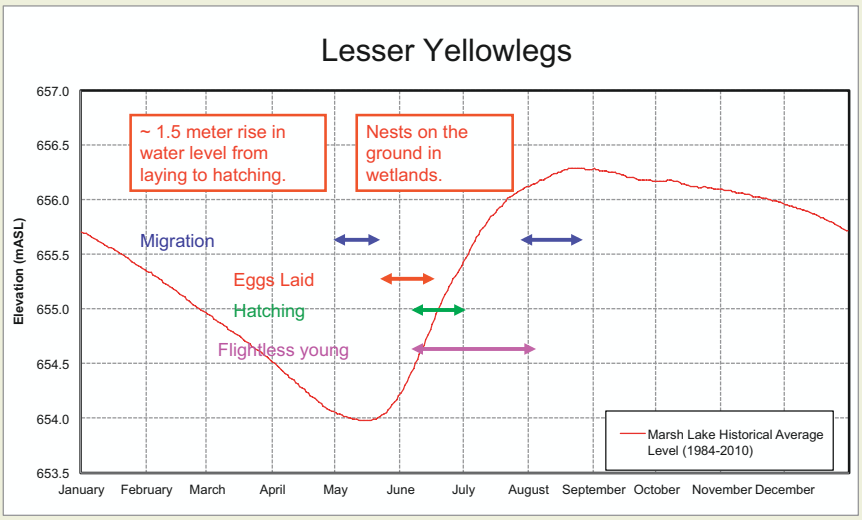
- Both Spring and Fall migrations occurring during period of lowering water, but much greater rate of decline in spring (~ 1 m)
- This may allow new areas to be foraged during migration as water level drops

Adaptations of Wildlife to Wetland Dynamics



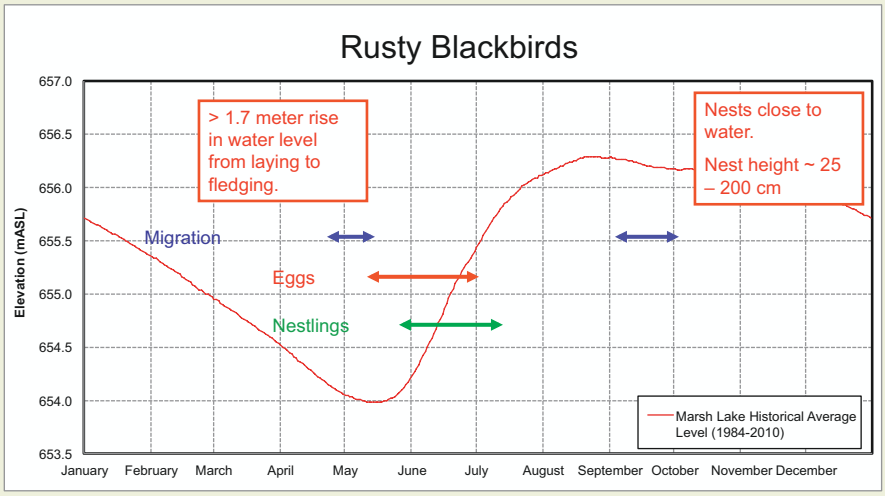
- Laying eggs and incubation occurring during period of fastest water rise (~ 2 m) creating risk for nesting within areas subject to inundation
- Less risk where topography is complex and wetlands are not directly tied to lake water influences

Adaptations of Wildlife to Wetland Dynamics



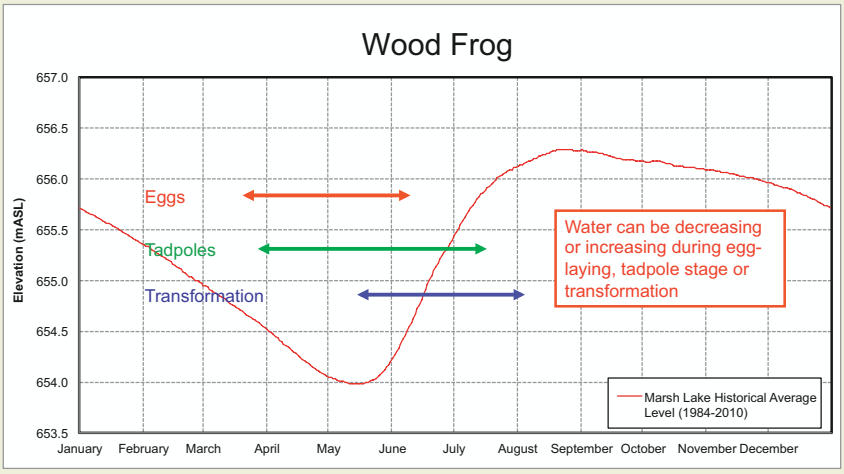
- Laying eggs and incubation occurring during period of fastest water rise (~ 1.5 m) creating risk for nesting within areas subject to inundation
- Less risk where topography is complex and wetlands are not directly tied to lake water influences

Adaptations of Wildlife to Wetland Dynamics



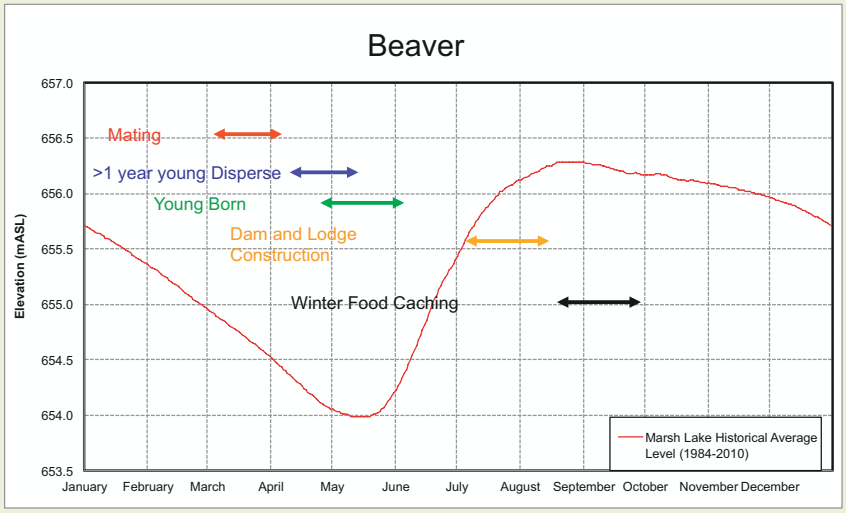
- Laying eggs and incubation occurring during period of fastest water rise creates risk for nesting within areas subject to inundation
- Less risk where topography is complex and wetlands are not directly tied to lake water influences, as well as in tall (> 2 m) shrub habitats

Adaptations of Wildlife to Wetland Dynamics



- Wide variation in egg-laying times throughout Yukon/Northern BC, likely related to wetland water temperature
- Able to breed earliest of northern frogs and may take advantage of relatively stable waters at low end of curve to breed

Adaptations of Wildlife to Wetland Dynamics



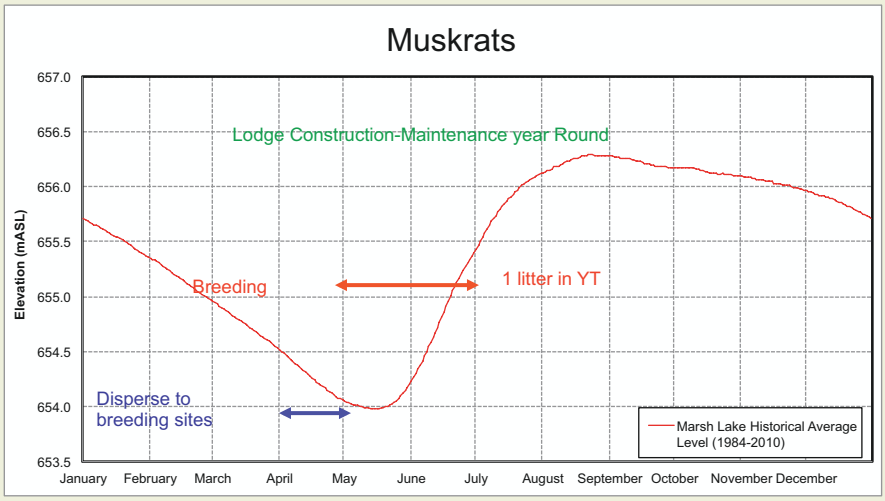
- When young are born is highest risk period and this tends to take place during low part of curve when water level changes are lowest

Adaptations of Wildlife to Wetland Dynamics

- Where beaver are not able to create dams to regulate water levels they have 2 lodge strategies:
  1) create a long series of chambers along a sloping beach
  2) use multiple lodges at different water levels

- Lodges in both photos appear to be active at time of photos
- Photo on right obtained July 22, 2010 with potential for > 1 m of water before full supply, which would overtop existing structure

Adaptations of Wildlife to Wetland Dynamics



- Breeding occurs during period of highest water change and kits are not weaned until 4 weeks after birth, creating risk for den sites in areas subject to inundation
- Likely that majority of muskrats use wetlands/ponds in areas away from lake to avoid inundation

Adaptations of Wildlife to Wetland Dynamics

Wetland Habitat Use - Moose

- Moose can be found in wetlands year-round foraging on willow and other shrubs
- Will forage on sedges and aquatic plants during spring, summer and into the fall

Wetland Habitat Use - Caribou

- Caribou primarily forage on ground-lichen, but will forage on sedges and other herbaceous plants during during spring and summer and can be found commonly in wetlands

Wetland Habitat Use - Bears

- Both Grizzly and Black bears will forage on a variety of herbaceous plants found in wetlands and in many areas will feed extensively on horsetails and sedges in the spring

Wetland and Wildlife Preliminary Assessments

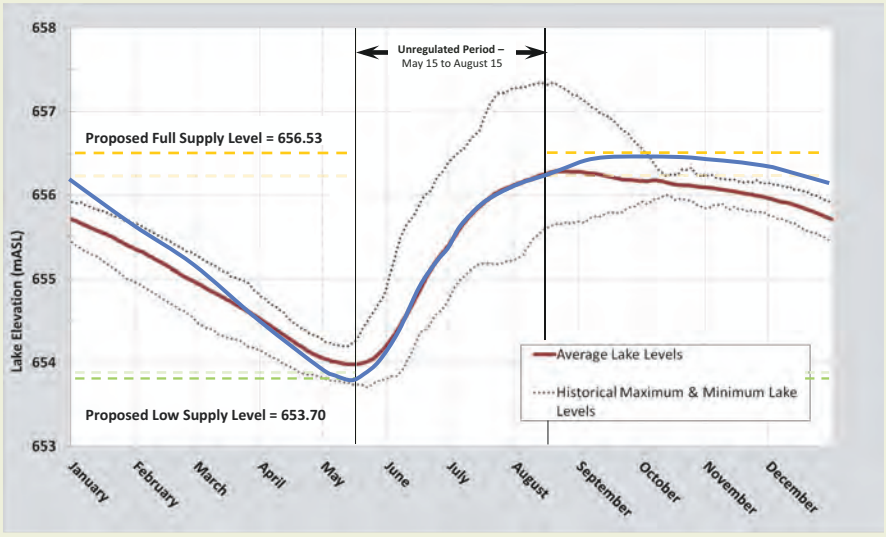
February 2012

ARDEA BIOLOGICAL CONSULTING

Wetlands and Wildlife Preliminary Assessments

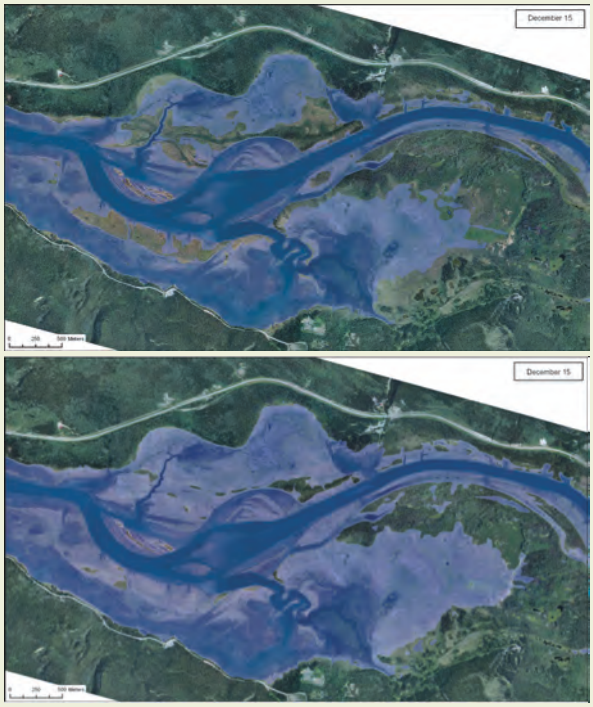
- Review the Proposed Water Control Regime
- Preparing the Information, Stating Assumptions and Limitations
- Preliminary Assessment Results

Review: Proposed Water Control Regime



Assumptions and Limitations

- Patterns of use by wildlife indicates that wetland use increases from south to north and that our effort was reasonable
- Data collection and analysis designed to be scaled up
  - Assumed that we could complete detailed analysis in portion of study area would allow scaling up to larger area
- Complete analysis conservatively (round towards conservation of value)
- GIS & Modeling used where possible to provide quantitative data on effects to vegetation community



- Visualizing the New Control Regime

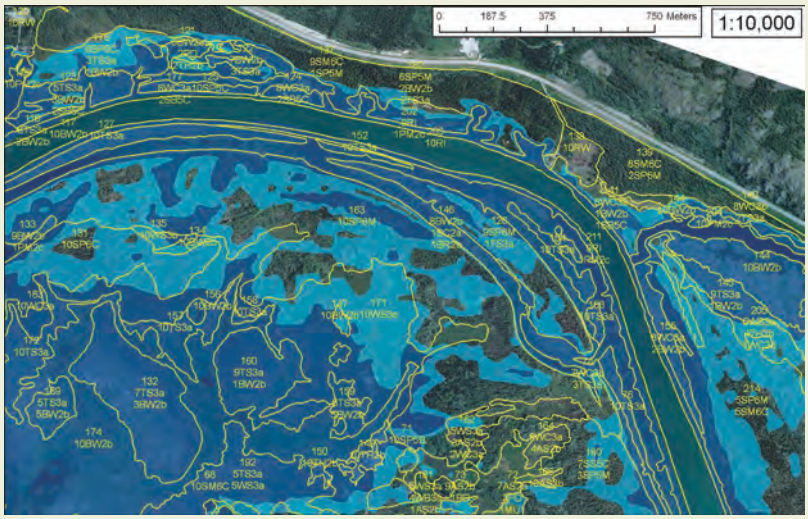
Current Control Regime

- Animation is of an average year and how water moves across Lewes Marsh from January to December

Proposed Control Regime

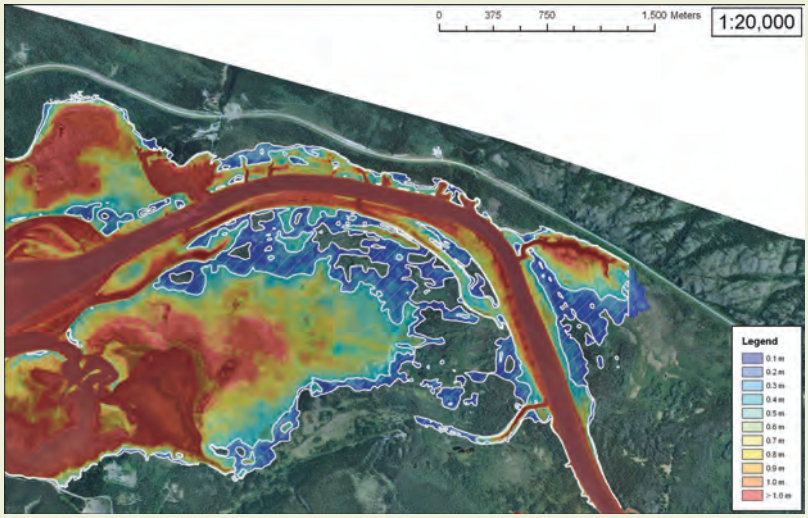
Assessment of Potential Effects

- Bathymetry information used to identify areas which will be under water in current control (shown in dark blue) and with proposed regimes (shown in light blue)

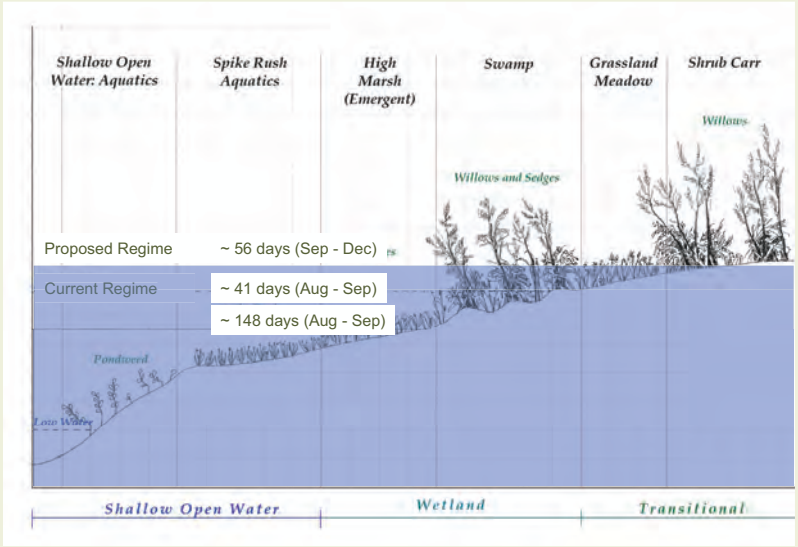


Assessment of Potential Effects

- Along with where the high water will occur, it is important to identify how much water will be over the wetland vegetation at the peak period



Assessment of Potential Effects

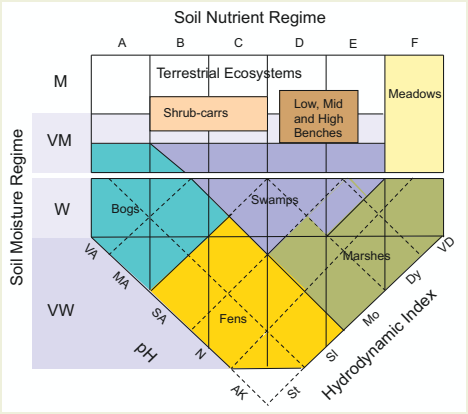


- Identification of number of days under different control regimes is also important

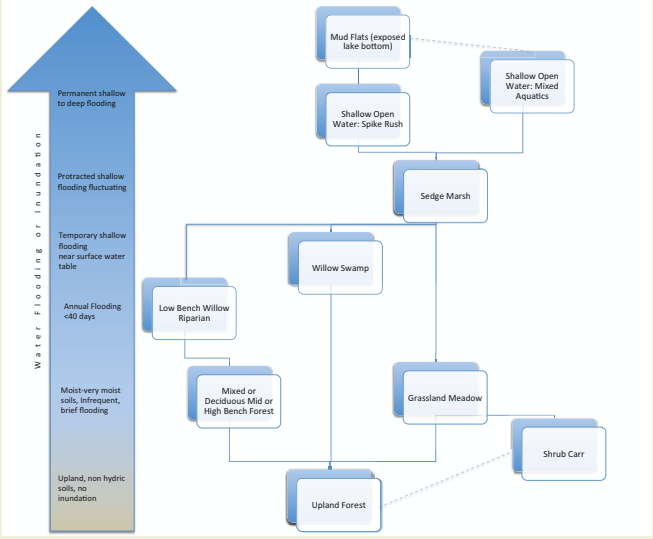
Assessment of Potential Effects

Recap: Wetland Vegetation Communities develop through complex relationship of factors:

- Soil nutrients
- Soil moisture
- Acidity / alkalinity of soils
- Water movements through the soils
- Level, duration and timing of inundation

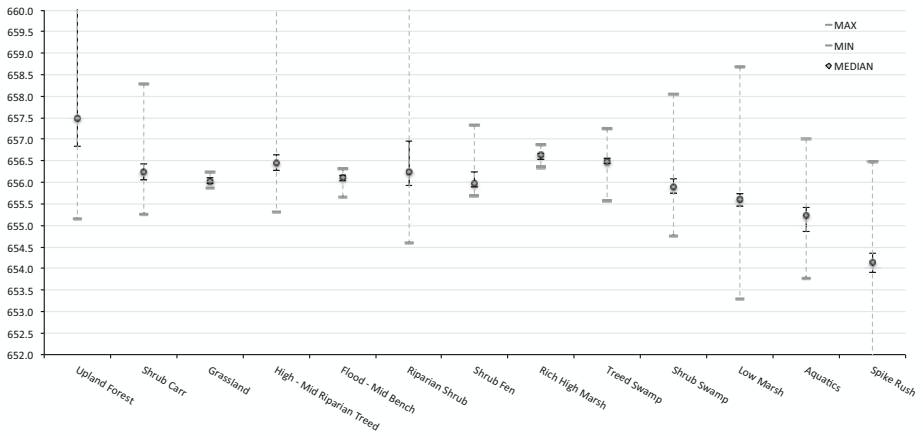


Assessment of Potential Effects



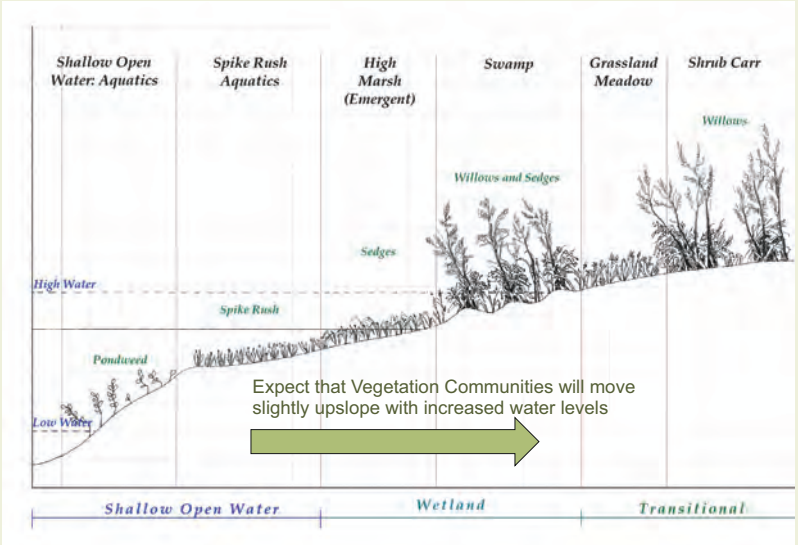
- Diagram outlining relationship between vegetation communities, water levels and duration

Assessment of Potential Effects



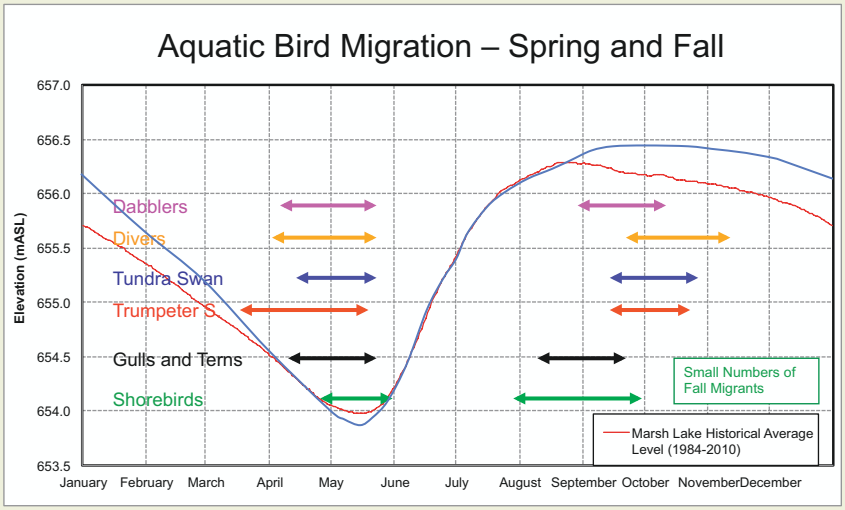
- Based on elevation information, we can identify where wetland vegetation communities are located

Assessment of Potential Effects



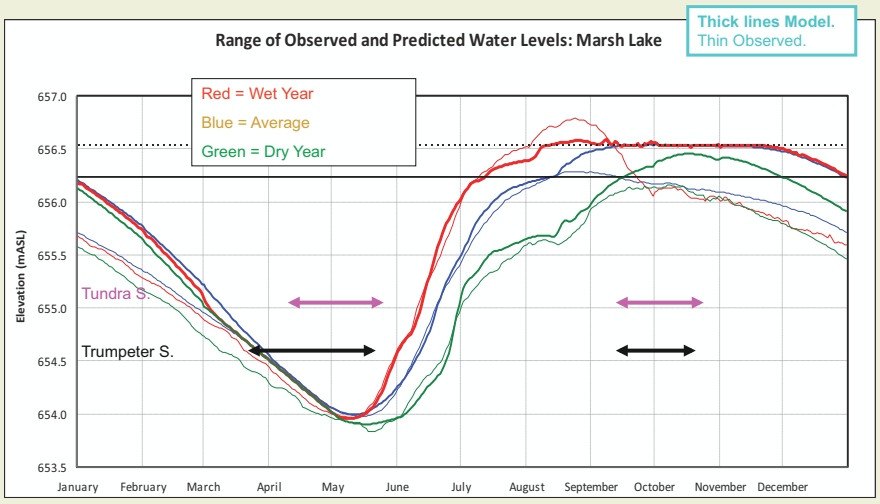
- Movement of communities will be dependent on the community type as many overlap in elevation
- Unlikely that we will see wholesale swaps of communities, predict only a shift in lower and upper regions

Assessment of Potential Effects



- Proposed control regime does not show big difference in spring water levels
- Fall water levels are 0.5 m higher during fall migration which may affect forage availability

Assessment of Potential Effects

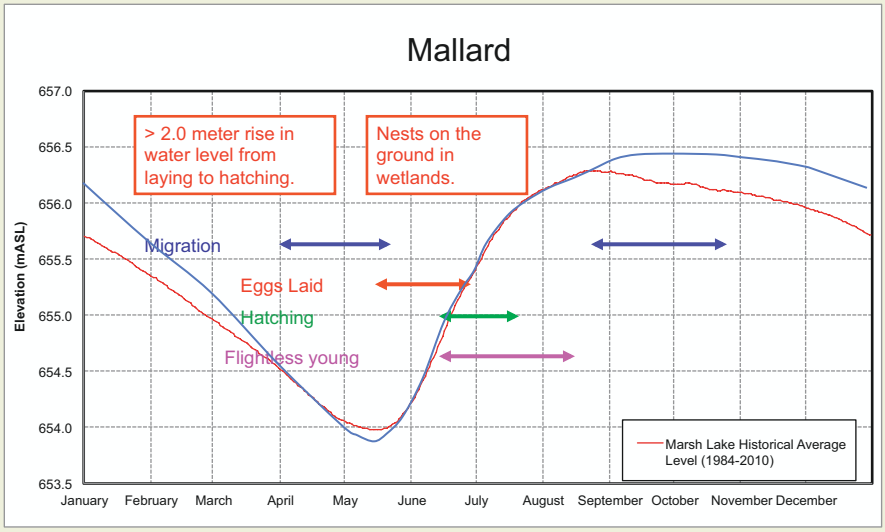


- This potential change in fall forage availability is within range of variability, but a further look is still required

Assessment of Potential Effects

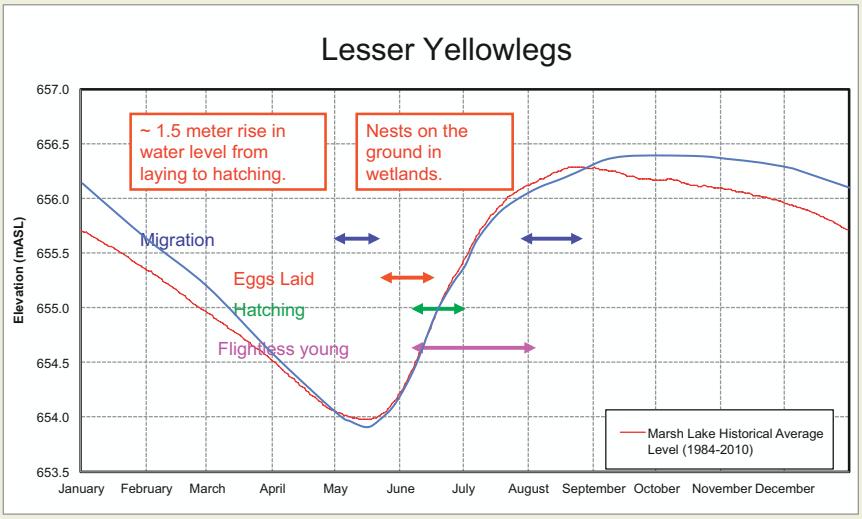
- Area of M'Clintock Bay where New Control Regime will cause some drying from early to late May, which is after the peak Swan migration

Assessment of Potential Effects



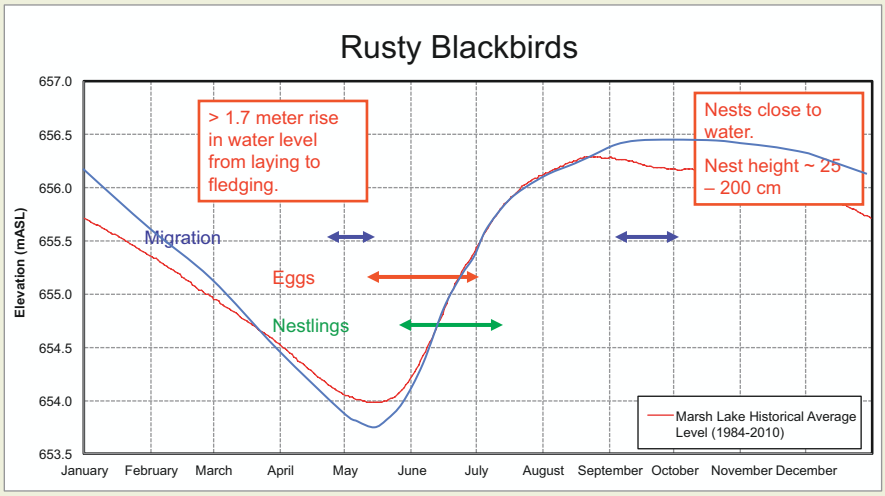
- Not a good strategy for Mallards to use this system for nesting, new control regime may make it worse as some may nest at lower elevations

Assessment of Potential Effects



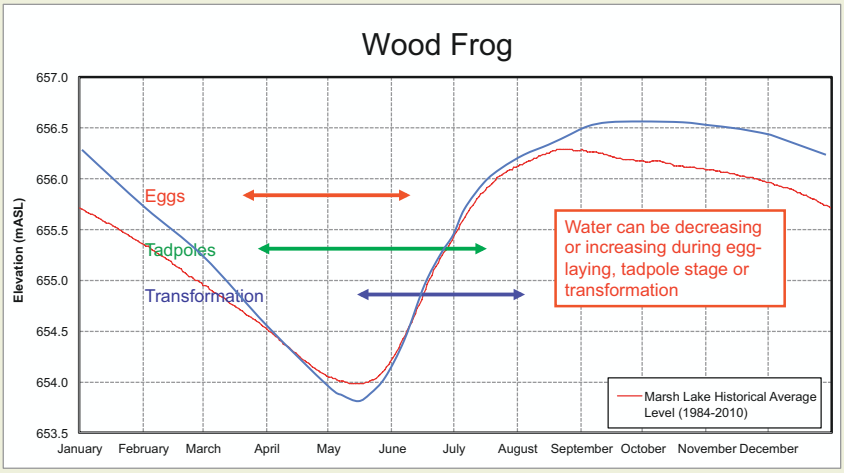
- Not a good strategy for Yellowlegs to use this system for nesting, new control regime may make it worse as some may nest at lower elevations

Assessment of Potential Effects



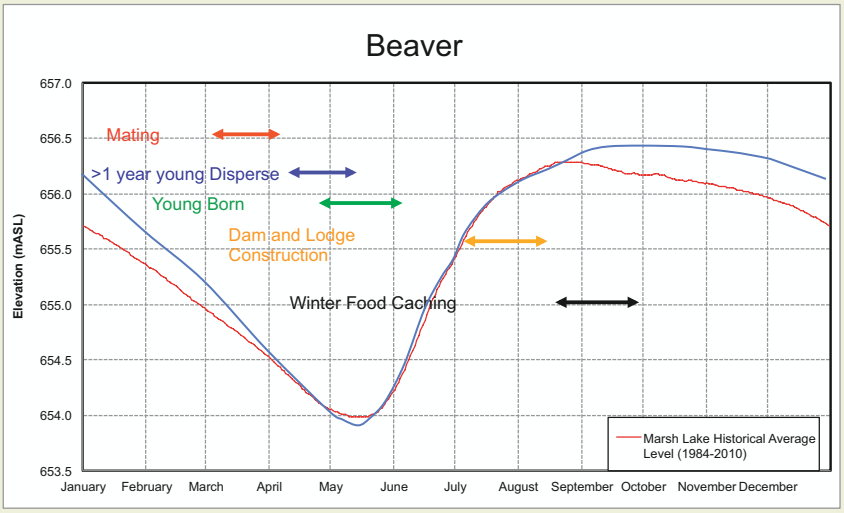
- New control regime may make it worse as some may nest at lower elevations, need to conduct more analysis to determine potential area affected

Assessment of Potential Effects



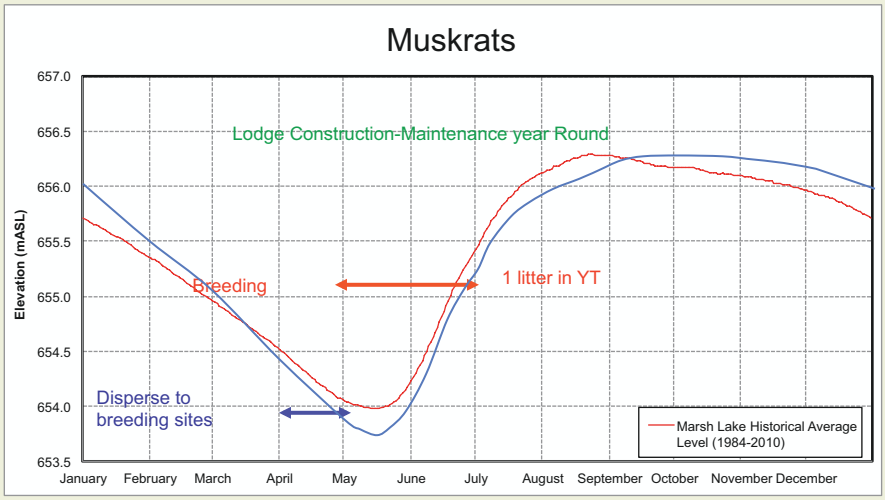
- Under proposed control regime, lower water levels during May could dry some egg masses, more exploration of where these areas are required to determine potential quantity

Assessment of Potential Effects



- Increased water levels during fall may require beaver to change locations or increase above water spaces in lodges

Assessment of Potential Effects



- Period from September to April will have increased water levels, with November to April under the ice
- Our assumption is that currently Muskrat are using under ice habitats for foraging and don't use push-ups in Lewes Marsh
- Increased water may decrease under ice water-free areas, which may increase use of push-ups

Assessment of Potential Effects

Potential Effects to Large Mammals

- Moose, Caribou and Bear foraging habitats (mixtures of willows, aquatics/sedges) are predicted to shift within wetland, but total available area not likely to change significantly