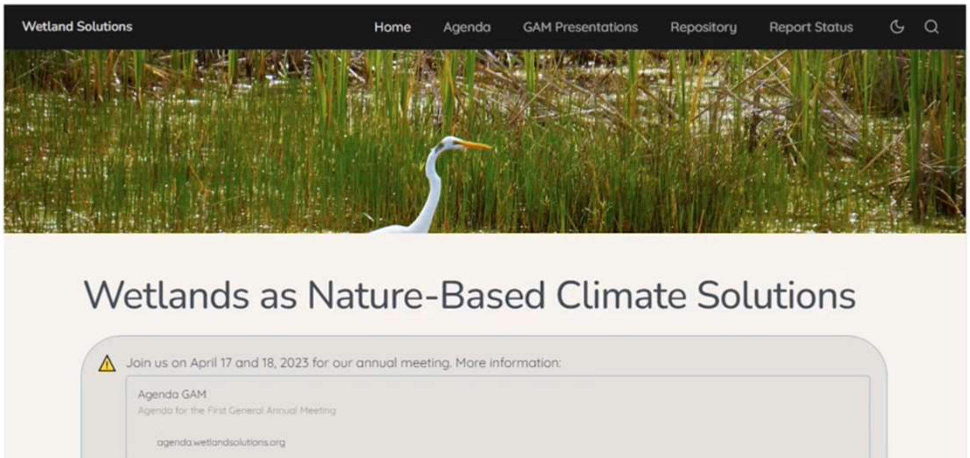
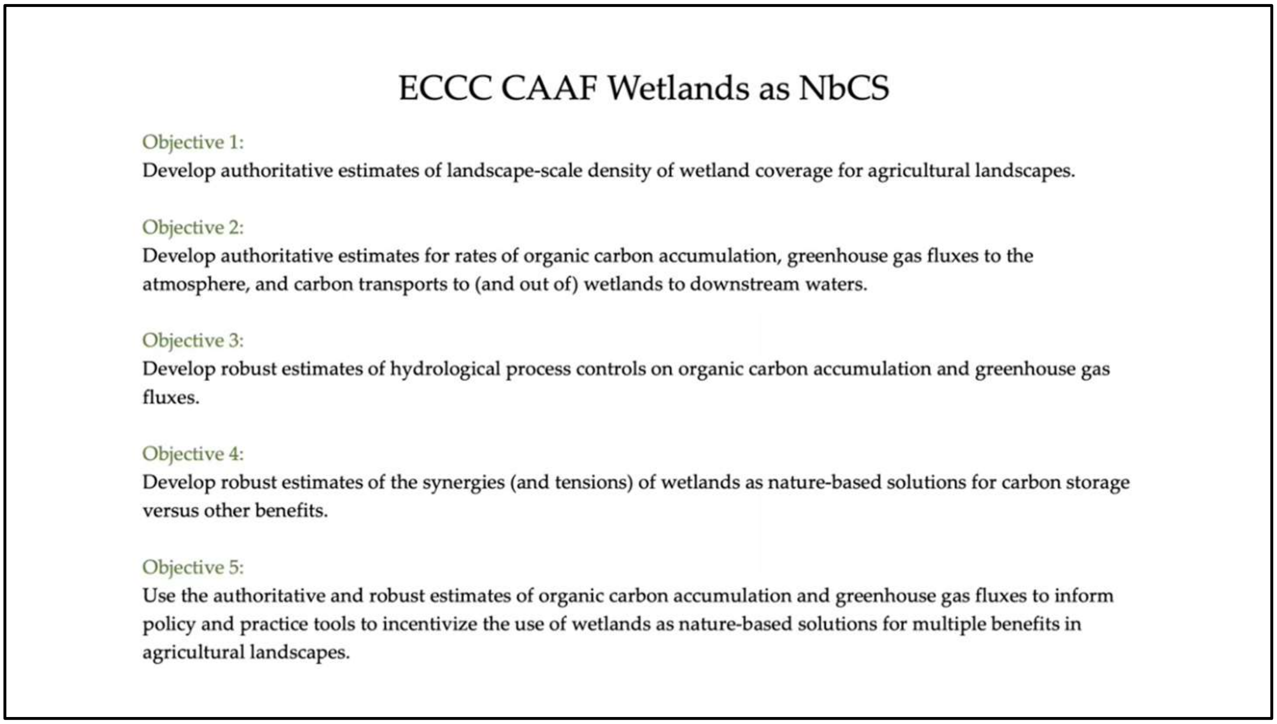
Irena Creed: I wanted to also acknowledge that we have a 20-person co-applicant team and all the not everyone's here today. You'll me recognize some of them members here. And I also want to acknowledge that we have a remarkable group of technicians, postdocs and graduate students. And hopefully once they've all landed, we'll be able to share that group as well. And furthermore, we've had Pascal, I think over 20 communities, not for profit groups, conservation groups, who had signed up to support this project as well. So, this is a mammoth project. I don't mind sharing with you that Marjorie Shepherd, who is the person overseeing all of these EEE TRIPLE C's projects indicated that this perhaps was one of the most what was the most complicated one. But I take that as a challenge that we really believe that this project we wanted to deliver something that was directly going to be taken up by government. We worked very closely with many government people in the development of the proposal. And many of them continue to be influencing it. So I'm just going to kind of want to go through these slides. Let me just get on to the right monitor.

wetlandsolutions.org



Okay, so Diego, who's our project manager, has already started to come up with a website. This is going to be our primary portal for engaging advisory co-applicants, collaborators, partners, and any updates and data and papers that are of relevance will be here. So it's still nascent, but write down wetlandsolutions.org. And you can see how the project will evolve. We may be tapping your shoulder to get bios or better photos from you. But this is going to be the destination of it.



Now, the advisors don't really know much about the frame of this proposal. They agreed almost on faith to participate. And so it did take quite a few months, almost a year to was it about a year Pascal, at least six months between submitting it and finding out that we were successful. There are five key objectives. And I'm going to go through each one of them in turn. The way that I'm going to present the highlights are by objective. So we don't have to read them here. We're going to see them throughout.

Objective 1:
Authoritative estimates of wetland coverage

PIs:

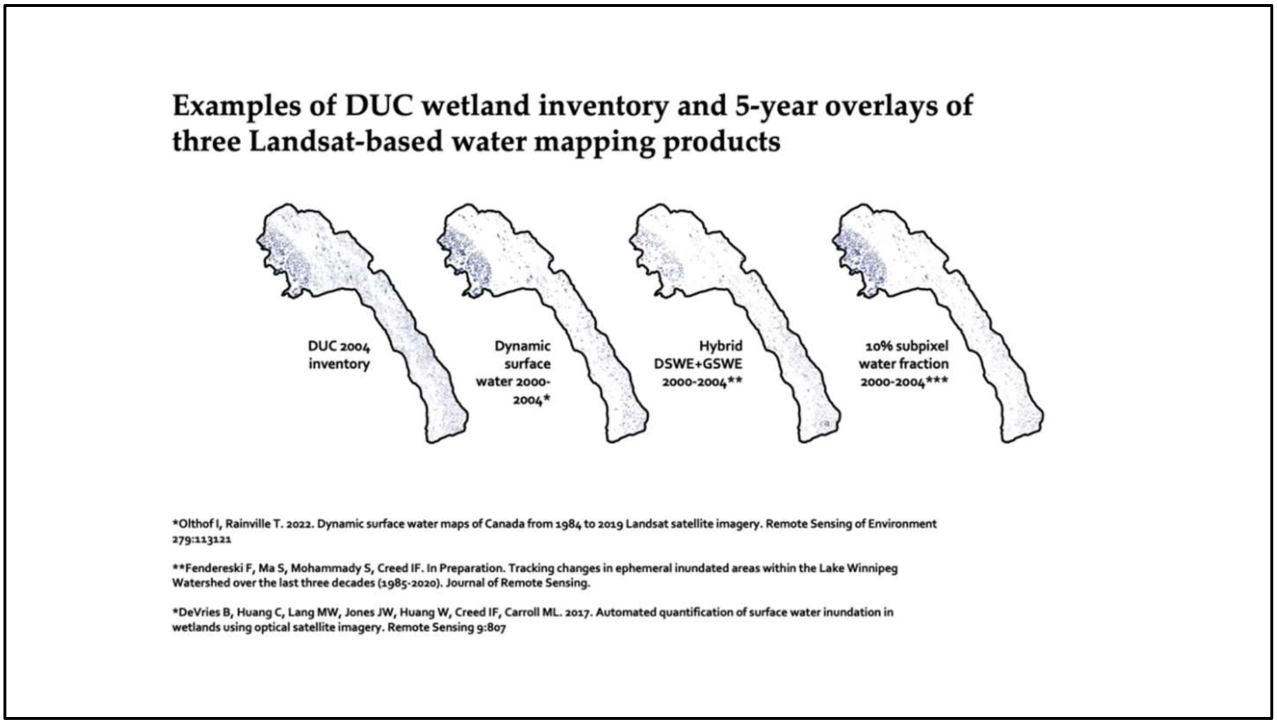
Irena Creed University of Toronto | **Ben DeVries** University of Guelph | **Genevieve Ali** McGill University

So the first objective is to develop authoritative estimates of wetland coverage. It may be quite surprising to both our European and American advisors that Canada has yet to have an authoritative wetland coverage. And we've been working a lot with many people in the government to basically come up with what would be the definitive wetland coverage that would be used in the national inventory. So we've been open to critique and engagement with a number of government scientists. I think David Aldred, we've already had maybe about 10 meetings trying to develop what will be the authoritative estimate of wetland coverage that will be used in the national inventory.

TASKS:

1. Compile wetland coverage databases in the agricultural landscapes of Canada
2. Develop annual standardized wetland coverage databases (1984-present) in the Canadian Prairie Pothole Region (over 520,000 km^2)
3. Develop estimates of wetland loss/gain associated with climate change and human modification
4. Share and demonstrate wetland coverage databases to government, non-government organizations, farmers

We had four key tasks which were to compile wetland coverage databases across the agricultural landscapes of Canada to develop a standardized version. We originally put 1984 to present. But Ben DeVries' on the call shared with us that there might be a possibility to extend it even further back to 1970. And since the national inventory uses 1970 as a benchmark year, we'll be exploring how to do that. We'll also be developing estimates of wetland loss and gain associated both with climate change and human modification. And then we're going to be sharing this database. One of the things we repeatedly get asked when we talk to our government partners is who's going to have access to this data. One of the things and Roland Kroebel was the one who really when I we started this journey with a meeting with Roland and Roland wanted to create a wetland information network and he wanted to have an open science open data repository where we could share data. I just want Roland to realize that this is still a major part of this grant and all the data and protocols and models, results. We want to be able to share them both with government non-government organizations and farmers.



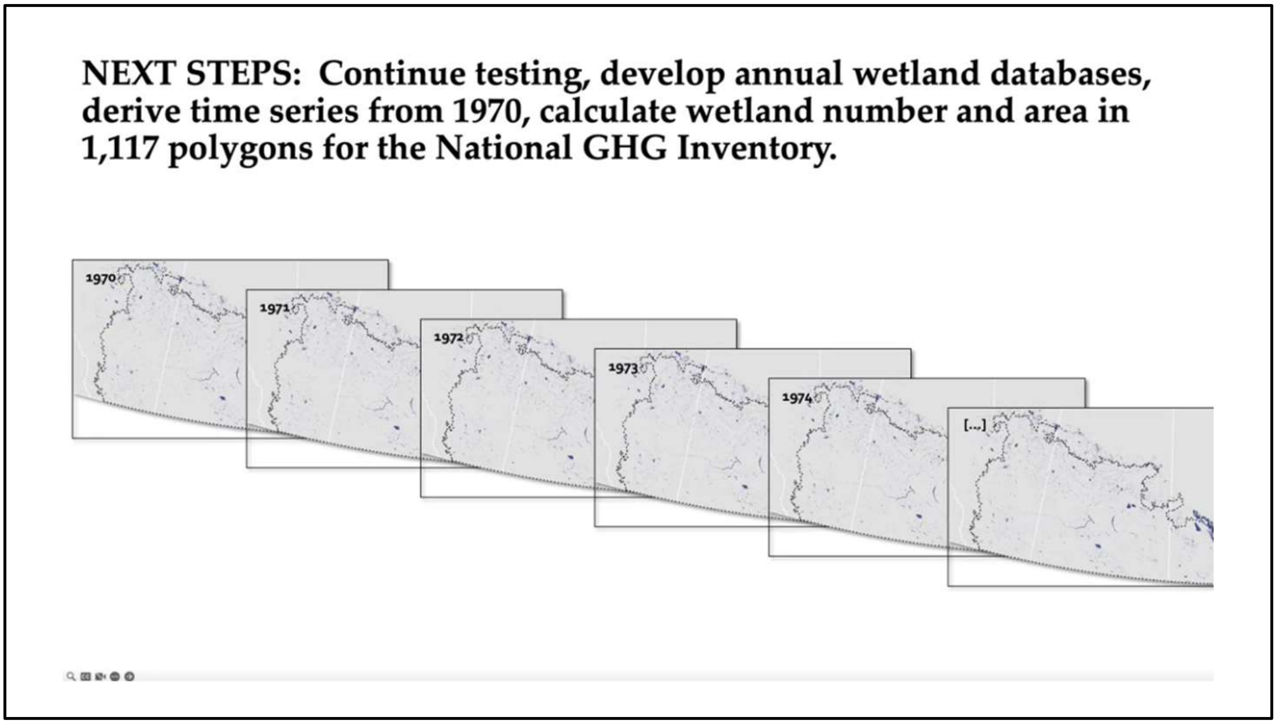
So some progress on how we are doing on making this wetland inventory. Within government circles the Ducks Unlimited Dataset which is ground surveyed is considered the gold standard. It has become our benchmark to compare all of our satellite-based estimates. There are three that we've learned of. One's called Dynamic Surface Water Extend. This is developed by another group in the federal government that we just learned about recently. My own group has been working on a hybrid model of D-SWS and the global Surface Water Extend model that's developed from Europe. Then Ben DeVries and I worked on a paper about looking at sub-pixel water fractions and the prairies and we're going to show you basically as you go from left to right it becomes more and more sophisticated in the satellite approaches by the Ducks Unlimited again considered the standard.

Landsat-based water mapping product	Kappa rank	Num diff rank	Area diff rank
Subpixel water fraction ≥5% 1-yr	29	42	40
Subpixel water fraction ≥5% 2-yr overlay	25	32	24
Subpixel water fraction ≥5% 3-yr overlay	15	29	20
Subpixel water fraction ≥5% 5-yr overlay	14	16	13
Subpixel water fraction ≥5% 7-yr overlay	24	18	26
Subpixel water fraction ≥5% 10-yr overlay	19	1 (1.30%)	42
Subpixel water fraction ≥10% 1-yr	26	8	19
Subpixel water fraction ≥10% 2-yr overlay	13	41	39
Subpixel water fraction ≥10% 3-yr overlay	10	40	38
Subpixel water fraction ≥10% 5-yr overlay	3 (0.531)	24	16
Subpixel water fraction ≥10% 7-yr overlay	2 (0.538)	31	25
Subpixel water fraction ≥10% 10-yr overlay	1 (0.551)	15	37
Subpixel water fraction ≥15% 1-yr	27	21	6
Subpixel water fraction ≥15% 2-yr overlay	17	25	15
Subpixel water fraction ≥15% 3-yr overlay	12	9	10
Subpixel water fraction ≥15% 5-yr overlay	7	13	12
Subpixel water fraction ≥15% 7-yr overlay	6	39	35
Subpixel water fraction ≥15% 10-yr overlay	4	20	31
Subpixel water fraction ≥20% 1-yr	34	10	14
Subpixel water fraction ≥20% 2-yr overlay	31	7	4
Subpixel water fraction ≥20% 3-yr overlay	22	27	22
Subpixel water fraction ≥20% 5-yr overlay	8	17	11
Subpixel water fraction ≥20% 7-yr overlay	9	22	18
Subpixel water fraction ≥20% 10-yr overlay	5	35	36
Subpixel water fraction ≥25% 1-yr	37	3 (2.04%)	3 (0.97%)
Subpixel water fraction ≥25% 2-yr overlay	35	5	1 (0.31%)
Subpixel water fraction ≥25% 3-yr overlay	33	11	9
Subpixel water fraction ≥25% 5-yr overlay	23	14	7
Subpixel water fraction ≥25% 7-yr overlay	18	4	2 (0.57%)
Subpixel water fraction ≥25% 10-yr overlay	11	23	27
Hybrid DSWE+GSWE 1-yr	42	6	23
Hybrid DSWE+GSWE 2-yr overlay	40	2 (1.81%)	5
Hybrid DSWE+GSWE 2-yr overlay	41	12	21
Hybrid DSWE+GSWE 5-yr overlay	39	28	28
Hybrid DSWE+GSWE 7-yr overlay	38	33	32
Hybrid DSWE+GSWE 10-yr overlay	32	34	30
Dynamic surface water 1-yr	36	26	17
Dynamic surface water 2-yr overlay	30	37	34
Dynamic surface water 3-yr overlay	28	19	8
Dynamic surface water 5-yr overlay	20	30	29
Dynamic surface water 7-yr overlay	21	36	33
Dynamic surface water 10-yr overlay	16	38	41

Subpixel water fraction maps generally provide the highest spatial accuracy and the nearest wetland area-to-frequency power law distributions to DUC wetland inventories

Most accurate — Least accurate

So what we're finding perhaps not surprisingly is that that sub-pixel water fraction does provide the highest spatial accuracy and the nearest wetland to aerial frequency power law distribution. What that means is we're getting the right number in the right area and generally the right spatial coincidence. This is still early work. This is based on analysis of one of the 12 Ducks Unlimited Watersheds that they've given us access to so that we could do this analysis but so far it looks like that sub-pixel water fraction map is the best and importantly Ben is creating program to put it on the iCloud so everybody could get access to this and make it as easy as possible.



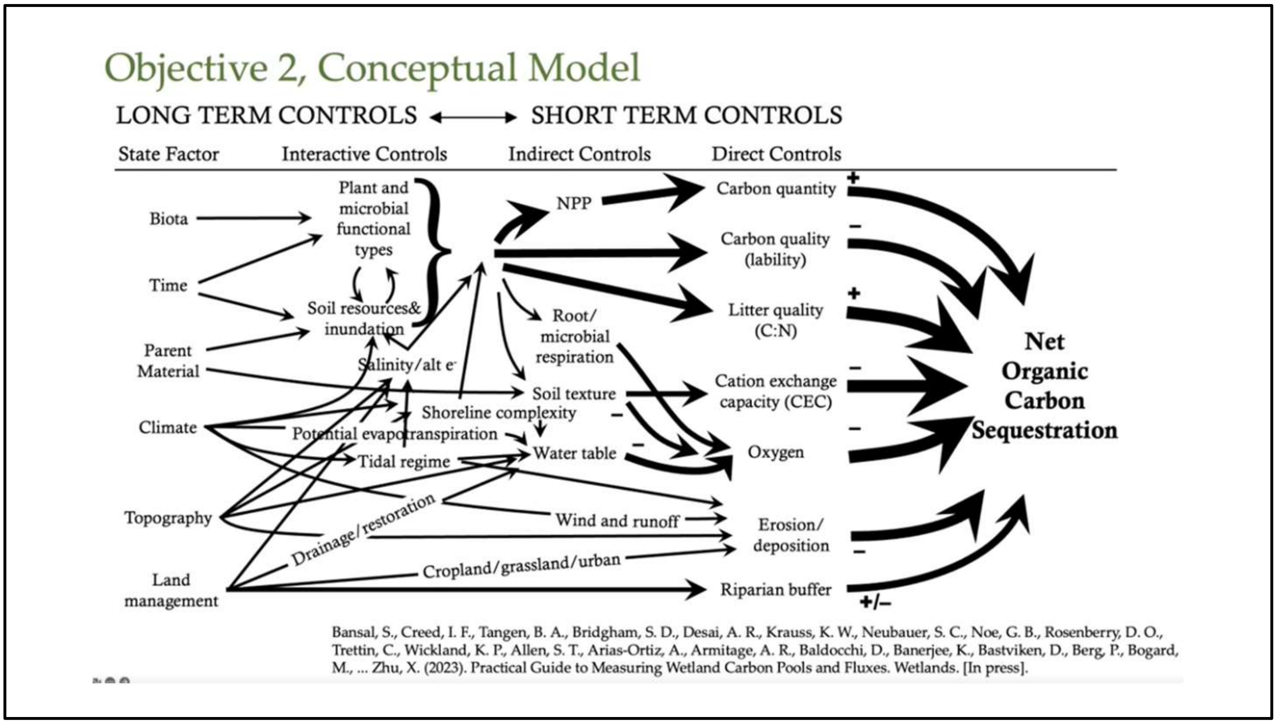
So again our next step is to come up with a full-time series of this and Ben DeVries will all this is an annual time series and again our ambition is to be able to project it back. We're using MSS Landsat versus the thematic map per series to 1970. It will be better than what the government currently has which is effectively like throwing a dart at a board and doing and squinting your eyes and estimating it. So, we are quite excited by Ben's idea of that we may be able to constrain those high-casting estimates using satellite imagery. The other thing that Ben is doing is going to be providing for some areas not for the wall-to-wall coverage time series within each year so we'll be able to get an indication of the dynamics of within year variability of the wetland extent.

Objective 2:
Critical review of process controls on GHG fluxes

PIs:

Irena Creed
University of Toronto

So here's objective two now which is really about understanding providing authoritative estimates on greenhouse gas fluxes and sequestration. This was the invitation I gave yesterday so I just wanted to put it there at critical review of process controls on greenhouse gases.



Very proud of the work that some of the PhD students that I have the privilege of working on and I came together to develop a first iteration of this conceptual model. If you if any of you have the bulk threshold ecosystem ecology led by Stuart Chapin you'll recognize this format which really looks at things like state factors and direct controls or what we call distal versus proximal controls on net organic carbon sequestration. We have included this and it has been vetted by an amazing group of wetland scientists and Sheel Bansal is leading a major a mammoth publication that will go into wetlands called practical guide to measuring wetland carbon pools and fluxes. And at this point we want to write the paper that is a critical review of all of the process controls that supports this figure. And further I'd like to be able to do one on the greenhouse gas fluxes including methane, CO2 and nitrous oxide and that's the invitation if other if anybody wants to participate in these critical reviews just to let me know.

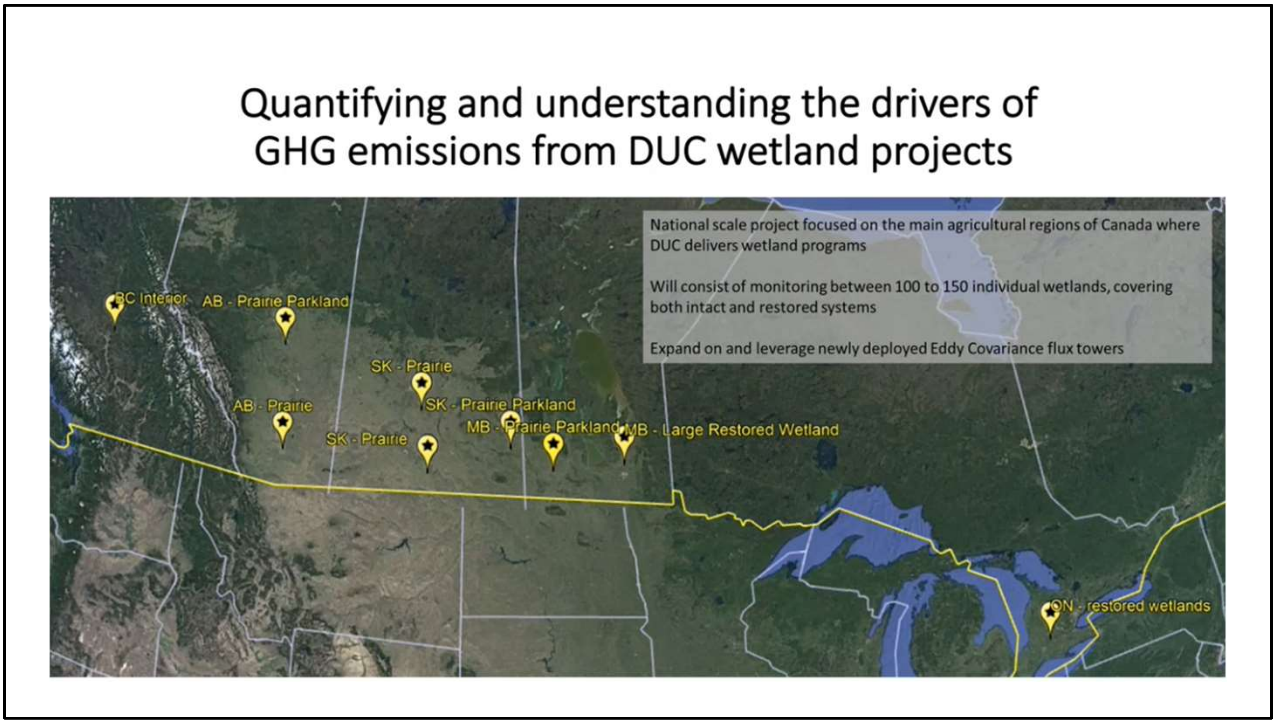
Objective 2:

Authoritative estimates for rates of organic carbon accumulation, greenhouse gas fluxes to the atmosphere, and carbon transports to (and out of) wetlands

PIs:

Pascal Badiou	**Matthew Bogard**	**Gail Chmura**	**Larry Flanaga**	**Sara Knox**	**David Lobb**
Ducks Unlimited Canada	Lethbridge University	McGill University	Lethbridge University	University of British Columbia	University of Manitoba

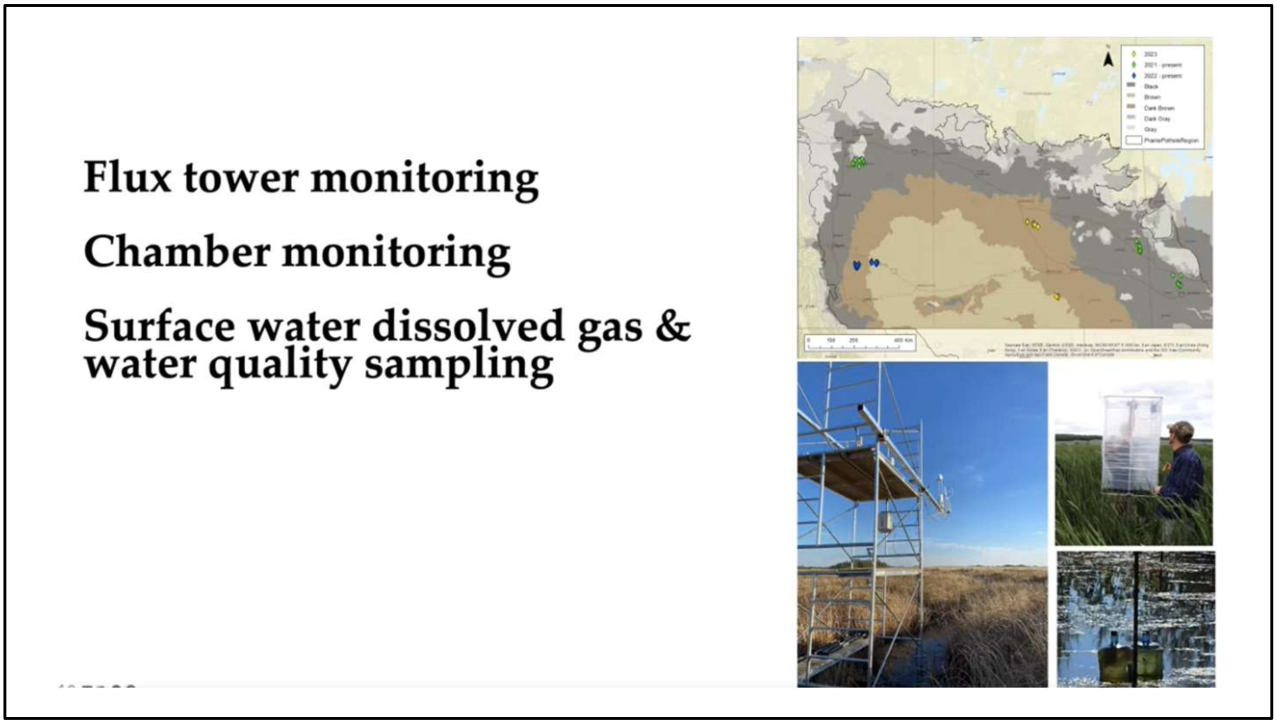
For objective two really the hard work is being done by this team and if I've left anyone out please let me know. But we have from Sara working in BC, through Larry and Matt working in the Prairies, Pascal also working in the Prairies and Gail is working in the and I think I'm missing Christian here by Gail and Christian are working in Ontario and Quebec and David Lobb is an extraordinary you know paleo scientist who uses isotopes to date cores and do estimates of carbon and he's opened up his lab opportunity to be able to date cores at any of these sites and that's something that came up yesterday that we're really excited about.



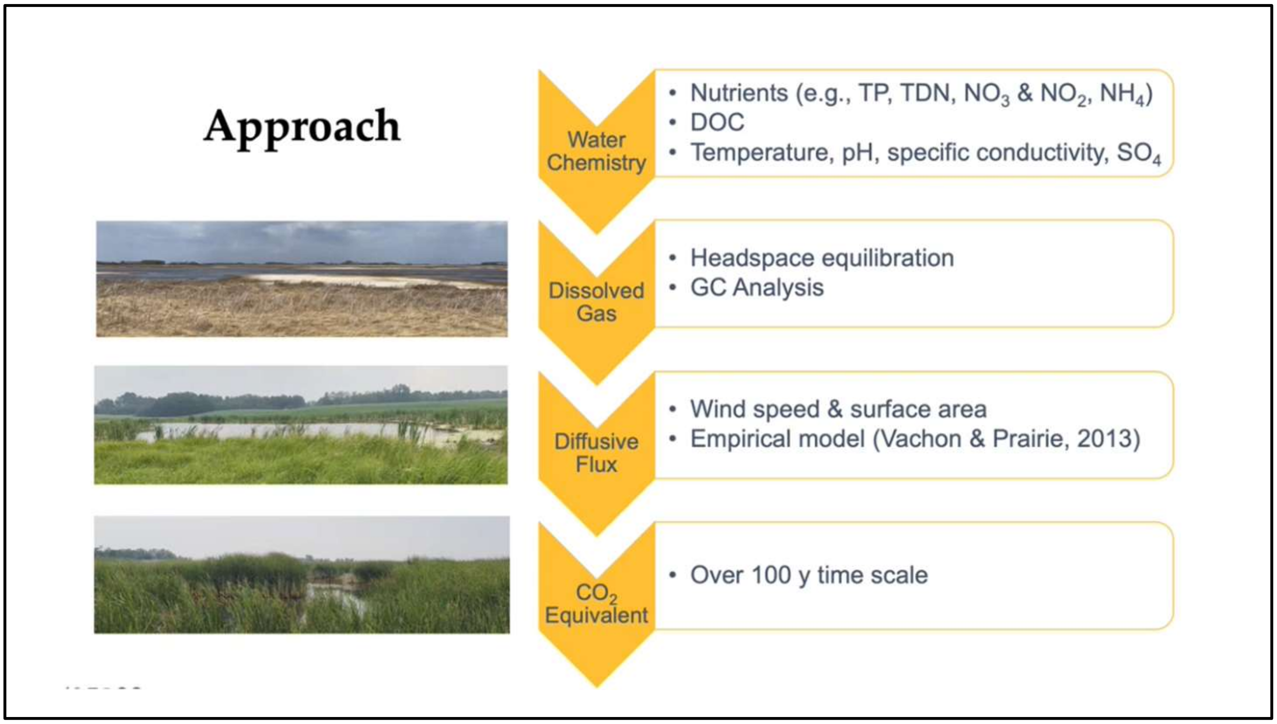
But I just want to show you some of the distribution of sites and again I'm not sure Pascal if I've the BC interior included the one that Sarah was working on. We have Prairie Parkland and then Prairie in the further south. Saskatchewan sites, Manitoba sites and Ontario sites. Pascal, we need to update this map to include some of the sites that we are also working on in Quebec.

Pascal: I can just speak quickly here so that map does not include potential flex to our site that Sara Knox would be working on in BC, and Gail Chmura from McGill is actually working on freshwater impoundments in Atlantic Canada. So, this this map is more focused on some of the DUC specific project sites where we're actually collecting data but some of our collaborators were working it in areas outside of the ones listed on this map. So, I think it truly is a national coast to coast project.

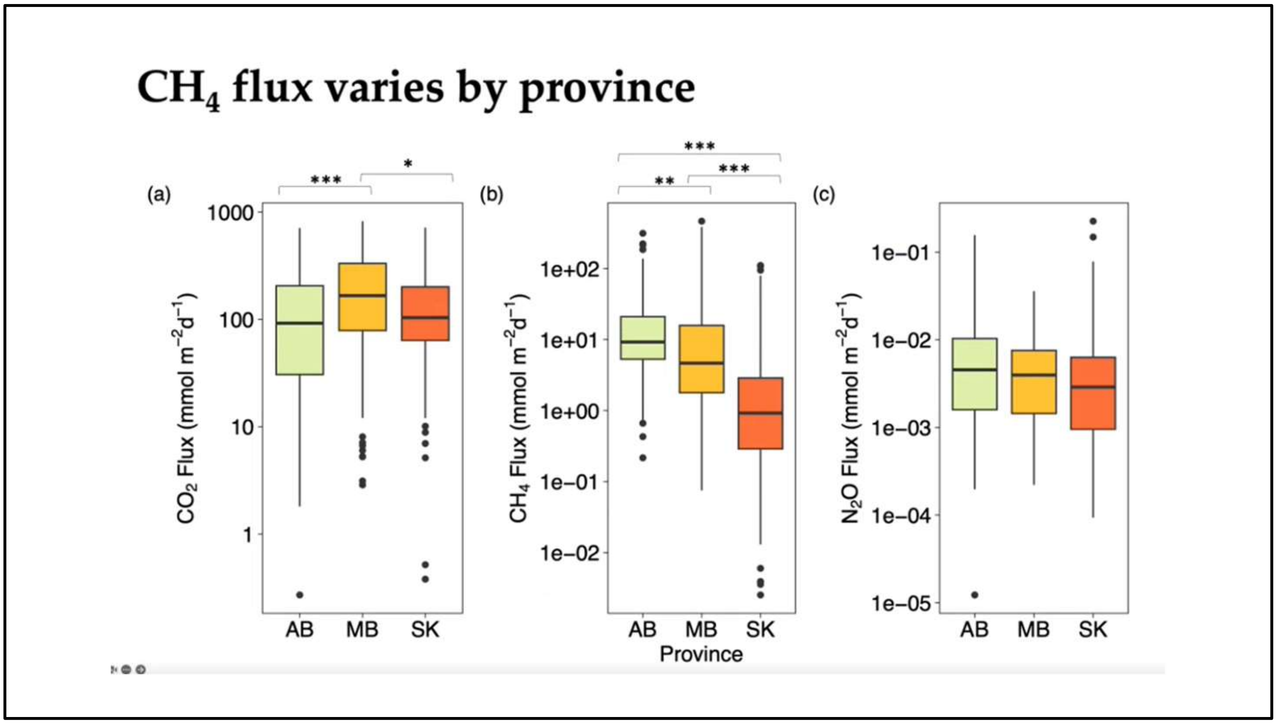
Irena: And I'm just going to focus a little bit on some of the presentation yesterday and I've kind of generalized this a little bit but we're really asking about what are the greenhouse gas fluxes from the wetlands, what are the drivers of wetland greenhouse gas cycling and does land use land cover impact these fluxes and so.



As you can see there's a combination of flux tower monitoring chamber monitoring surface water dissolved gas and water quality sampling.

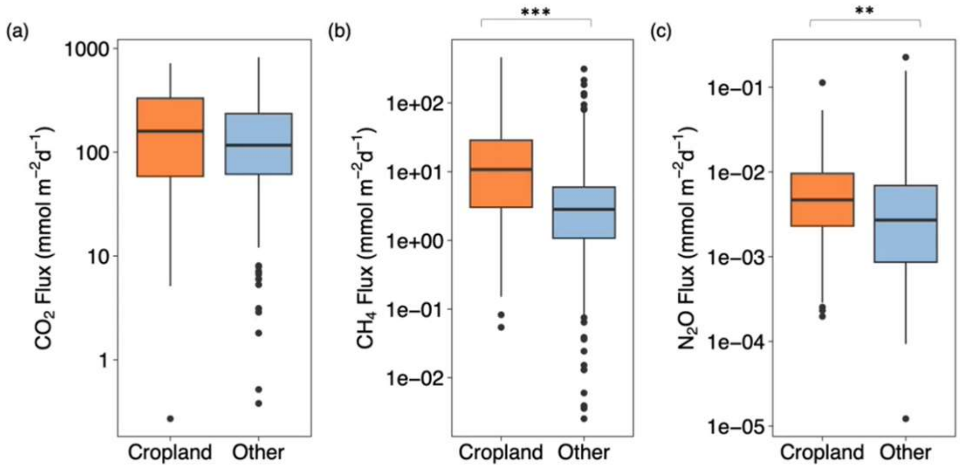


This is an incredible like I don't know when this work started I suspect it started before we got funded but an incredible body of work and it really looks at the nutrients the DOC temperature and you know physical chemical controls also on the dissolved gas and also then on the diffusive flux to basically come up with the CO2 equivalents of what these wetlands are contributing to greenhouse gases.



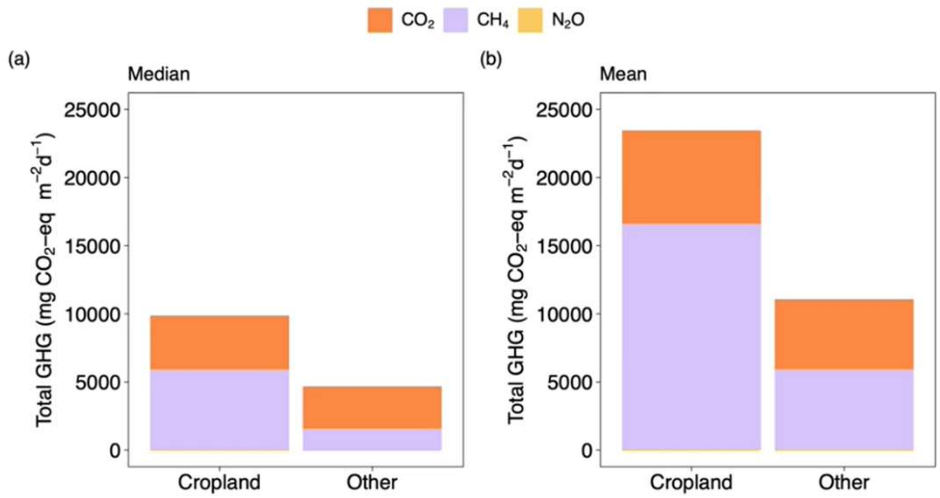
And one of the things that I found really interesting is how the methane flux varies by province and so on the left you'll see Alberta, Manitoba, Saskatchewan, and you'll see it with the CO2 flux and the middle is the methane flux and on the right is the nitrous oxide flux and while the wise scales vary you will see the take home message here is that there are fundamental differences in the methane flux according to province and I'm reminded of some of the work that Tim Moore did when he did across country analysis of organic carbon in soils and wondering you know some of what other properties might be influencing it.

Higher CH_4 fluxes in cropland wetlands than grassland/pasture



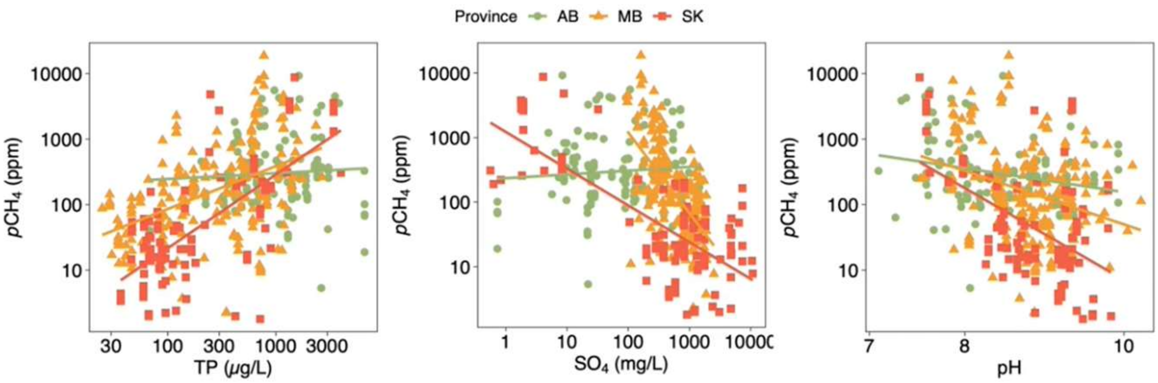
So Laura and Matt and potentially others you know summarized they also looked at the cropland versus other things like grassland and they found that the higher methane fluxes were found in cropland wetlands compared to the grassland pasture which is again very important and

Higher <u>methane</u> flux in croplands <u>doubles</u> the global warming potential

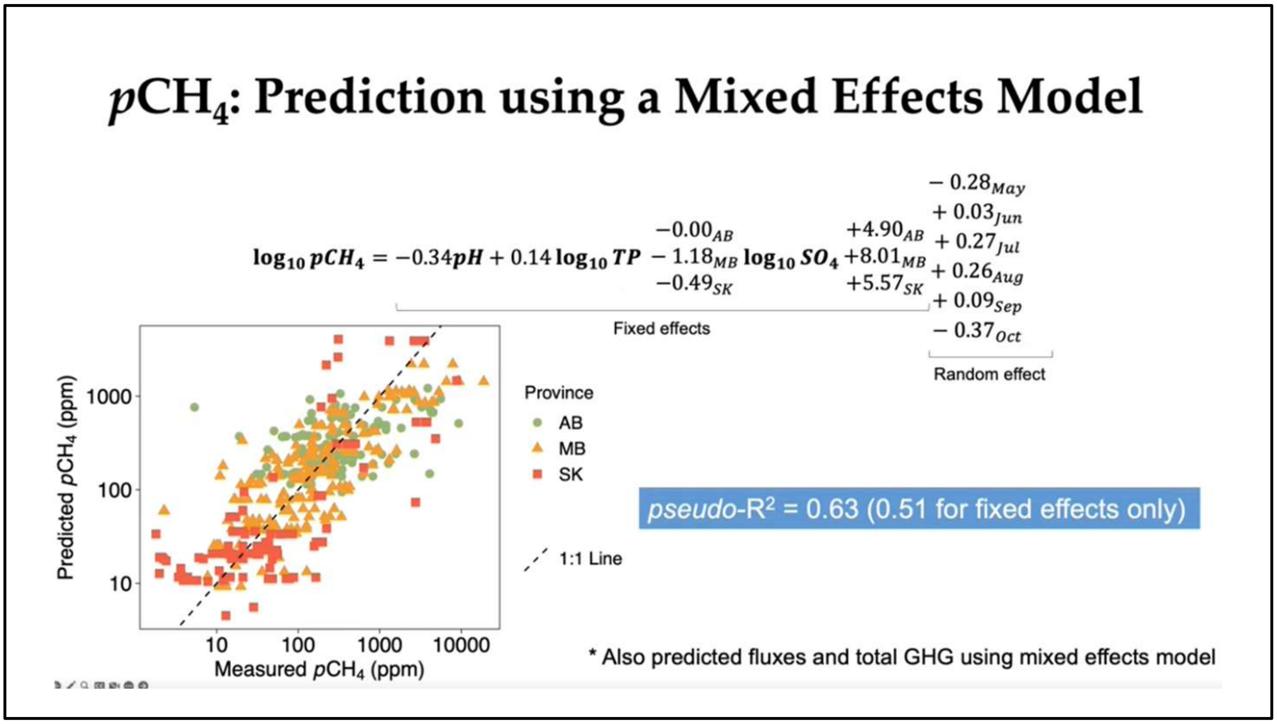


it matters because the higher methane flux in the croplands almost doubles the global warming potential and so it's really important to understand what would be controlling these methane fluxes particularly in the human managed landscapes which are the croplands.

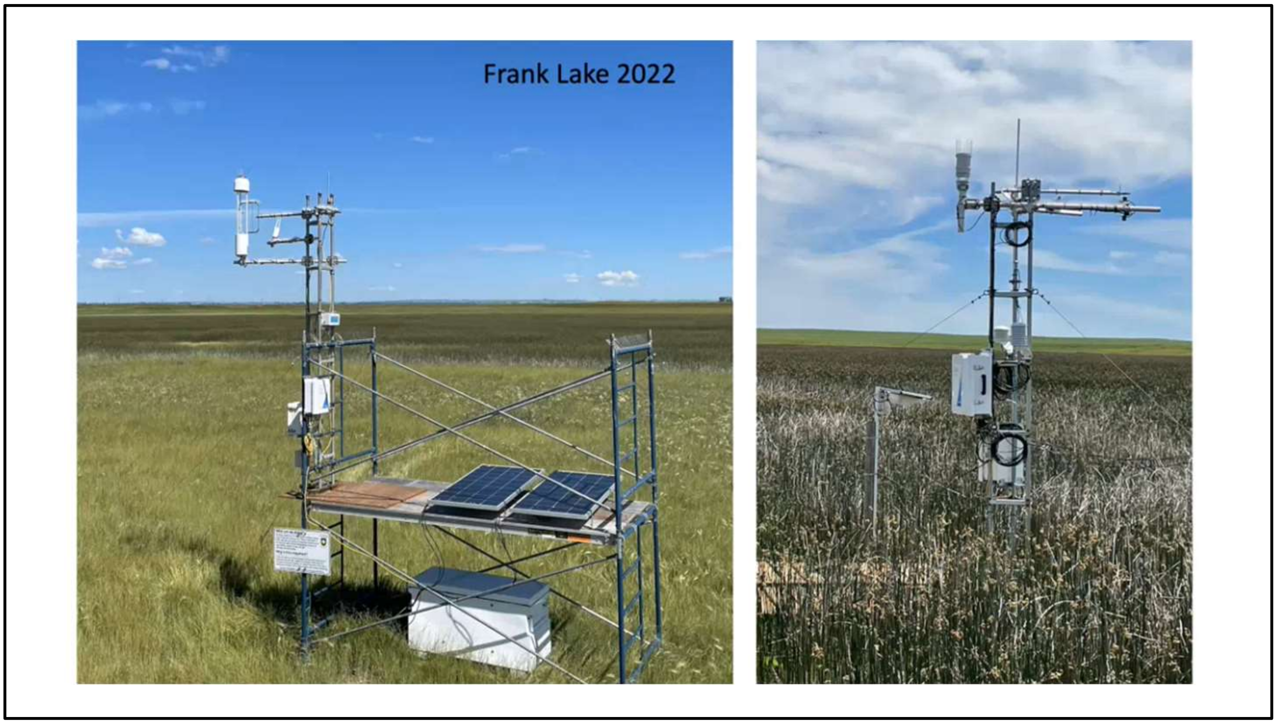
pCH_4 vs. TP, SO_4, and pH differ by province



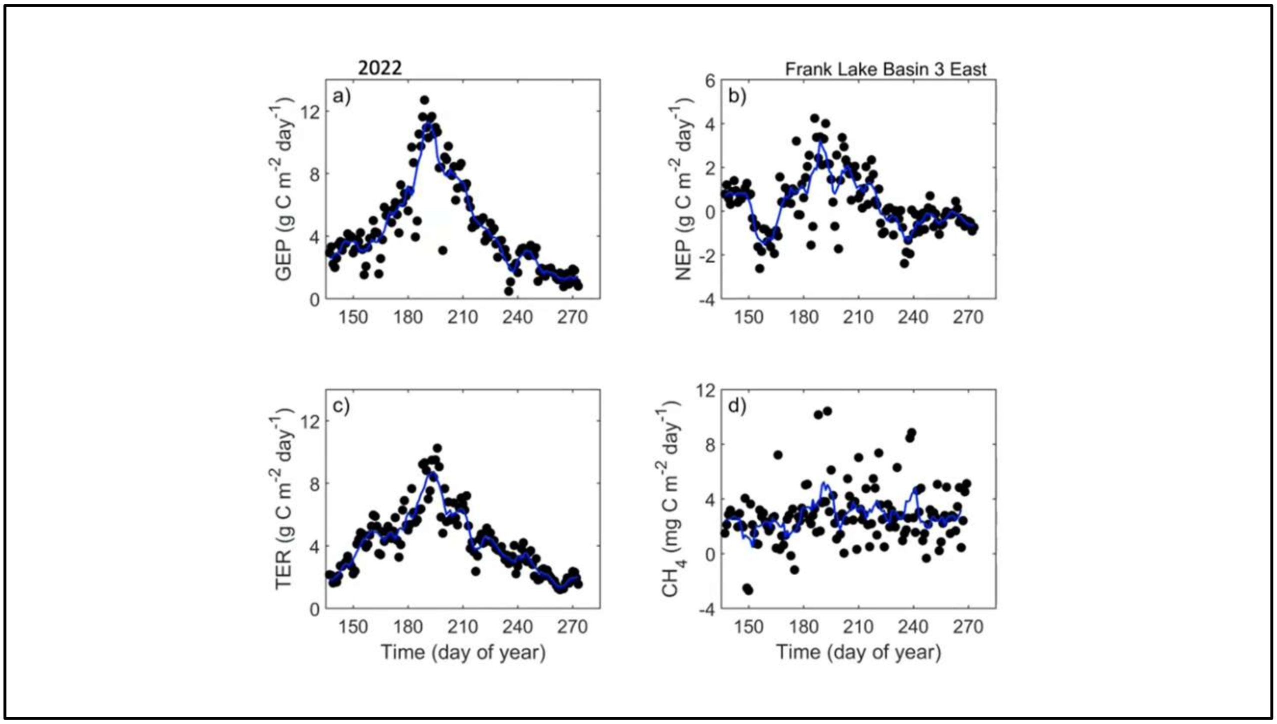
And so they've run a number of models where they looked at total phosphorus sulfate and pH and the really interesting finding here I'm one might look at this and feel sad because they can't predict things but the relationships vary so much depending upon which province you're in and so you can see more convergence with the TPN methane but you can see in some cases like sulfate that there's you know almost different directions in in terms of the correlation lines. Now of course we want to be able to add to this with BC, Ontario, potentially Quebec, and the Maritimes and we are also working on standardizing protocols so that we can ensure inter comparability of data amongst the sites,



The final slide that I wanted to show from Laura's work is being able to predict this and so they looked at a mixed effects model this one is just for methane and looked at the relationship of TPN sulfate and a random factor and basically we're able to come up with reasonable R-squared estimates explaining over 60% which is our indicator that you know maybe this might be useful for applications and so really excited that she was able to do that work so thank you Laura.



The next one I wanted to share with you is work that Larry Flanagan's working on and again here's the flux towers here for one of the lakes



With these flux towers we're able to look at the GEP and TER and this is examples for one year in Frank lake and

Frank Lake Basin 3 East Wetland (2022)

NEP = GEP - TER

CO_2 Budget (May – September)	(g C m^{-2} $season^{-1}$)
Ecosystem Photosynthesis (GEP)	629
Ecosystem Respiration (TER)	583
Net Ecosystem Productivity (NEP)	46

I just wanted to get the overall carbon budget that we'll be able to do for May to September notice that the net ecosystem productivity is positive at around 46

Frank Lake Basin 3 East Wetland (2022)

NEP = GEP - TER

CO_2 Budget (May – September)	($g\ C\ m^{-2}\ season^{-1}$)
Ecosystem Photosynthesis (GEP)	629
Ecosystem Respiration (TER)	583
Net Ecosystem Productivity (NEP)	46

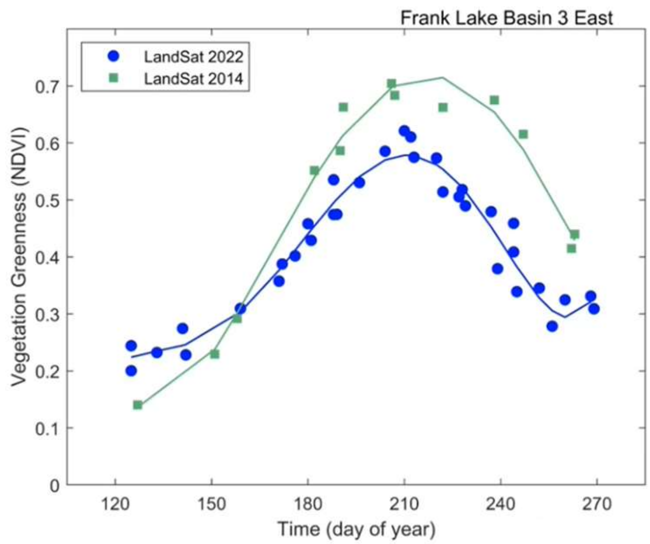
Methane Release slightly offsets CO_2 sequestration

Sustained-Flux Global Warming Potential (100-year)

(1 kg CH_4 = 45 kg CO_2)

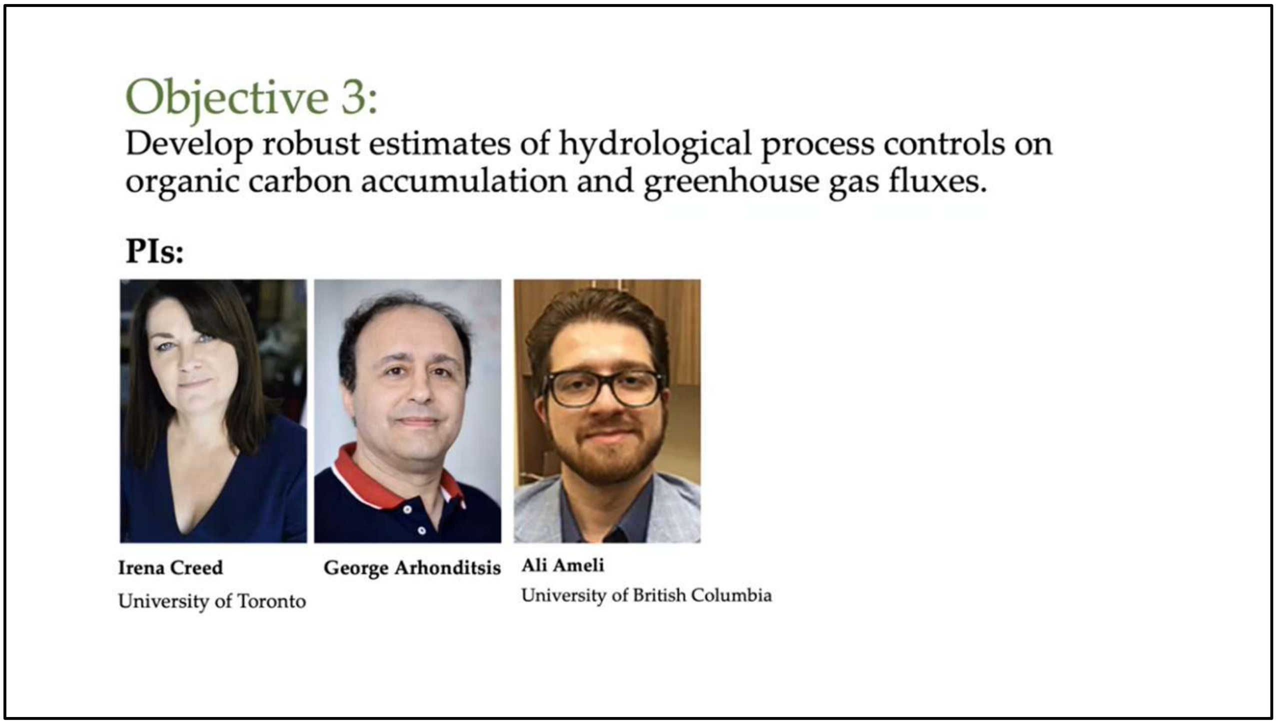
CO_2 and CH_4 NEP = 40 $g\ C\ m^{-2}\ season^{-1}$

And I wasn't sure if I interpreted this right but with this data Larry was saying that the methane release slight slightly offsets the CO2 sequestration and that you know when we look at this from a carbon balance and methane release is more than the CO2 sequestered that's really important and

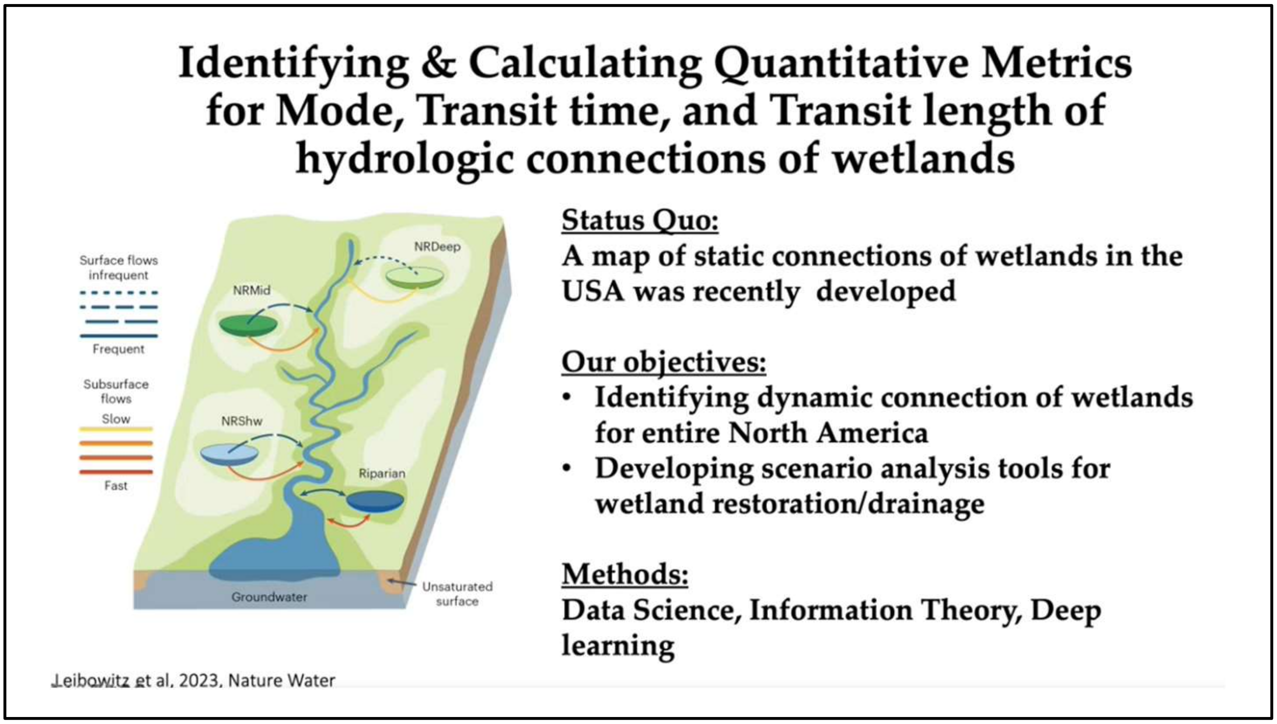


Shortened Growing Season
and reduced LAI in 2022
due to relatively dry conditions

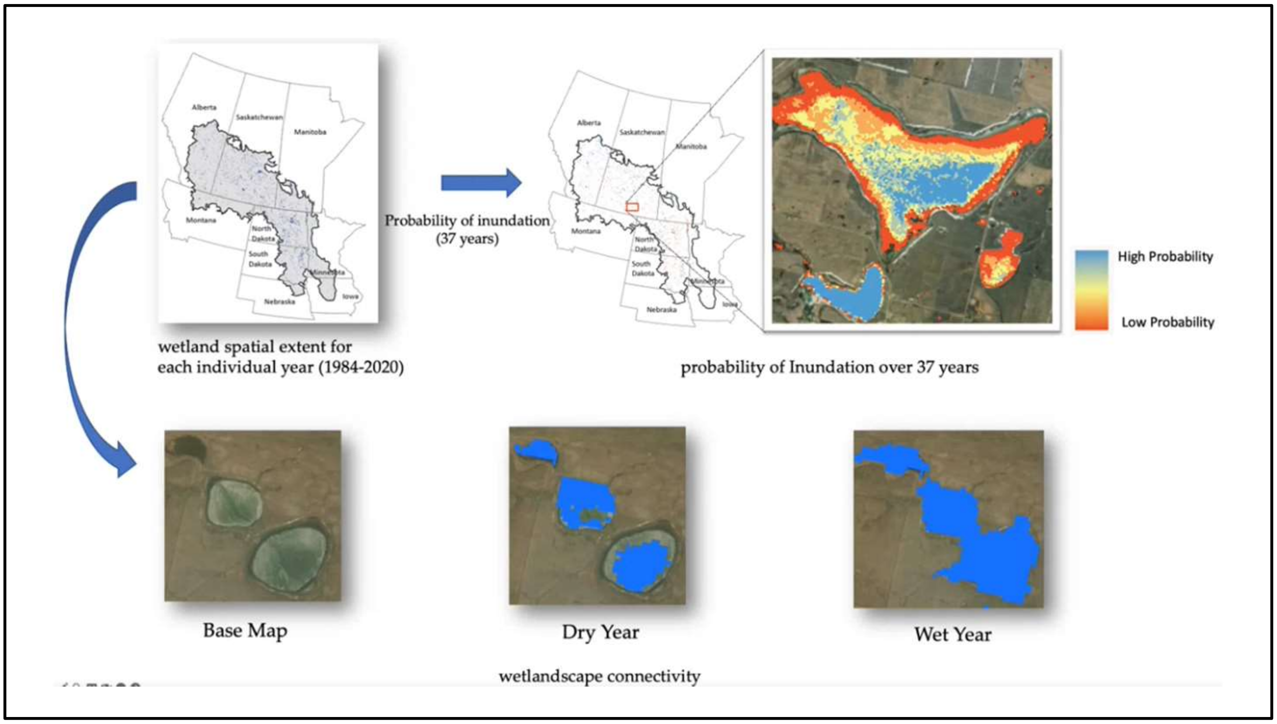
so when we look at the vegetation greenest the NDVI Larry found that the year that this was based on was 2022 that's the blue line on this graph and that blue line showed that it was relatively drought year and when you look at something from a previous year in 2014 it was actually much more greener much more wetter and so when we go back to understanding these balances and the role of methane the climate change climate condition is going to be really important in terms of our assessment of these fluxes.



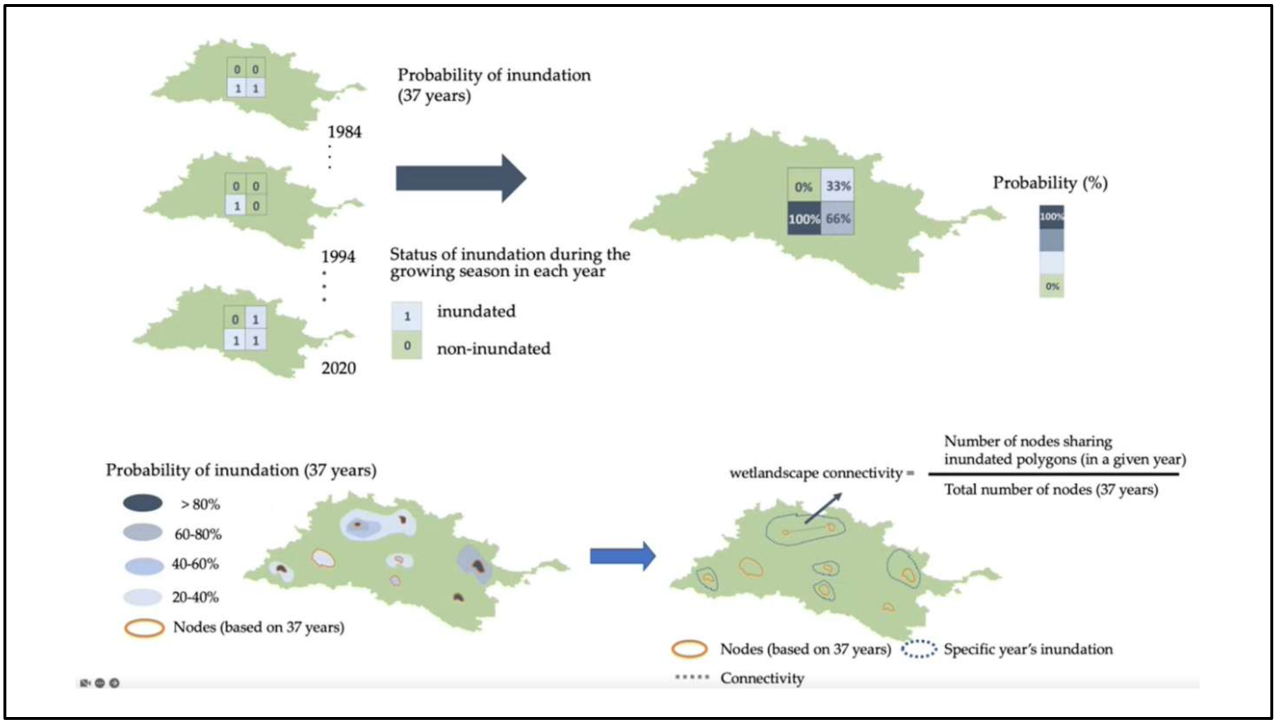
Moving on to objective three this is about developing robust estimates of hydrologic process controls on organic carbon accumulation and greenhouse gases so we really you know one of the thing I remember was from Doug McDonald was the importance and but for those who may not know Doug McDonald is a government research scientist with ECCC was the fact that we always look at this in a vertical sense and we don't really consider the lateral fluxes and so was quite excited that we might be able to predict the movement of DOC upstream downstream with these hydrologic models and…



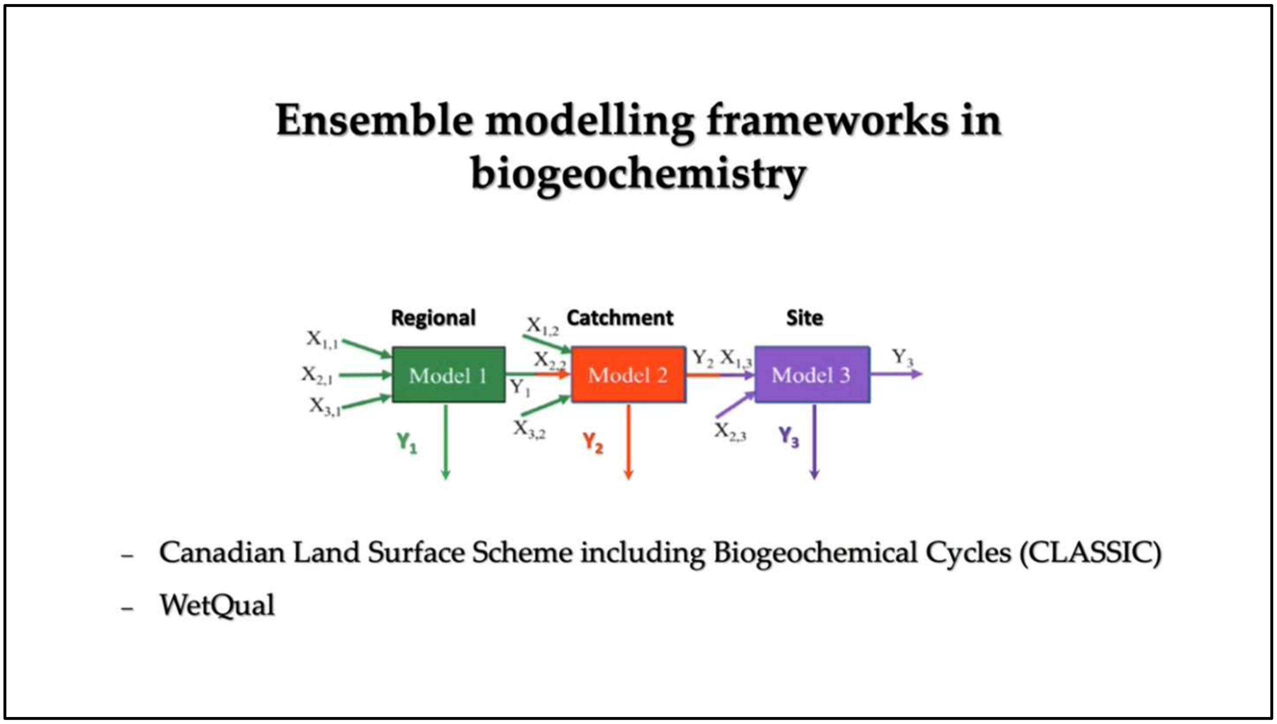
We are approaching it with two different ways one of them is more index based so it's statistical models that are using process oriented indicators and so it's based on the very recently published paper in nature water which was basically looking at hydrologic connectivity of wetlands to downstream waters and being able to predict things like total dissolved solids DOC as well as other parameters and found out that this hydrologic connectivity is really important for some water quality parameters less so for others. Ameli Ali is going to be taking this approach that was just recently published which was based on a static it was like long-term kind of steady state and he's going to make it dynamic which I think is really exciting so the status codes and mop of static connections of wetlands in the USA he wants to make it dynamic connections he also wants to look at scenario analysis for wetland restoration and drainage and using a whole suite of statistical learning techniques including deep learning and so part of the data that I hope will either be used to be input for the dynamics or could be used to validate the models that Ali's coming up with are the remote sensing.



Some of the PhD students who developed the D-suite plus G-suite hybrid model this is some of the results where we're able over a 37 year time period able to look at the probability of an inundation if you look at the top right figure you'll see a wetland the red zone is relatively dry and you can see where it is always inundated in this case and some of the ones below is one chain to one sequence of wetlands on the left is the base map you could see what it looks like in a dry year versus a wet year so clearly these dynamics are going to be really important not only for the movement of carbon upstream downstream but also in terms of transformation of that carbon potentially to CO_2 and methane.



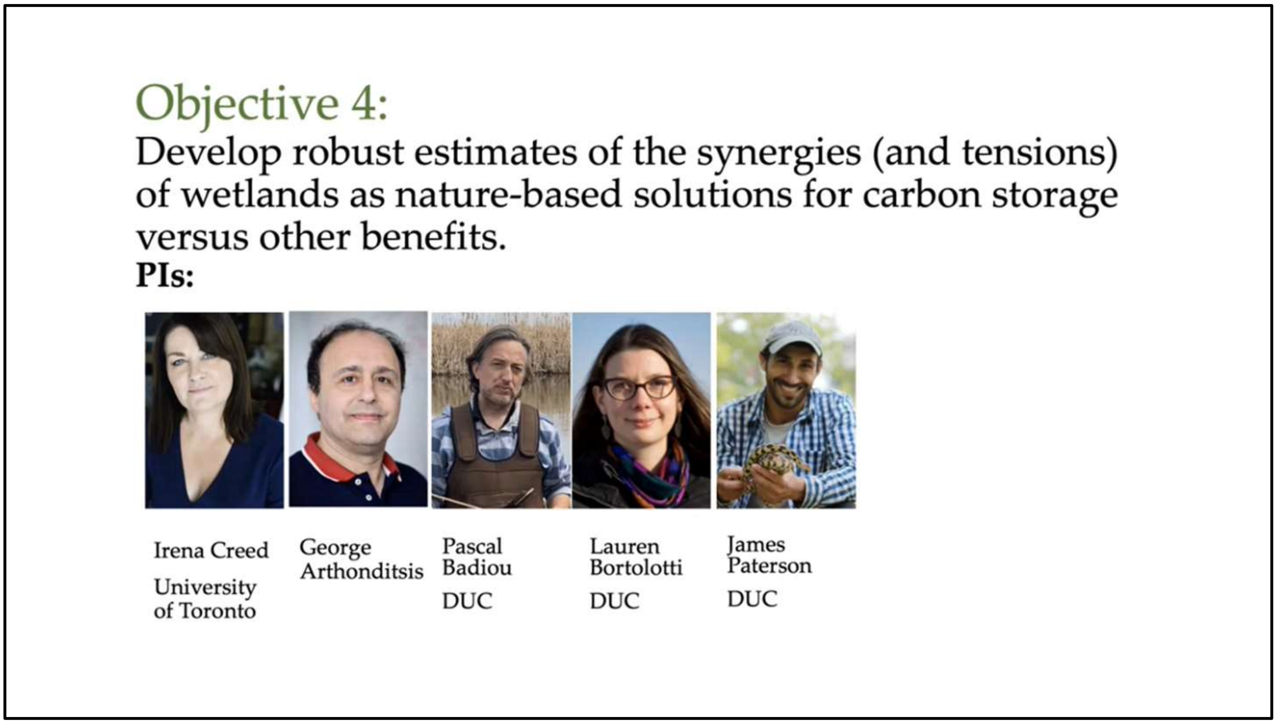
Sassan and Furhough have been doing this kind of work to come up with indicators of the probability of the connectivity and has done this for the entirety of the lake Winnipeg watershed so just wanted to have Ali look at this work and see how it might be integrated into that.



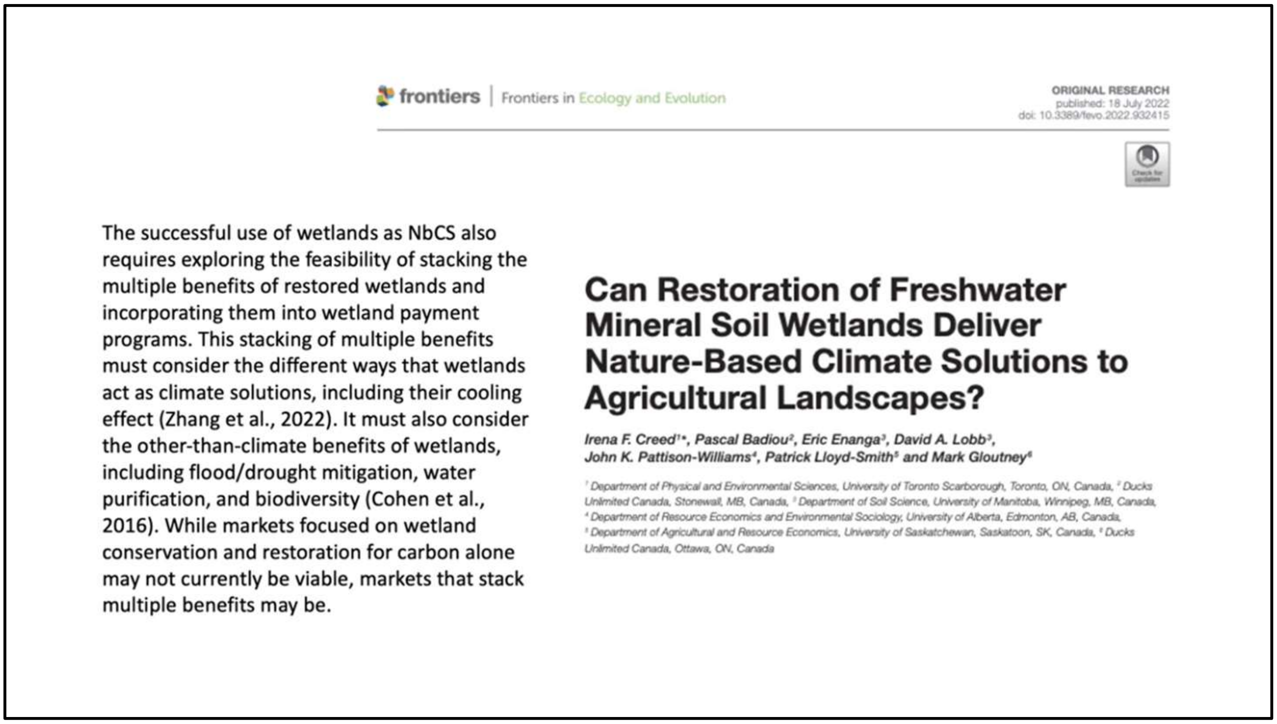
There's another approach and that's really focusing on the hydrology and connecting it to water quality through a statistical approach George Arhonditsis is using an ensemble modeling framework to look at the biogeochemistry and George I just have this one slide here because I needed to be fast but I he's using the Canadian land surface scheme including biochemical cycles classic model which is really a regional scale model he's also combining that ensemble approach from different scales so the regional to the site and looking at wet qual which is a wetland specific model the way I understood it yesterday and George can you just confirm whether you are only looking at the biogeochemical modeling or if you're also looking at the hydrology.

George: we're not looking it will be combined hydrological and biogeochemical modeling in fact to have in a properly characterized biogeochemistry you need to have the hydrology the physical background right and then you start the parameterization of a biogeochemical model.

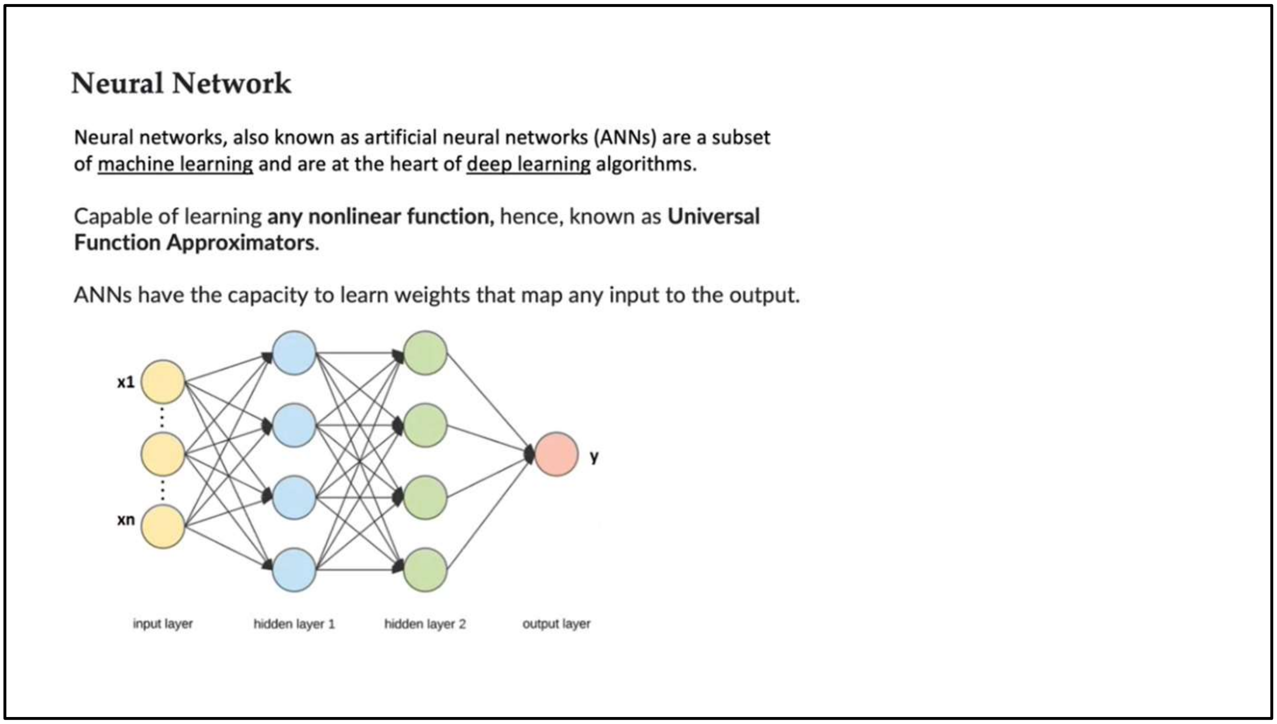
Irena: thank you I wanted to add the framework for hydrology and biogeochemistry but I thought I needed to check with you first so once again we're taking more statistical approaches and I know that Ali also does mechanistic hydrologic models but between Ali and George will be able to look at the hydrology and the biogeochemistry.



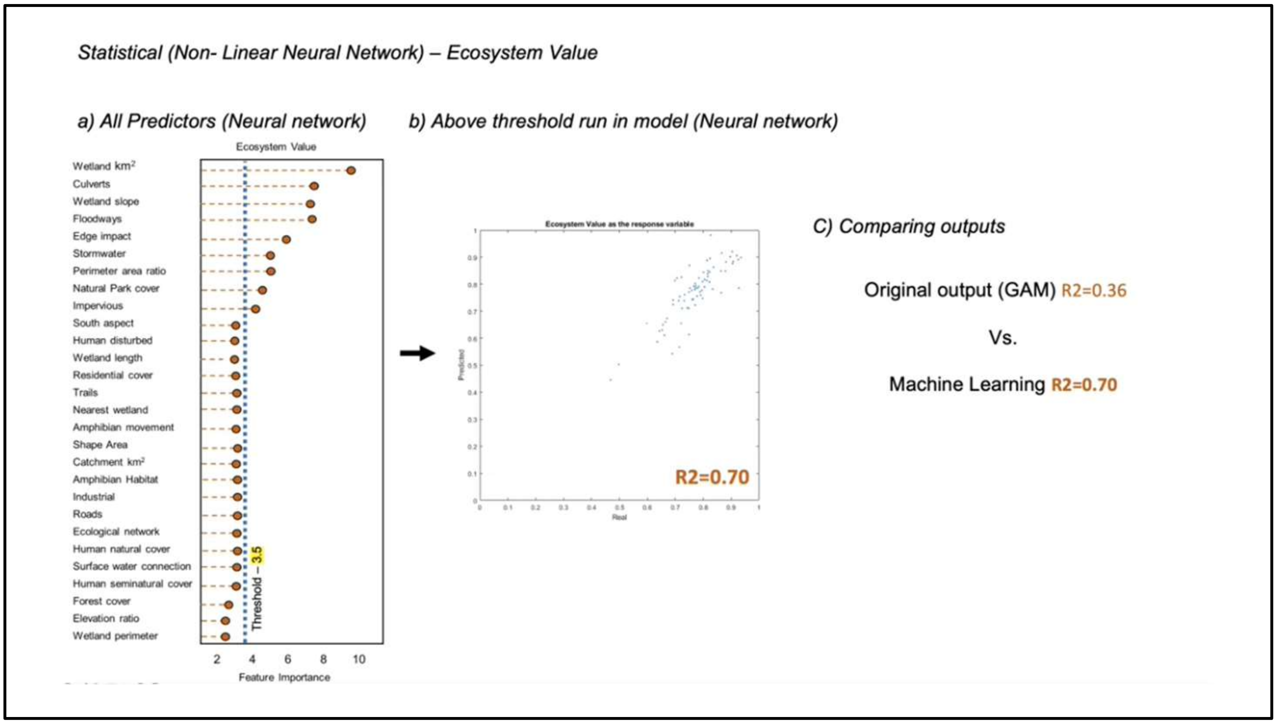
The fourth objective is to develop robust estimates of the synergies and tensions of wetlands as nature-based solutions for carbon storage versus other benefits. I've added George to this team partly because we have since the first project that was funded by ECCC, we've had the privilege of getting two additional projects. One of which is based on the Great Lakes St. Lawrence Basin, and that will be looking a lot at ecosystem services. So, myself and George are really doing the modeling part and Pascal Lauren and James are really collecting the data that we'll be able to look at these different ecosystem services.



This is work that is still nascent but I wanted to share with you a paper that Pascal, David Lobb, and John and Pat, in fact this was my first opportunity of working with John and it's kind of like we became fast friends and hope to work together for a long time and so what happened was that I, Pascal, Eric Enanga who was a postdoc and David Lobb really did the science work in terms of looking at carbon sequestration and we brought on the economists John and Pat to help us look at can restoration of fresh water minerals deliver nature-based climate solutions from a cost-benefit economic lens and this paper was published in 2022 and what the finding was if we do it at least for this site which was an Onandaga which is an Ontario it's known as the Tim Horton's Camp at least for this site for the data that we had, the answer would be no. If we did the nature-based climate solutions for carbon only, we would we would be losing money, but if we stacked it with other ecosystem services that's when we would really be making it very beneficial. That is based on what it currently costs to restore wetlands and it is basically a very minimalist approach of plugging ditches there is a whole area of science that can look at fast tracking the recovery and the sequestration of carbon that's outside the scope of our project but if anyone's interested in doing that what would like to talk further about that. Especially since I just met somebody from the Weisman Institute in Israel and they are looking at microbiomes and how they can reduce pollutants and we're talking about the potential of microbiomes that could actually enhance carbon sequestration and minimize nitrous oxide and methane flux.



Having said that though we I've had the privilege of being able to work with the Mistakis Institute which is a conservation organization in Alberta and they have gone and collected ecosystem service data for about a hundred wetlands in Alberta. I just wanted to share with you that they were really struggling with the statistical analysis and trying to be predictive of what value of ecosystem services there are and here we're talking about hydrologic health ecological health and water purification or water quality. In fact, their models were basically only able to present predict about 20% of the variants although it was statistically significant so we started using some of these deep learning techniques in particular neural networks



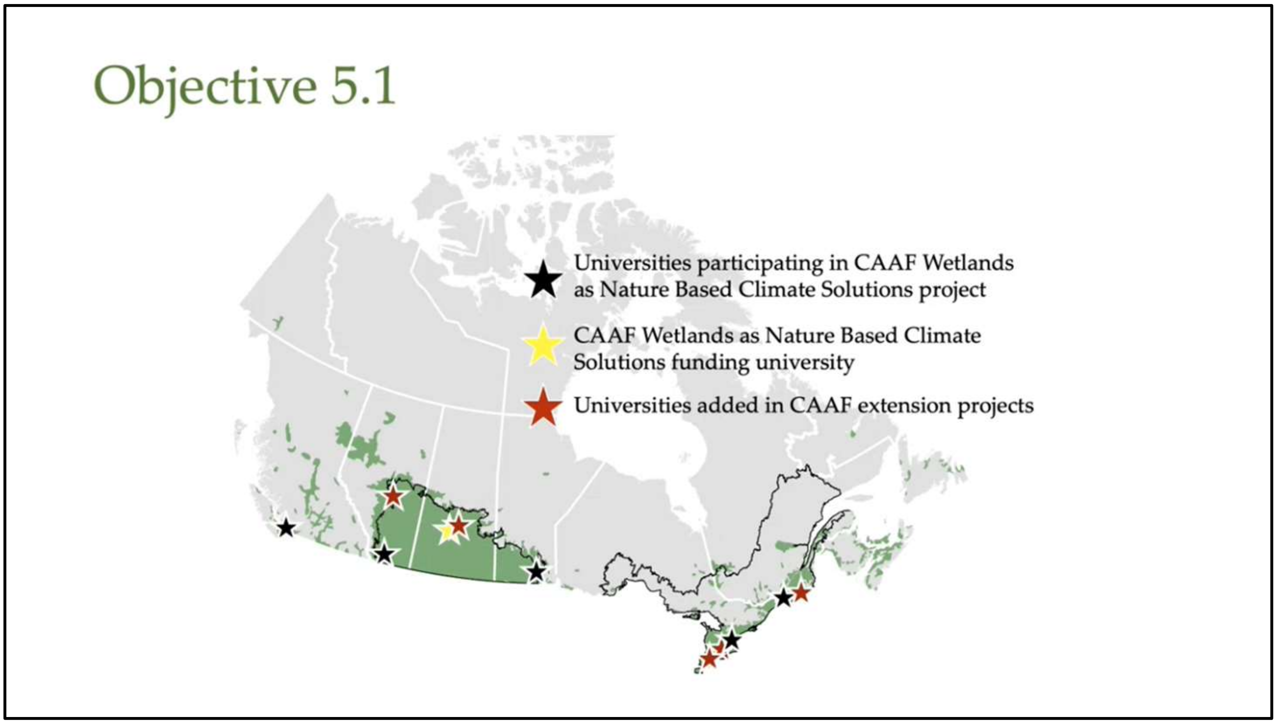
And we were able to basically we put all of the potential variables into the neural network and found that we were able to come up with predictive models of over 70%. So again, over almost doubling the amount of explanation of variants from the original model that they were doing to what deep learning did. Just to be razor sharp we sat and this is very much about the a priori hypothesis development approach to science. We sat in a room expert around the room went through all the predictors and said these are the variables that are important for predicting a certain ecosystem service. She put them into a linear regression model and the output was about 36. What we find with these statistical learning techniques is that the computer is able to turn off and turn off turn on and off different driver variables and they're also able to you know basically tell us which are the predictor variables that are the most important. And so, going from something that is heuristic and expert opinion based versus deep learning we can explain much more of the variants which I think is a cool technique that I wanted to share with you all.

Objective 5.1 Wetland Information Network

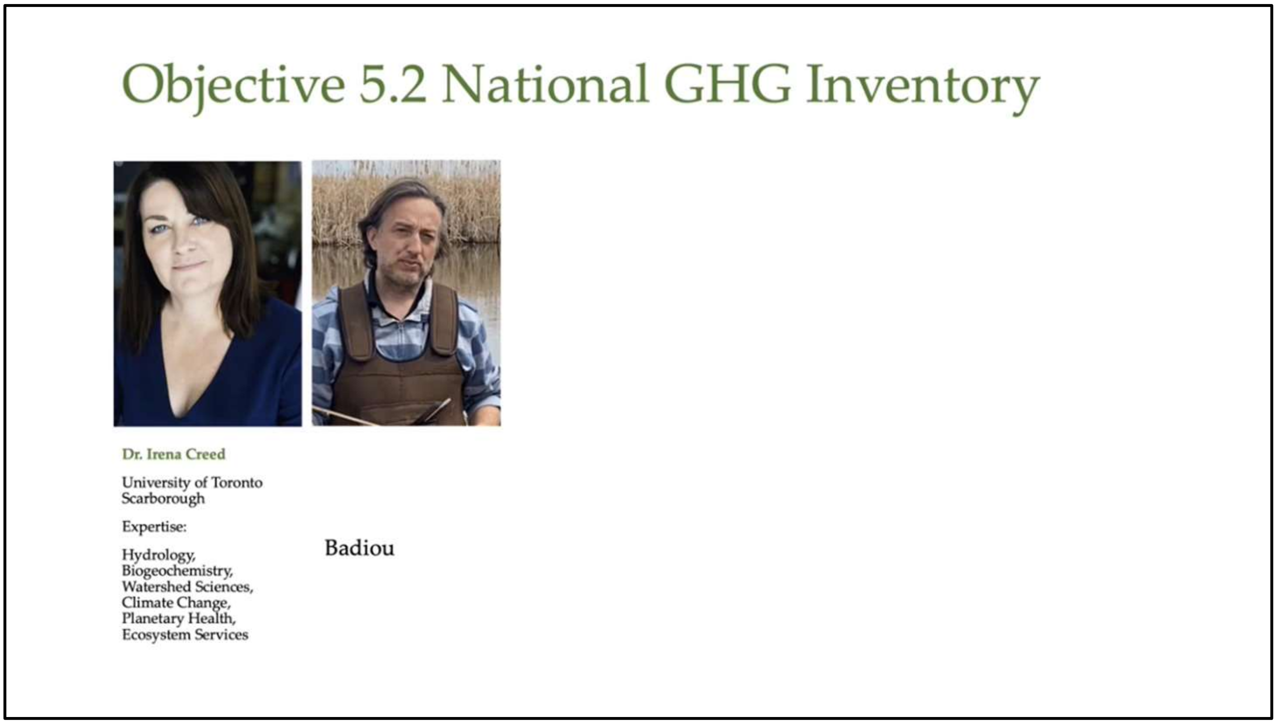
Irena Creed
University of Toronto

Pascal Badiou
Ducks Unlimited Canada

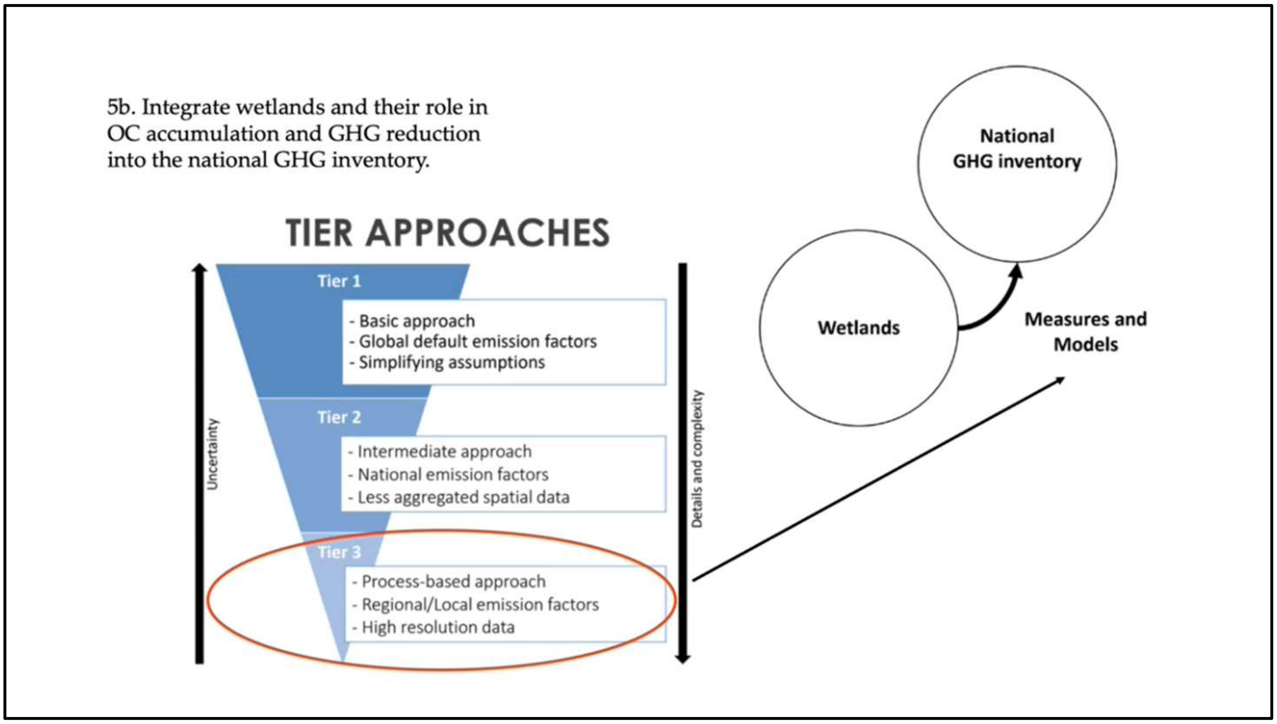
The Objective five this is really the last objective and it's really about moving towards what are the outputs that we hope will lead to outcomes in this project.



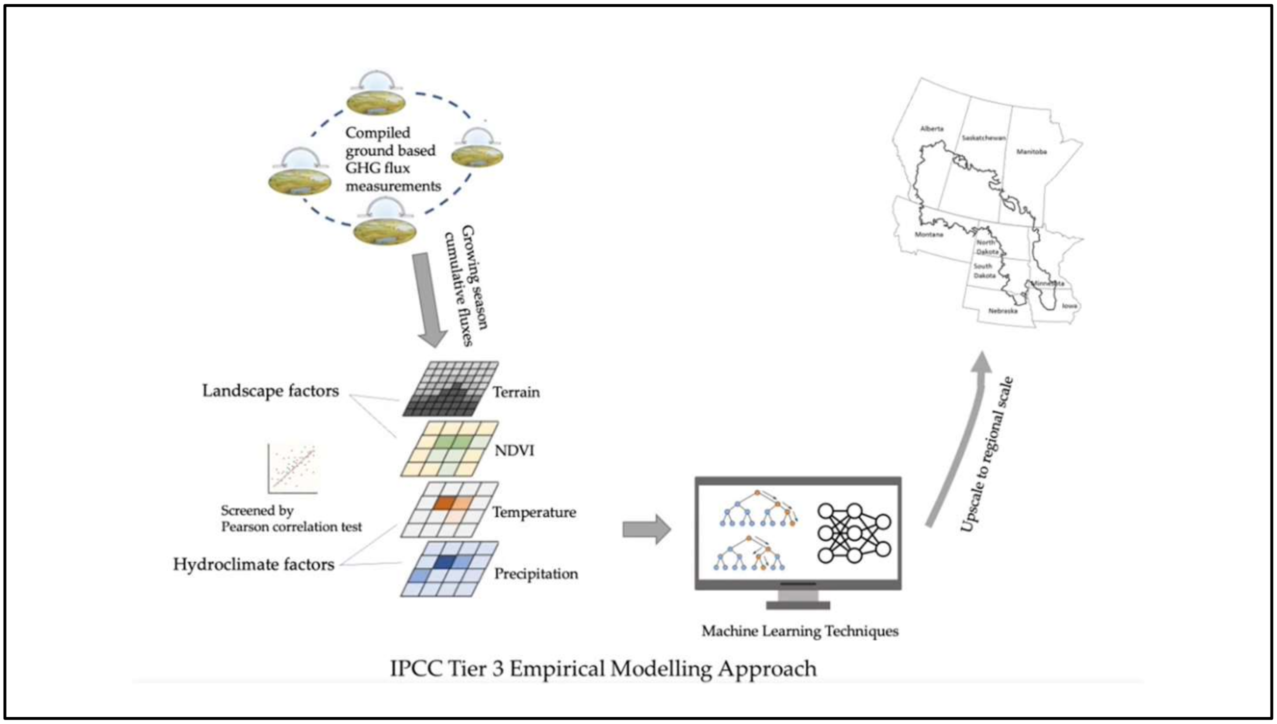
And the first one is a wetland information network and initially we want to focus on it in Canada with all of the various academic institutions participating supplemented of course by the rich government partner data as well as potentially some from the communities. But we also want to infuse it with data and protocols and models from our international partners both in Europe and in the US. And so we want this to be open access and we are now going into a phase where we're going to talk about how do we protect publications and students work versus how do we deliver our commitment for open science to the government partners in particular who are really under pressure to be able to have our data input and inform the national greenhouse gas inventory.



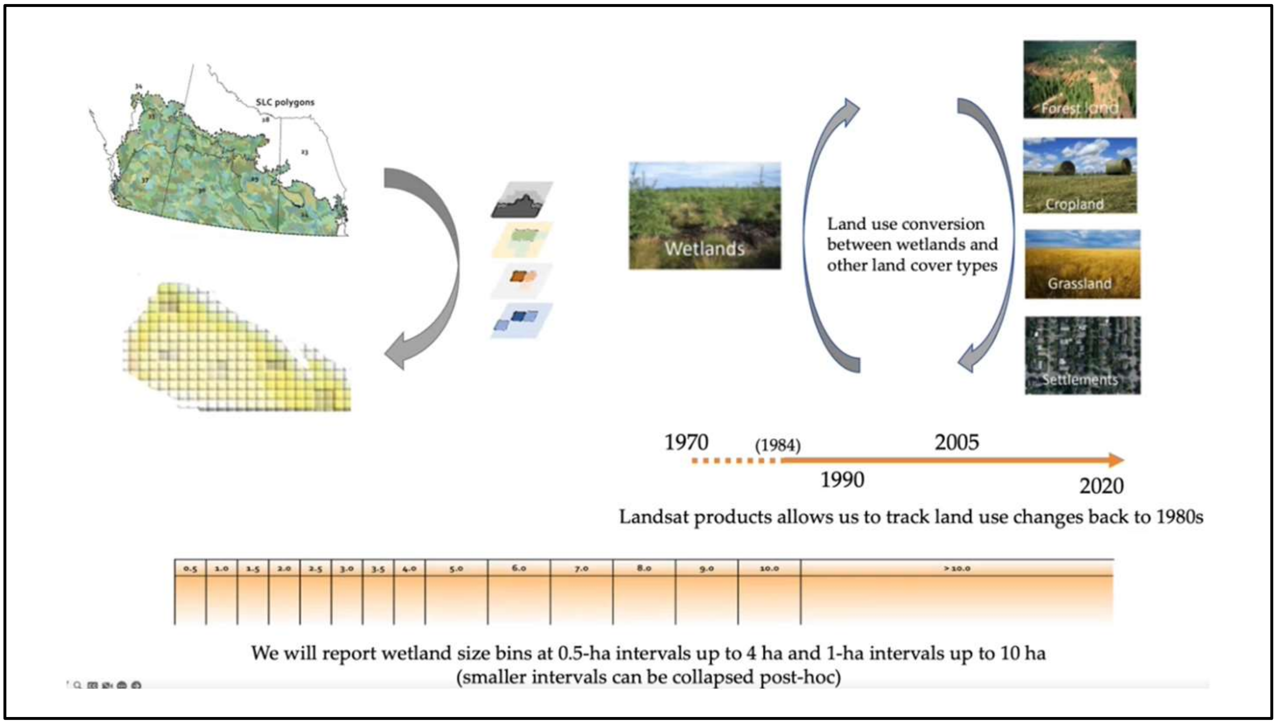
The second one is really we're actually helping them go from the IPCC tier one approach to a higher-level approach for the national greenhouse gas inventory.



I have here just basically they do not have wetlands in their national greenhouse gas inventory and the federal government has been given a deadline of one year to include the Prairie Pothole landscape into their national greenhouse gas inventory and soon after that maybe 18 months after that they need to do the same for the Great Lakes St. Lawrence Basin. So those are considered to priority areas that we must that the federal government must include within the national greenhouse gas inventory.



Okay so this is like an example of how important our international partners are. We met Sheel and it was on a previous project that Tim Moore was part of the NSERC strategic partnership grant that kind of was the precursor for this one. Sheel has just recently published a paper that had the same ambition as we do but it was focused a singular focused on methane. How do you come up with large geographic scale estimates of methane fluxes? We were working in parallel to that but then we had the advantage because Sheel is a generous scholar who shared with us his approach and then we realized that we were working in the north on the Prairie's Pothole region focused on carbon sequestration and he was working on the south focused on methane and why are we not working together on the entirety of the Prairie Pothole region and coming up with a harmonized approach to making these predictions. So shout out to Sheel for sharing us with us all of his variables. I think we can do more we can advance it further Sheel by using some of the statistical learning techniques but our ambition is to use these satellite derived data sets and meteorological station derived data sets put them in through the deep learning and upscale to the whole Prairie Pothole region. Again, federal government is anxious to get this done within a year.



The other thing that we learned from Sheel was that size of wetland matters and Sheel can you just quickly share with everybody what's how you incorporated wetland size into your methane model. I think you used three categories is that right?

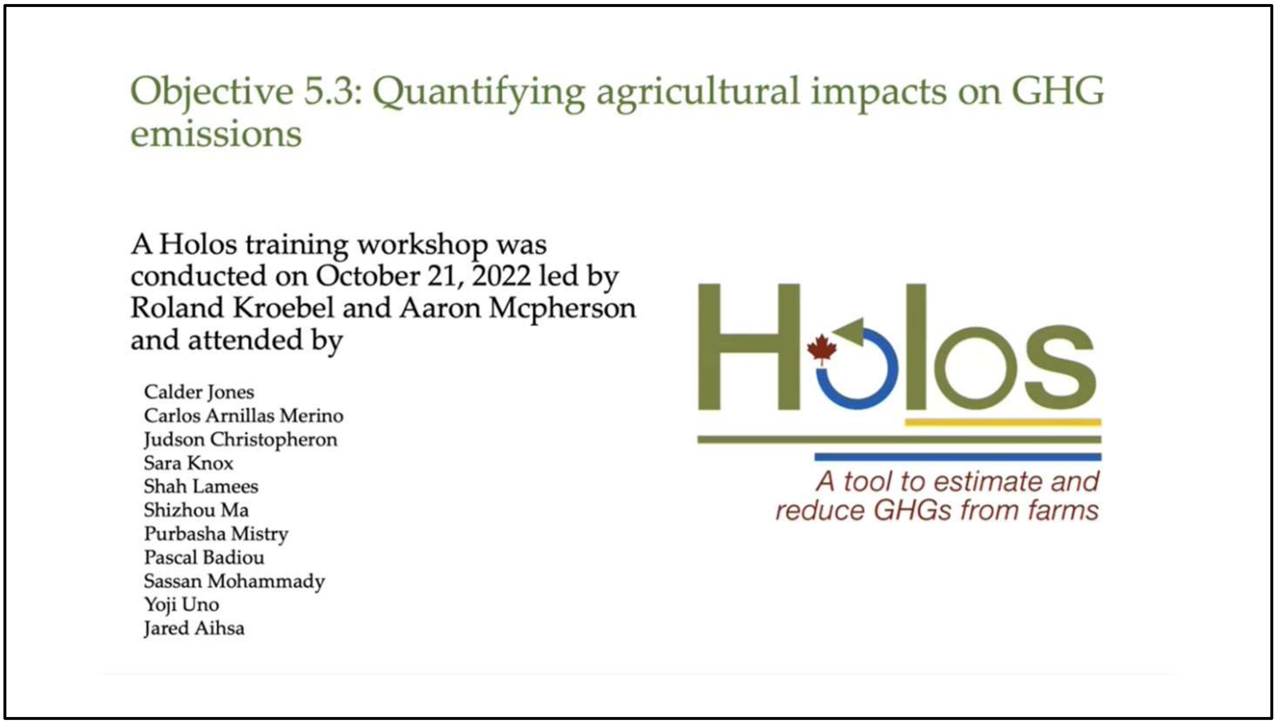
Sheel: We actually had it as a continuum but yeah basically we found that 75% of the methane is coming out of 25% of the wetlands there were all kind of in this size category that was around the one to four hectares in size. So, you know those are probably also the ones that have really good carbon sequestration as well. So yeah that gives us an opportunity to also manage the wetland systems a little better because we did a little back at the angle of calculation with Lauren and the smallest wetlands that don't emit a lot of methane are frequently drained into a medium size wetland that doesn't emit a lot of methane. So there's a lot of opportunity for managing wetland emissions by just kind of leaving the smallest wet.

Irena:

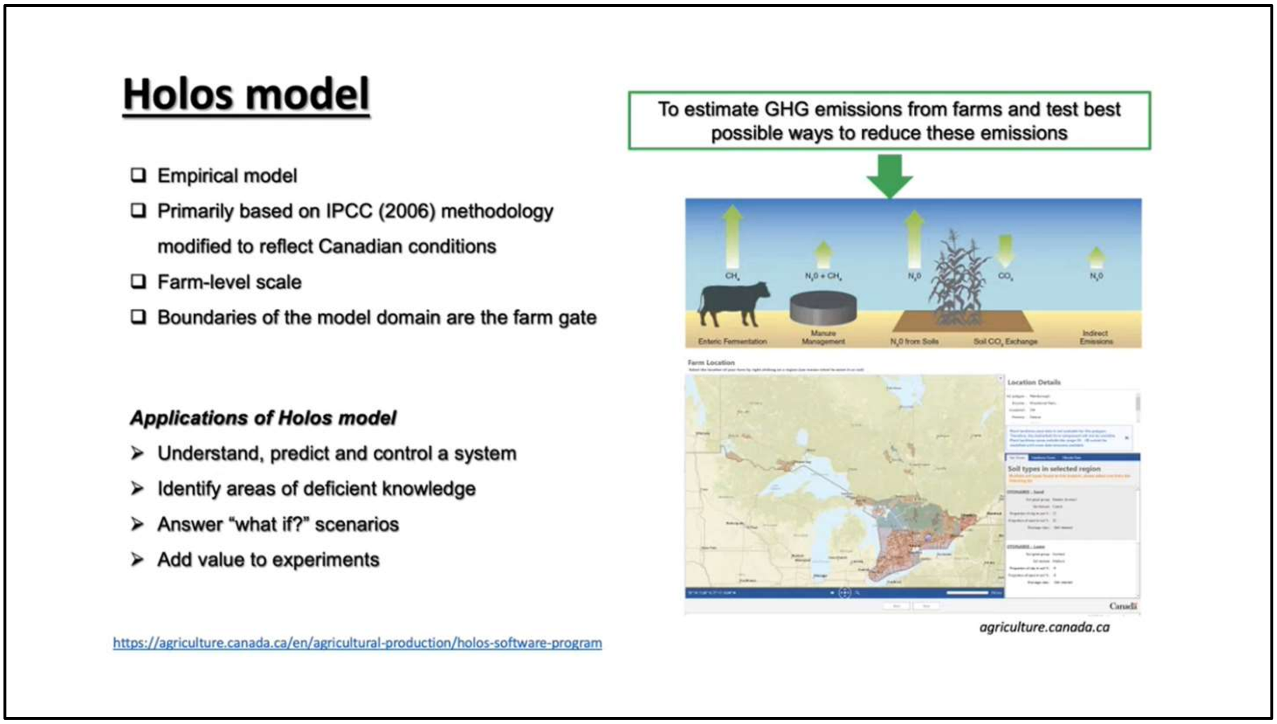
That's really interesting inside. I didn't know that. So it sounds like there's like this goldilocks effect of what size produces the most methane if it's too small it doesn't if it's too large it doesn't. And so with that knowledge we're going to be looking at again not quite a continuum but because the national inventory data wants it based on these size increments but we've decided to go and be fairly comprehensive in the sizes that we'll look at for which we'll be estimating carbon sequestration methane and CO_2 fluxes. And again part of the whole national greenhouse gas inventory requires us not only to look at wetlands in their current state but also the rate of conversion of wetlands to other land covered types. And here we're talking about forest, crop-line, grassland, and settlements, and vice versa. So, we'll be looking at the loss to the effects on the national greenhouse gas inventory of wetlands lost to other land covered types and other land covered types becoming wetlands.

Objective 5.3 Agricultural impacts on GHG emissions

For the third sub-objective we're looking at the effective agricultural impacts of greenhouse gas emissions.

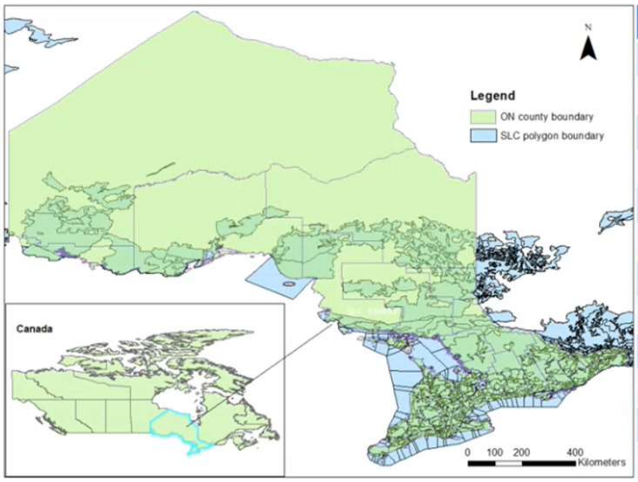


I'm really pleased to have Roland here who is basically the grandfather of the Holos model and thank him for hosting a training workshop that was held in the fall. Both Roland and Erin and about a dozen people participated.



George I'm going to put you on the hotspot here because what I didn't know until yesterday is and now I hear that there's a PhD student working on this. It's going to be using the Holos model. Oh, the grandfather was Henry Jansen I did not know that thank you Roland I'll correct my narrative.

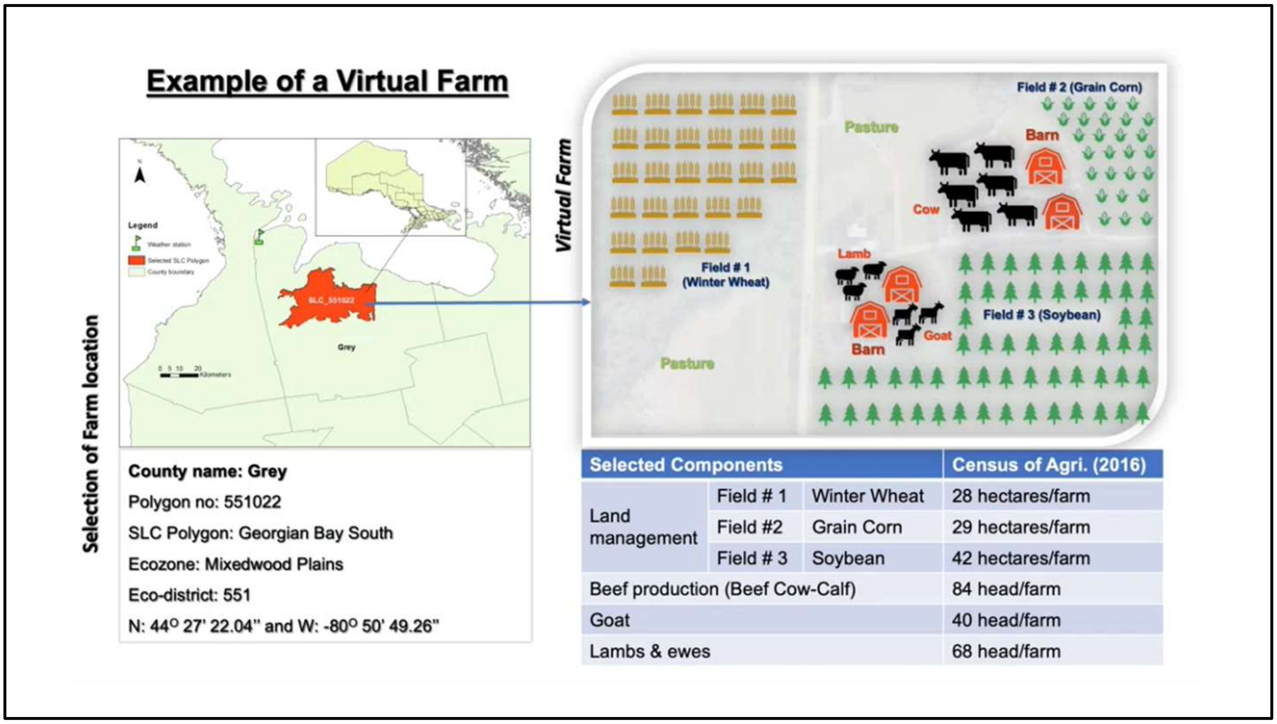
County boundary, Ontario



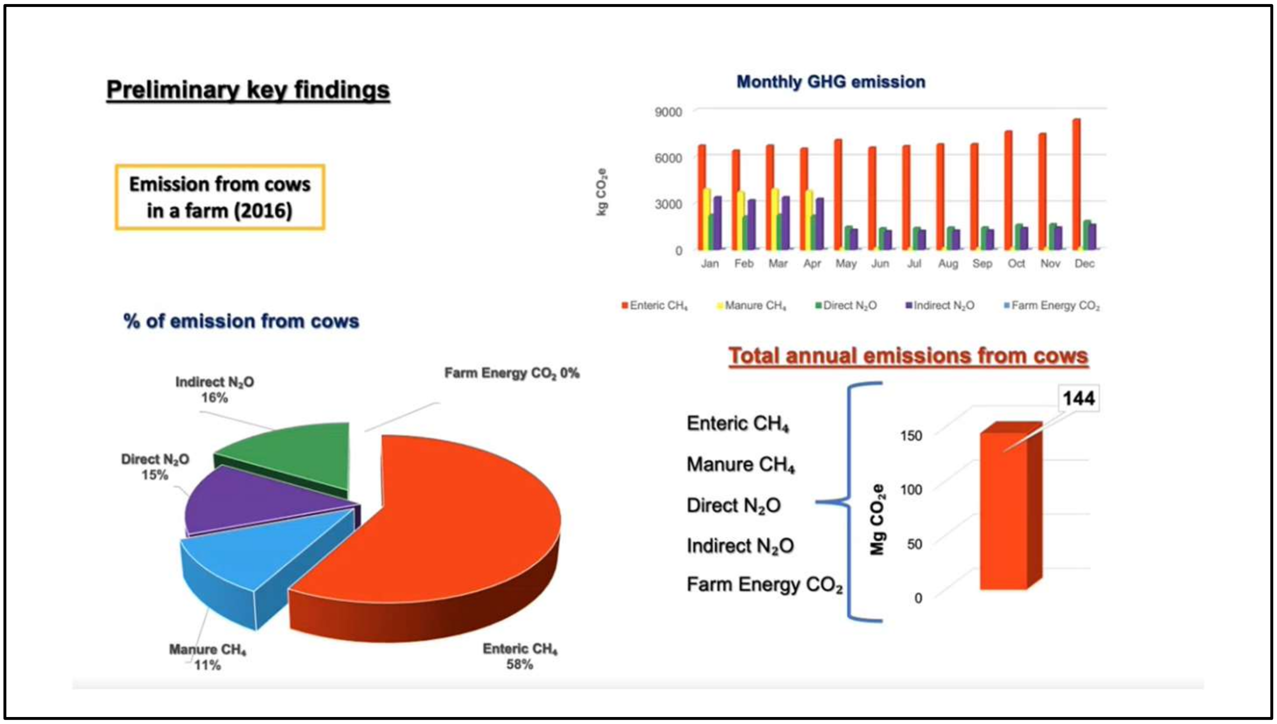
Components (Holos model)

Location specific variables
Soil zones
Plant Hardiness Zones
Climate Data (Temperature, Precipitation, PET)
Available components
Land management (Crop rotation, field)
Beef production (Beef cow-calf, beef finisher)
Dairy cattle
Swine (Grower-to-Finish, Farrow-to-Wean)
Sheep (Lambs & ewes, Rams, sheep feedlot)
Other livestock (Goat, Bison, Deer, Horses,…)
Poultry (Chicken, Turkey, …)
Infrastructure (Anaerobic Digestion)

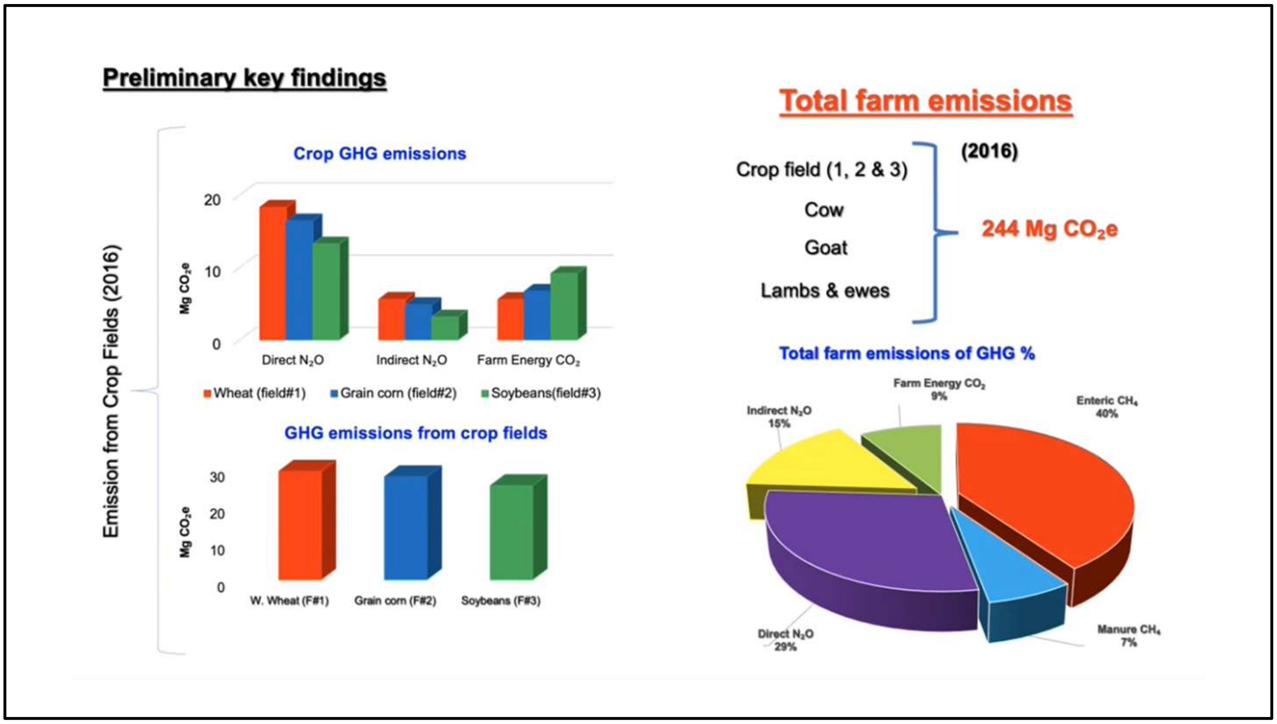
I just want you to and Rajnash she who's here is the one who's going to be incorporating this into his PhD and they've gone deep into Ontario and



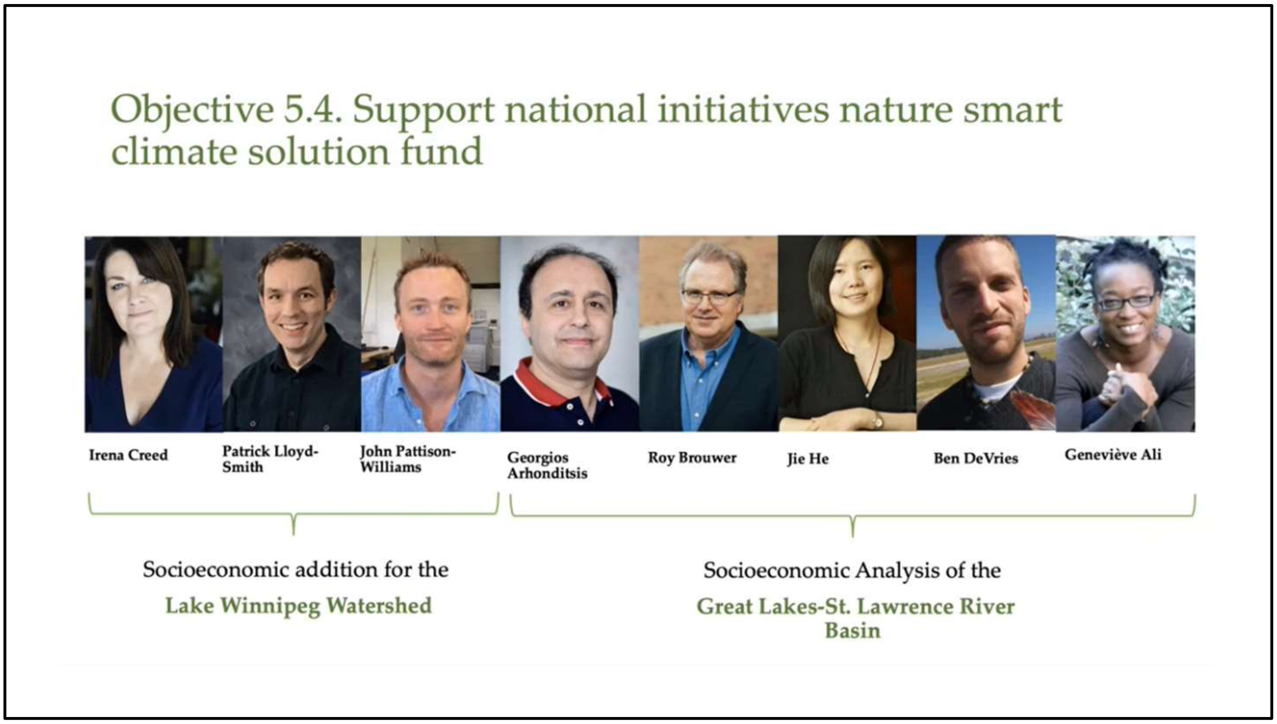
They're looking at all of these incredible data sets that they've already had access to. They're going to be coming up with these farms and develop some of these estimates.



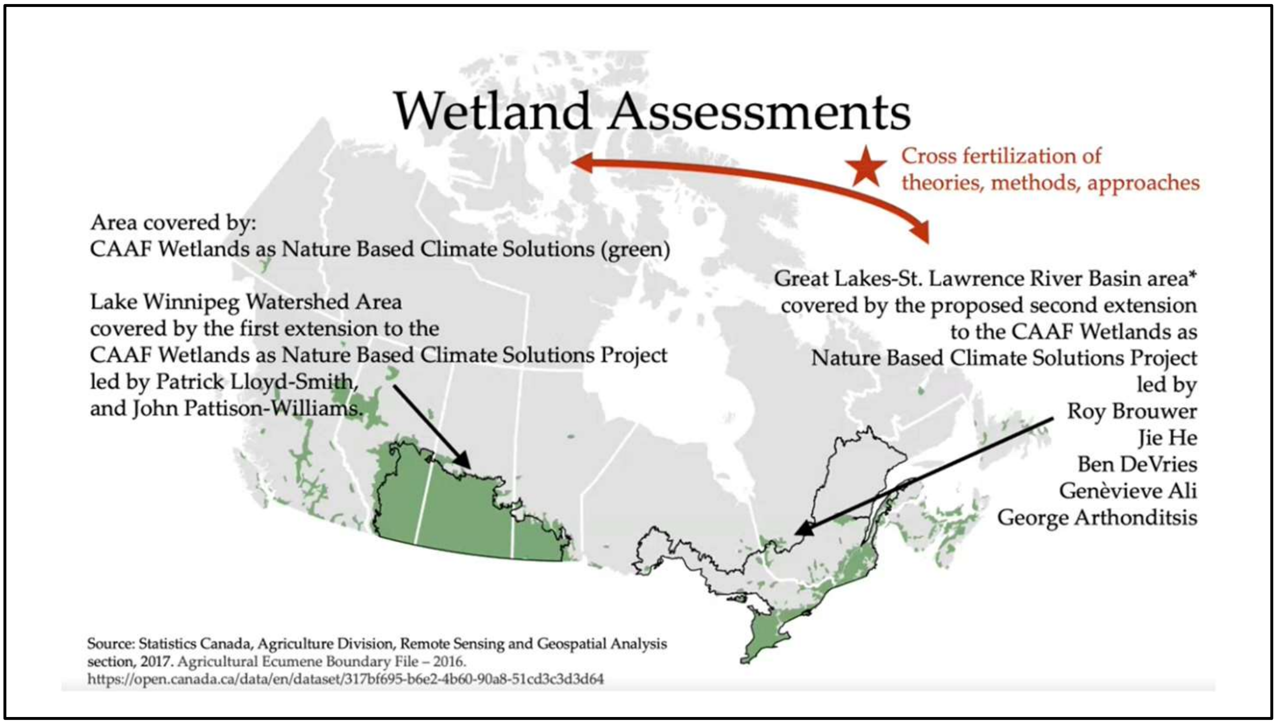
So, Roland I knew that you were going to be on the call. I just wanted you to be aware of that.



My question to George though was that we really needed to weigh in with you about has Roland been able to incorporate wetlands into the Holos model or not, and if not can we kind of work together to facilitate it and if yes maybe we need to be using the new version of the Hollis model and we'll come back to that in the open discussion.



The next one is to support national initiatives on the Nature Smart Climate Solution Fund. Since January we have received to what we call extension projects to the major one. The first one was really focused on the Lake Winnipeg watershed. Remember what I said this is one of the most high priority areas for the federal government because of their need to include it in their next National Greenhouse Gas inventory and Pat and John and I met through Pascal and we produced that paper and now they're doing a full blown socio economic analysis for the Lake Winnipeg watershed. Almost as soon as this project launched, Guillaume came back to me and he said can you do the same thing for the Great Lakes. Built another team and you'll see the members that are here. George, Roy, Jie, Ben DeVries, Genevive joined this project through the second extension project and so.



We're covering two major watersheds Lake Winnipeg on the left Great Lakes St. Lawrence on the right and even though their genesis were distinct paths what we hope is that there will be a lot of cross fertilization of theories of methods and approaches in this socio economic analysis and so I just kind of want to go through for both of these projects,

Lake Winnipeg Watershed and Great Lakes-St. Lawrence River Basin

Task 1:

Evaluate methods of mapping wetlands and estimating historical rates of land use change and conversion of wetlands in the Great Lakes-St. Lawrence River Basin.

Task 2:

Create an inventory of wetlands and identify historical rates of land use change and conversion of wetlands in the Great Lakes-St. Lawrence River Basin.

Task 3:

Identify the main socio-economic drivers of wetland conversion and projecting how these drivers might change the rates of wetland conversion, and the resulting GHG

Task 4:

Cost-effectiveness and cost-benefit analysis of restoration and/or conservation of wetlands on agricultural lands as NbCS in the Great Lakes-St. Lawrence River Basin.

And I say for both of them John because we really want to have any benefit on the more the higher funded project which came later on the Great Lakes to benefit the Lake Winnipeg one but the first task is really to evaluate those methods of mapping wetlands and estimating the historical rates of land use change and conversion of wetlands in both watersheds. The second one is to create the once we have the techniques down and again remember I showed you that sub pixel approach whenever we go back to the government they say can you do better can you do better on the wetland inventory and I'm hoping now with the sub pixel approach they'll be satisfied that we are approximating the gold standard which is the field-based ground-based work that Ducks Unlimited does and so with that we'll be able to move to task two which is to create an inventory of the wetlands and to establish those historical rates of land use change and the conversion of wetlands and remember what I talked about it's converting it from wetlands to one of those other land use categories and vice versa. The third task will be to identify the main socio economic drivers of wetland conversion and projecting how these drivers might change the rates of wetland conversion and the resulting greenhouse gases and finally to look at cost-effective in this and cost benefit analysis of restoration and or conversion it should and conservation sorry of wetlands on these landscapes and so the next slide is heavy I'm not going to go through it but if anybody asks me a question on the socio economic one.

Lake Winnipeg Watershed and Great Lakes-St. Lawrence River Basin

Cost-effectiveness and cost-benefit analysis of restoration and/or conservation of wetlands on agricultural lands as NbCS in the Great Lakes-St. Lawrence River Basin.

4a. Estimate implementation costs (including the opportunity costs (benefits foregone)) of wetland conservation and restoration under different policy scenarios.
4b. Assess the cost-effectiveness of wetlands as NbCS compared to alternative courses of action and then account for leakage (i.e., displacement of emissions from avoiding an activity to another location) and how this affects the outcome of the cost-effectiveness analysis.
4b. Develop spatial economic optimization procedures for wetlands as NbCS, based on cost minimization of the identified policy scenarios under climate change.
4d. Develop spatial optimization procedures to maximize the benefits of wetlands' ecosystem services associated with the policy scenarios (carbon sequestration, flood control, water quality regulation, and biodiversity).
4e. Build an integrated decision-making tool that connects mechanistic ecosystem function models with ecosystem service models.

I want you to know that this is the depth of work that we're doing here it's going to involve things of cost benefit leakage spatial economic optimization ecosystem services modeling really proud of what we we're going to be doing here looking for great students who might want to participate in it.

And then finally and this is very brief the final of the objective five outputs that we will create we hope to create is to contribute to the national index on ag food performance and Steve Webb has been one of the key players in discussing what that national index on agri-food performance should be he is the executive director of the Global Institute of Food Security at the University of Saskatchewan and because of a lot of the work involving water in this in the food water tensions that exist Jay Famiglietti the former executive director of Global Institute of Water Security both of individuals are co-applicants on this project and both of them are providing cash contributions to enable us to be able to explore how we can improve refine the national index on agri-food and just this is an icon that is used for the national index on agri-food and you can see that there are four buckets: one is economic, one is societal well-being, one is health and food safety, and one is the environment and it's really that environment economic boxes that we can really contribute to in the work that we're doing.

So those are my highlights and we have 35 minutes left and really I want to talk about turn the table and have everybody speak about what do you think about the project we're doing how do you want to engage and I really want to give privilege to the people who weren't on the call yesterday to express their ideas and then if we have time everybody can exchange but really want to hear from our international advisory group.