Response to Sergey Loiko

Thank you for your comments on the manuscript which raised some relevant points that helped strengthen the manuscript. We addressed every comment in detail and changes in the manuscript are highlighted them in blue below:

General Comments by Sergey Loiko:

This work represents an important biogeochemical study that complements our knowledge of the impact of soil fertility and lake environment on the productivity of aquatic plants in the cold Arctic climate using the example of the Barrow Peninsula, Alaska.

Specific Comments by Loiko:
Introduction Line 37-41: Note that, in addition to the listed cases of increase in vegetation productivity, there are many other illustrative of higher productivity of vegetation, relative to the background, within the basins of drained thermokarst lakes (Loiko et al., 2020, doi: 10.3390/plants9070867), dried up bottoms due to catastrophic events and warm years (Nitz et al., 2020, doi: 10.5194/tc-14-4279-2020), as well as in places of activation of landslide and thermokarst processes on the slopes (Khitun et al., 2015 in Fennia - International Journal of Geography; Ukraintseva et al., 2014 in Landslides in Cold Regions in the Context of Climate Change), and sites of thawing of ground ice (Becker et al., 2016, doi: 10.1111/1365-2745.12491). The productivity of the vegetation of the listed places is high due to the higher fertility of the soils.
To highlight the aforementioned processes, we added a follow up sentence in the introduction reading:
In addition, abrupt thaw and recent lake drainage events enhanced during warm summers has also contributed to increased productivity through the availability of fertile soils (Turetsky et al 2020, Loiko et al 2020, Nitze et al 2020, Jones et al 2012).

Line 70-74: Note that there is recent information about a new unaccounted for a nutrient source that is
concentrated under the active layer in the ice. These recent data make clear the reasons for the increase in productivity with increasing active layer thickness (References: Lim et al., 2020, doi: 10.1016/j.chemosphere.2020.128953 ; Subedi et al., 2020, doi: 10.5194/tc-14-4341-2020 ; Fouché et al., 2020, doi: 10.1038/s41467-020-18331-w).

We agree on the release of nutrients by thawing of permafrost. We updated the references to include Fouche et al 2020 in the original sentence:

This phenomenon [nutrient increases in aquatic habitats] will likely become more pronounced as increasing temperatures in Arctic soils continue enhancing nitrogen mineralization (Uhlířová et al 2007, Weintraub and Schimel 2003) as well as permafrost degradation and nutrient leaching (Keuper et al 2012, Reyes and Lougheed 2015, Frey and McClelland 2009, Fouché et al 2020).

Methods in this section of the article, it is also worth giving a brief description of the soils (mineral, organogenic, peat thickness). Line 150-151: At what distance from each other were the collected individual plants of the two studied species? In fact, even on a nanoscale horizontal scale, the properties of soils and sediments can change

noticeably. Therefore, if the soil is not selected exactly in the place where the plant grew, then the correlation will be weaker. It is better to clarify this fact for a better understanding of the article by readers.

Samples of plants were taken a few meters apart (1-4m) within the area of soil sampling. We acknowledge that soils in polygonal landscapes are highly heterogeneous given cryoturbation mixing. This helps explain the low correlation coefficients between soil and leaf nutrients. However, we designed the collection to give an overall representation of plant-soil relationships for detection using remote sensing. Highlighting these challenges will help clarify the reader about the limitations and uncertainty in these processes. Therefore, we added a section in the discussion that reads:

"We designed the sample collection to give an overall representation of plant-soil relationships for detection using remote sensing. The plant leaf samples and soil samples were not taken within the exact location, but rather, plants were collected in different areas of the monotypic stands trying to have a diverse representation of the species within each pond. Similarly, soils were collected in 3 different locations within the same area and mixed together for processing. However, given the high heterogeneity in soil properties on polygonal tundra due to cryoturbation, the relationships between soil and leaf nutrients are likely weakened and may explain the low strength of the correlation coefficients."

We also added information on the organic horizon thickness on the methods section:
"Soil organic horizon varies across the landscape due to the age of the landform (i.e. drain thaw lake basin) and cryoturbation of the soil. Nonetheless, sites are located in old and ancient drain thaw lake basins where the surface organic thickness ranges between 15 and 35cm from surface (Hinkel *et al* 2003)."

Line 160-162: Clarify the sampling depth.
Did you sample to a depth of 10-20 cm, that is, in the ranges 0-10 or 0-20? Or did you collect the horizon from 10 to 20 cm? This is important since the distribution of nutrients is highly heterogeneous in depth. The maximum concentration always falls within the 0-5 or 0-10 cm layer. However, the supply of labile forms of elements strongly depends on the soil density, which in turn depends on the type of substrate (mineral or organogenic).

Soil samples were taken at a depth range of 10-20cm given that most of the root zone for these species fell in this range. The original text reads: "For each site, sediment samples from the active root soil depth of 10-20cm for each species were collected in triplicates within the site." And we added a following sentence to the text that reads: "Soil at this depth range was a combination of mineral and organics and varied among sites and within each site. Thus, the combination of 3 soil samples in each site aided to minimize soil heterogeneity discrepancies and give an overall picture of soil conditions."

Line 169-170: The article indicates that the biomass was taken into account for each plant species, and not for the entire plant community. This means that in communities with several dominant species, the biomass of a particular

plant species depended not only on soil fertility but also on the biomass of other plant species. Therefore, the question arises, were all communities monospecific? If there were communities of several plant species, it would be correct to normalize the biomass to the cover (proportion of the species) of the measured species for which the biomass was measured.

Both plant species in this study generally grow in monotypic stands surrounding the ponds and inside the ponds (A. fulva only). We added "Monotypic" to the sentences bellow for clarity:

Line 115: These graminoids are the dominant cover in aquatic habitats, generally growing *as monotypic stands* on the edge and/or inside tundra ponds (Villarreal *et al* 2012, Andresen *et al* 2017)
Line 155: Each sample consisted of 10-15 plants collected from different water depths and multiple randomly selected locations in pond habitats *within monotypic stands of each species*.
Results- For this section, one can calculate the ratio of nitrogen to phosphorus in the biomass of the studied plants (according to Wassen et al., doi: 10.1038/nature03950). This interesting indicator shows which of the elements limits the formation of aboveground biomass, phosphorus or nitrogen.

Wassen et al 2005 used fertilization experiments from literature to identify general thresholds for N & P limitations. We did not use ratios in this study given that the thresholds of N:P ratios for identifying N or P limitations are not know for aquatic tundra graminoids. Therefore, we used biomass as the main indicator of nutrient limitation which is widely accepted.

Discussion- Jones et al., 2012 (doi: 10.1029/2011JG001766) and Loiko et al., 2020 (doi: 10.3390/plants9070867) show that NDVI is affected by the thickness of the peat. Have you measured the thickness of the peat? Could the litter or peat have affected the biomass of plants, their projective cover and NDVI?

We did not measure the thickness of the peat. All our sites have relatively large amounts of peat that has been mixed with mineral soils through cryoturbation in this polygonal landscape. We included a statement in the methods with an overall information of soil organic layer :

"Soil organic horizon varies across the landscape due to the age of the landform (i.e. drain thaw lake basin) and cryoturbation of the soil. Nonetheless, sites are located in old and ancient thaw lake basins where the surface organic thickness ranges between 15 and 35cm from surface (Hinkel *et al* 2003)."