Individual Appearance of DR. KAREN E KOHFELD, Professor,
Before the Standing Senate Committee on Agriculture and Forestry

BACKGROUND: RESEARCH TOPICS OF THE COPE LABORATORY: My research area focuses on Earth system science and understanding the natural and human influences on climate and carbon cycling. Students in my group collaborate with a wide range of agencies and address the following topics:

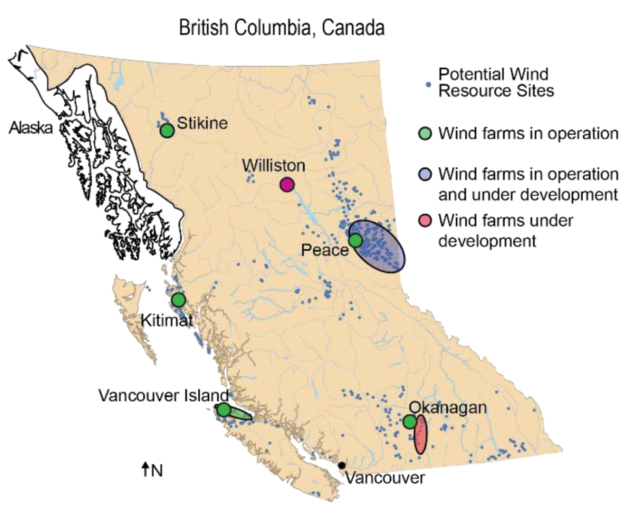
(1) Establishing baseline of understanding of past changes in climate and carbon cycling over the past 10- to-100,000 years.
(2) Examining historical changes in regional wind behavior, extreme weather (such as Pineapple Express and wind storms), and fire frequencies
(3) Understanding coastal carbon cycling, such as carbon storage in coastal wetlands and ocean acidification

For the purposes of this appearance I would like to share results from two studies which I think will be of most relevance to this committee's objectives.

ISSUE 1: FUTURE RELATIONSHIPS BETWEEN WIND SPEED AND RUNOFF BEHAVIOUR IN BRITISH COLUMBIA AND THEIR IMPLICATIONS FOR RENEWABLE ENERGY PLANNING
(Collaborators: Charles Curry (Pacific Climate Impacts Consortium), H. Joseph Bailey (REM))

GOAL: The goal of this study has been to explore how wind speeds in BC are expected to change relative to changes in runoff over the next century. We address questions such as where are wind speeds the highest in projected drought years, when hydropower reserves are lowest? We used the Canadian Regional Climate Model simulations conducted with a "business as usual" future climate change scenario to 2100. For this committee I focus on what the model simulations say about seasonal changes in river runoff (Figure 1), which are likely most relevant to water resource management for agriculture and forestry.

Figure 1. Location of six sites (green and magenta) examined for seasonal runoff changes. Blue points represent potential wind resources identified by the BC government in 2010. Blue points represent potential wind resources identified by the BC government in 2010. Oval identifies region where >40% of BC's large hydropower generation.



RESULTS RELEVANT TO THIS PANEL:

(1) Between 1979 and 2099, modeled river runoff is projected to increase everywhere, with largest changes (10-15% per decade) along the northern coast. However, variability is especially strong in southern BC and central Alberta (which still experience multiple decades of negative trends in runoff.)

(2) Importantly, the seasonal timing of peak runoff is expected to shift earlier by one month, particularly in the Okanagan and Williston regions. More precipitation is projected to fall as rain instead of snow, and thus less water is stored in the snowpack. Runoff is fed into the watersheds earlier in the season.

RELEVANT IMPLICATIONS:

(1) An earlier Spring runoff peak is consistent with other work suggesting that we can expect that the drier Spring/Summer season will extend for a longer period each year as we move into the future, which has implications for regional water availability and resource allocation for agricultural activities within the province.

(2) A longer period of low runoff, especially when coupled with projected, higher temperatures, suggests that we can expect a longer fire season that has the potential to produce drier fuels.

ISSUE 2: UPTAKE OF BLUE CARBON BY BRITISH COLUMBIA'S COASTAL WETLAND ECOSYSTEMS
(Collaborators**:** M Pellatt and J Yakimishin (Parks Canada), C Robinson (Fisheries and Oceans Canada), V Postlethwaite, S Chastain, A McGowan, and M Gailis (REM)).

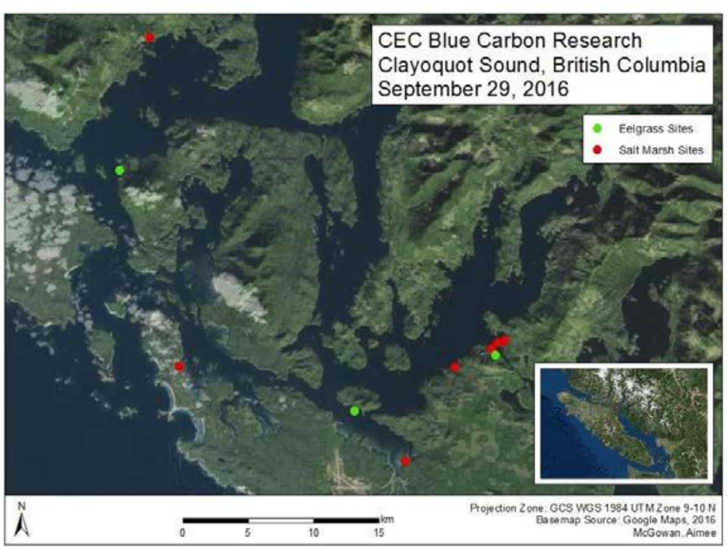
BACKGROUND: Blue carbon is carbon stored in the biomass and sediment of vegetated coastal ecosystems, such as seagrass meadows, mangroves, and salt marshes. In the tropics and subtropics, these systems bury carbon at substantially higher rates per unit area than terrestrial forests, and therefore have been touted as important for climate change mitigation, but very few data exist on the Pacific Coast of Canada (Figure 2).

Figure 2. Cores collected from Clayoquot Sound salt marshes have dark, carbon-rich soils.

Photo Credit: Stephen Chastain and Marlow Pellatt

GOAL: The COPE lab was funded by the Trinational Commission for Environmental Cooperation (CEC) to quantify the storage and sequestration rates of carbon in BC salt marshes and sea grasses in Clayoquot Sound (Figure 3) and Boundary Bay (not shown). Can blue carbon storage be considered a co-benefit to complement other ecosystem services of coastal wetlands in BC?

Figure 3. Locations of salt marsh and seagrass meadows sampled in Clayoquot Sound.



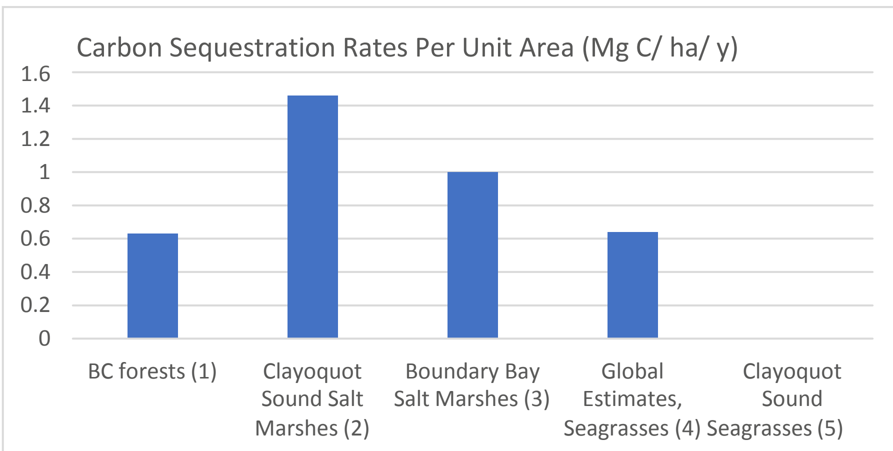
RESULTS:

(1) Seagrass meadows had significantly higher carbon storage than nearby non-vegetated sites, indicating that the region's seagrass meadows still contribute to carbon storage. However, for this part of the world, carbon sequestration by seagrass beds is very small, 3 orders of magnitude less than global averages (Figure 4).

(2) Regional salt marshes store carbon at rates comparable to other marshes globally, and substantially higher per unit area than BC forest sequestration rates.

(3) Note, however, that when we account for the areas of these marshes (~200 hectares) and BC forests (~66 million hectares), BC forests sequester about 5 orders of magnitude more carbon per year than these two marsh areas.

Figure 4. Carbon sequestration rates per unit area for BC regional salt marsh soils, seagrass meadows (Clayoquot Sound and Boundary Bay), BC forests, and global seagrass beds.



SOURCES: (1) Peng et al. *Geophys Research Letters* (2014); (2) Chastain and Kohfeld *CEC Report* (2017); (3) Gailis, Pellatt, and Kohfeld (unpublished); (4) McLeod et al. *Frontiers Ecol and Environ* (2011); (5) Postlethwaite et al. *PLOS One* (accepted, 2018)

RELEVANT IMPLICATIONS:

(1) The low seagrass carbon storage emphasizes the need for regionally specific data before implementing blue-carbon based climate change mitigation.

(2) The high carbon accumulation rates (per area) in coastal salt marshes mean that, locally, they could serve as a potential climate change mitigation co-benefit, when considered alongside other ecosystem services of salt marshes (ie. biodiversity and salmon habitat).

(3) Projected sea level rise means that coastal salt marshes are subject to "coastal squeeze." They are sandwiched between the ocean and hard infrastructure, such as seawalls and dykes, and will be constrained as sea level rises.

(4) Erosion of the marshes will both limit the annual carbon storage and result in loss of salt marsh carbon stocks.

(5) Managing sea-level rise in coastal areas will need to balance competing issues, such as the protection of agricultural land along the coast and salt marsh conservation.