Slide Number	Key Points
1	Water quality means different things to different people. There is the drinking water side of things, which is concerned with how safe the water is for human consumption and can include things like E-coli and other pathogen (bacteria, parasites, etc) testing. There is the fisheries side of things, which is primary concerned with monitoring water quality with regards to achieving or maintaining the 'ideal parameters' for particular species. And finally, there is the ecology/limnology side of things, which is concerned with lakes/rivers/etc as healthy, functioning ecosystems. Its focuses include robust food webs, nutrient cycling and maintaining ecological functioning. We work entirely within the third framework (ecology/limnology) and we hope today to share our enthusiasm for the subject and help you understand a bit more about what is going on beneath the surface of your lake. We aren't able to talk about pathogens, potabillity of the water or management of particular fish species as we simply do not work in these areas and would be doing you a disservice in attempting to talk about them!
2	The data we are presenting to you today is part of a large monitoring program we carry out annually in the Kawartha lakes region and Kawartha Highlands Provincial Park, supported by donations from cottagers such as yourselves. So why carry out this monitoring work? Let us say that we are sampling a lake for the first time. We don't know what 'normal' looks like for that lake. We don't know if the results we get are within the normal range or if something else is going on. By monitoring annually, we can build a picture of what that lake is like and establish some baselines from which we can then detect 'extreme' events such as an influx of phosphorus from a broken septic tank or an algal bloom. We can build up a valuable picture of how a lake varies over time and broaden our understanding of how lakes work, particularly the Kawartha lakes in this instance. Additionally, once we have this baseline data, we have a strong foundation on which we can carry out more in-depth research.
3	This is a list of all the parameters we collect from the lakes. This is a very long list and we won't bore you with the full details of all of these parameters. This is more of a general overview of the amount of information we can and do collect.
4	We have been sampling the Kawartha lakes since 2015 (with a gap in 2016) and most years, we sample around 30 lakes both in the Kawartha region and the Kawartha Highlands Provincial park. The more different types of lakes we can sample, the more informative our data set is. Here you can see the lakes (and the Mississagua river) we sampled last year…
5	Here we have some of the 2018 data, including Catchacoma. The 5 parameters we

	have listed here do not in and of themselves tell us a great deal about the water quality. Rather, they allow us to build an overall physical picture of the lake which we can then use to help us better understand the other data we collect; think about it like laying a strong foundation before you build a house. We won't dwell too much on these data, the headline takeaway is that they are all within the parameters we'd expect for lakes in this area.
6	This graph shows dissolved oxygen (DO) at the top and bottom of each of the lakes. So, what can dissolved oxygen tell us? Oxygen may be added to the lake by gas exchange with the air and by plants releasing oxygen as the photosynthesis to produce energy. Oxygen is then used up by animals in the lake respiring (breathing it in) and sometimes by matter decomposing on the bottom, so measuring DO can tell us about the balance of all these processes. Generally speaking, the water towards the top of the lake will have an oxygen saturation of around 100%, which is the same as the air. It may also go slightly above this if there are a lot of plants and algae photosynthesising or below if there is a lot of decomposition occurring. Now, why do we measure the top and bottom of the lake and why is it so different in some lakes? A bit of limnology 101 now: As most of you will know, warm air is lighter and so tends to rise to the top of a room. The same is true with water; when the sun heats up the top layer of water, it stays sitting on top and does not mix with the cooler, denser water below. This forms three distinct layers – the epilimnion, which is the warm, top layer of the lake. The metalimnion (also known as the thermocline) is the middle layer between the warm and cold water and this may move up and down during the lake as the top layer gets more or less warmed. The hypolimnion is then the bottom, colder layer. So, as well as not mixing temperatures, the layers also mean that there is not much mixing of oxygen. This means that at the top of the lake, where contact with the air is constantly replenishing the oxygen and keeping it around the same saturation as the air. At the bottom of the lake however, there are animals respiring and matter decomposing, which is using up the oxygen but no oxygen is making it from the air past the thermocline so as the summer progresses, the bottom of the lake generally becomes depleted in oxygen.
7	The graph is looking at total phosphorus. Phosphorus is the thing that gets spoken about a lot in regards to lake health and water quality. Now the first thing to mention is that phosphorus is an important nutrient and without it, there wouldn't be much life in the lake. But, as with most nutrients, too much of a good thing can be bad.

	Unlike nitrogen and oxygen, there is no phosphorus in the air, so all the phosphorus in a lake is coming into the lake from the surrounding land. We'll be talking a little later on about how phosphorus makes its way into lakes so let's focus now on the effects of phosphorus on a lake. One of the main things phosphorus promotes is the growth of algae, so more phosphorus means more algae. Also, a slow and steady influx of phosphorus leads to slow and steady algal growth whilst a large sudden influx of phosphorus leads to sudden algal blooms. Like phosphorus, algae isn't a bad thing – it's the base of a healthy lake food web and many animals feed on it. But, like phosphorus, too much at once can cause problems. When you get a big bloom of algae, it grows while it has access to nutrients then dies off once it has used up those nutrients. When it dies, it sinks to the bottom of the lake and rots, using up oxygen down there and even causing more nutrients to be released, causing more algal blooms and so on! Additionally, towards the end of the summer, the pesky but harmless green algal blooms can be replaced by toxic blue-green algal blooms, which can have very damaging effects on the animals in the lake and humans and pets going in the lake. Like DOC, phosphorus is usually fairly consistent between the top and the bottom but you can sometimes see a spike at the bottom of the lake if large amounts of phosphorus are being released from decaying matter. Although there are really no hard and fast rules about what a 'good' amount of phosphorus is, you will generally hear that a range of around 5-15ug/L is normal. Within this range, you generally have enough phosphorus for plants and algae to grow and feed the ecosystem but not so much that you are getting algal blooms. With the exception of spikes at the bottom of a couple of the lakes, the phosphorus for the Kawartha lakes is well within a 'healthy' range.
8	This graph shows chlorophyll-a concentrations. This is a pretty direct measure of how much algae is in the lake; chlorophyll-a is the compound algae uses to photosynthesis and produce food so the more chlorophyll-a we see, the more algae there is. As with phosphorus, there really is no hard and fast rule about 'good' amounts but the 3-10ug/L range generally means a healthy, low productive lake and no algal blooms.
9	Here we have a graph showing the relationship between nitrogen and DOC – as you can see, there is a very consistent relationship between the two. We would expect to see this because the two elements exist in a complex together (think hydrogen and oxygen existing as a complex in H_20). The main reason for showing this graph is to highlight the consistency in this relationship between lakes in the Provincial park and outside of it.
10	This graph is looking at the relationship between phosphorus and chlorophyll-a. As we have discussed, there is a close relationship between the amount of phosphorus

	and the amount of algae but the really interesting part of this graph is the apparent split between lakes within the provincial park and lakes outside of it. This really highlights the reasons why the ongoing collection of data is so important – it allows us to spot trends like this and start to think about what might be causing them. It's fairly early days for us in investigating this trend so we don't have any answers for you but there are several avenues we're looking at including land use in and around the lakes (cottages, agriculture, etc)
11	So, what are the take home messages from all this data we've thrown at you? Simply put, the lakes in this region are fairly consistently unproductive (low algal biomass), stratified (they have layers) and are what we would expect to see for lakes in the Kawartha region – usually in water quality testing, no news is good news!
12	Here we have some data collected by the Lake Partner Program showing 5-14 years' worth of phosphorus data collected from Cold Lake, Picard Lake, Mississauga Lake and Catchacoma Lake. This is the kind of long-term dataset that we aim to build for all the lakes we monitor. Again, this is really highlighting the importance of having these long term data sets – someone who just tests Picard lake in 2007 is going to draw very different conclusions from someone who just tests it in 2012 and neither conclusion will be as accurate as the one we can draw from collecting every year!
13	We covered the effects of phosphorus and other nutrients earlier but now we'd like to talk about some of the ways in which these nutrients find their way into the lake. This diagram shows some of the sources of nutrients, with human-introduced sources in red arrows and natural sources in blue arrows. The natural inputs can't really be changed, nor would we want them to be; they form an important part of nutrient cycling in watersheds but for any of us who are concerned about the health of the lake and the impacts we as humans are having, the first thing we can consider is how we can reduce our inputs as humans. Some of the really easy things we can all do are: Avoid or reduce using fertilizers on your lake-side gardens Avoid brushing lawn clippings into the lake Avoid washing pet waste into the lake
14	The big take home message here is that prevention is better than the cure. If we can aim to reduce the amount of phosphorus entering our lakes before it becomes an issue then we will be able to manage its effects much more effectively.
15	So where next? What work are our donors helping us plan? We are aiming to continue building on our long term dataset and increase the number of lakes sampled Use the baseline data to support more targeted seasonal sampling to see how lakes change through the year Use the baseline data to support small targeted experiments to assess lake processes such as primary production (algal growth) and nutrient cycling Sample animals from lakes to build up a bigger picture of the food webs

	Standardize and improve sampling and data storage to assist future studies.
16	A massive thank you to the donors who have made and continue to make this work possible. And to the students and volunteers who come out and assist with the sampling.
17	Any questions?