WCS Canada

Yukon Water Board
Whitehorse, Yukon
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RE: Hearing in the Public Interest on Placer Mining in Wetlands.

December 14, 2020

Dear Chair Piers McDonald and members of the Yukon Water Board,

Thank you for the opportunity to provide comments on the issue of placer mining in wetlands. Our attached comments are organized to first address the questions from the Yukon Water Board as detailed in the 'Notice of public interest hearing re: placer mining in wetlands' (Section A) and second to provide scientific information both in support of our comments and in response to information provided in the Hearings (Section B).

As conservation scientists with Wildlife Conservation Society (WCS) Canada, we have recognized scientific experience and knowledge related to wetland conservation and management, and more broadly to ecology and conservation, and as such our emphasis in these comments is on the scientific basis for wetland conservation and management.

WCS Canada urges the Board to respect the spirit and intent of First Nation Final Agreements and only authorize mining in wetlands once effective measures are in place to protect and reclaim wetlands, including:

- The identification and protection of areas of high value through collaborative mechanisms, such as approved land use plans or other mechanisms agreed upon by the Yukon Government (YG) and Yukon First Nations;
- A wetland policy agreed upon by YG and Yukon First Nations, including disturbance thresholds by watershed;
- Wetland reclamation standards agreed upon by YG and Yukon First Nations; and

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- Mechanisms to guarantee that funding will be available for reclamation and that reclamation will be successfully completed.

Sincerely,

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<u>SECTION A. RESPONSE TO YUKON WATER BOARD QUESTIONS RE: PLACER MINING IN WETLANDS</u>

 # 1: What information should be required to support a water licence application related to placer mining activities in wetland areas?

The following information and processes should be required for all licensing and permitting of placer mining in valley bottoms of Yukon, regardless of whether impacts to individual wetlands are direct or indirect.

1. <u>Wetland mapping</u>: Detailed wetland mapping across the entire drainage, including differentiation of wetland sub-class (e.g. treed bog, treed swamp, marsh, shallow open water) within a single wetland complex. To support climate-informed land use planning, all wetlands should be mapped for their peat complexes and carbon storage and prior to any new license being approved, any carbon lost should be mitigated or restored via reclamation.

2. <u>Biodiversity inventory</u>: Inventory of biodiversity using a multi-taxa framework that incorporates a suite of biotic and abiotic indicators that collectively reflect wetland functions and values. See more detailed discussion in Section B.

    Definition: An indicator is a measurable characteristic used to assess and report on the condition of values of interest.

3. <u>Adaptive management framework</u>: An adaptive management framework that includes ongoing monitoring of key functions and values through abiotic and biotic indicators in a before-after-control-impact (BACI) design, and a process for feedback and update of management plans as indicated by changing status of indicators.

4. <u>Cumulative effects mapping and assessment</u>: Mapping and classification of existing anthropogenic disturbance within the drainage, and the spatial and temporal extent of impacts on wetland functions and values.

    Definition: Cumulative Effects are defined as changes in the environment and/or society that result from multiple interactions among human activities and natural processes in combination with other past, present and future activities. A Cumulative Effects Assessment is a systematic process of identifying, analyzing, and evaluating the cumulative effects of a proposed project. A Cumulative Effects Framework brings together different tools and strategies available to address cumulative effects management objectives. Cumulative Effects Management is the identification and implementation of measures to control, minimize or prevent the negative consequences of cumulative effects. This means taking a holistic view of the region by looking at the overall impacts of all developments on the landscape.

 # 2: What should the wetland conservation, development and utilization objectives be for a watershed and how can they be balanced on an application by application basis?

Wetland conservation objectives <u>cannot</u> be achieved on an application by application basis in the absence of regional land use planning and a precautionary and ecosystem-based approach to management.

We recommend these principles for wetland conservation in the Yukon:

1. <u>Regional land use planning</u>: Prior to granting a license or permit, a regional land use plan should be completed to ensure: i) ecological, social, and cultural values are identified and mapped, and targets and areas for protection are agreed upon; ii) cumulative effects of previous development activities are known and new development projects do not exceed ecological thresholds; and iii) critical sites for carbon sequestration (such as peatlands), climate refugia (such as groundwater-fed wetlands), and climate corridors (such as wetland networks, which allow species to move to cooler areas and adapt to rising temperatures) are identified and protected.

    Definition: Thresholds are defined by a level of impacts or concerns due to a combination of stressors that ultimately trigger a management action. Thresholds are informed by a combination of technical understanding and a socially defined level of acceptable change. A tiered threshold approach can often be used which includes "cautionary" and "critical" levels to prevent a certain result or condition to occur.

2. <u>Precautionary principle in all decision-making</u>*:* The Convention of Biological Diversity applies the Precautionary Principle as follows "… where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat".

    It is highly likely that spatial and temporal cumulative effects of wetland loss in the Indian River and other heavily impacted drainages has resulted in a significant loss of pre-disturbance biodiversity. In addition, testimony to the Water Board made it clear that placer mining poses significant threats to the cultural, social, and Traditional values of First Nations in Yukon. Therefore, the precautionary principle should be applied in drainages with even low levels of disturbance until scientific studies can identify both temporal and spatial thresholds in cumulative effects to wetland functions and values.

3. <u>Ecosystem approach to management</u>: As defined by the Convention on Biological Diversity, an 'Ecosystem' is a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (https://www.cbd.int/decision/cop/?id=7148). An ecosystem approach considers all levels of biological organization, from genes to species to ecosystems; considers the structure, processes, functions, and interactions among organisms and their environment; recognizes the multiple spatial and temporal scales at which these occur; and incorporates an adaptive management framework which is critical given the complex and dynamic nature of

ecosystems and incomplete knowledge or understanding of this complexity, and allows for responsive management in a ‘learning-by-doing’ framework.

#3: What wetland reclamation objectives should be considered during the water licensing process?

Wetland reclamation cannot restore the complex abiotic and biotic interactions of an intact wetland, particularly peatland ecosystems that have developed over long periods of times. Given the absence of information to manage risk to wetlands and their functions and values, we should be first focused on inventory, monitoring, and protection.

However, in areas where wetlands have been identified for placer mining based on a wetland policy and regional land use plans, reclamation should be invested to the highest standards. This requires measurement and mitigation of wetland functions, and long-term investment in monitoring.

SECTION B: BRIEF REVIEW OF SCIENTIFIC INFORMATION OF RELEVANCE TO TESTIMONY HEARD AT THE YUKON WATER BOARD HEARINGS

The following sections contain scientific information on wetlands, their functions and values, and management selected to respond to testimony at Yukon Water Boards Hearings in Public Interest. The ecology, management, and conservation of wetlands has been studied and described in numerous scientific texts and journals and thus the full breadth and depth of considerations for wetland conservation and management in relation to placer mining in Yukon is well beyond the scope of these comments.

BIODIVERSITY

What is Biodiversity?

An understanding of the term 'biodiversity' is critical to management and conservation of Yukon's wetlands and their functions and values. A widely used definition for biological diversity, or biodiversity, by the scientific community is that used by the Parties to the Convention on Biological Diversity (CBD), which includes Canada, is:

> *"Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. (Convention on Biological Diversity; https://www.cbd.int/convention/articles/?a=cbd-02)*

Importantly, this definition encompasses variability at multiple levels: 'within species (thus including genetic- and population-level measures), between species (all measures of species-level variation), and within ecosystems (thus including measures at landscape or regional levels, such as major vegetation types or biomes)*"* (Mace et al. 2012).

How do we measure biodiversity?

Capturing the full variability of biodiversity at a site, i.e. within species, between species, and within ecosystems, is difficult to achieve with a single metric. The most commonly used metric of biodiversity is species richness; other measures include evenness (a measure of the equitability among life forms, e.g. relative abundances of species) and heterogeneity (the dissimilarity among species and their ecological functions) (Cardinale et al. 2012, Mace et al. 2012). Diversity indices incorporate information on both richness and evenness. But even these indices cannot capture all layers of variability that are inherent to the biological diversity of an area.

While species richness can provide some information about the biodiversity of a location and its value for conservation, it should be used in conjunction with other metrics, including species composition, relative abundance, endemism, and functional role in an ecosystem (Fleishman et al. 2016, Mace et al. 2012). The spatial and temporal domain of species (e.g. individual home ranges) and intra (within) and inter (between) -specific interactions (e.g. reproduction; predator-prey dynamics) should inform the scale for quantifying and describing the biodiversity of an area (Fleishman et al. 2016).

Community-level metrics, such as diversity and species richness, can obscure important changes in species composition resulting from habitat loss or disturbance (Morissette et al. 2019). In particular, they do not reveal changes in community composition based on species responding positively versus negatively to anthropogenic disturbance, which is critical for understanding impacts of human activity on ecological communities and biodiversity. Species responding positively to human-driven changes in the environment are often habitat generalist, meaning they are not strongly tied to a single habitat but are able to use a wide range of habitats. In contrast, species responding negatively are often habitat specialist, which are more likely to be rare or threatened.

WETLAND FUNCTIONS AND VALUES

What is a wetland?

An understanding of the nature, dynamics, diversity, processes, functions, and values of wetlands is critical to developing an ecosystem approach that ensures conservation of wetland functions and values across Yukon. As noted in our cover letter, a full scientific examination of this subject is not possible in these comments.

Wetlands form at the interface of land and water. Canada's National Wetland Working Group (1997) defines a wetland as:

> "Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment".

Somers and McKenzie (2019) provide a more detailed description of wetlands specific to mountain systems, such as occurring here in Yukon. It emphasizes the interaction of hydrologic and geomorphic processes in the formation and functions of wetlands.

> "Wetlands are geomorphic features with the water table at or near the land surface for extended periods of time, leading to unique hydrophilic soils, plants, and hydrologic functionality. For wetlands to form, poorly draining substrates (e.g., glaciolacustrine clays) and a wet climate (i.e., precipitation well in excess of evapotranspiration) are required. Given the extensive till deposits and higher precipitation rates in mountain regions, wetlands often form and can act as carbon sinks and biodiversity hot-spots."

Hydrology of wetlands in northern mountain systems

In mountain systems, hydrologic regimes are linked longitudinally (upstream-downstream), laterally (lowland to upland), and vertically (surface to sub-surface) (Hauer et al. 2016). The nature of a valley bottom, i.e. the types and spatial arrangements of aquatic, terrestrial, and riparian (including wetland) ecosystems, is driven by biophysical processes resulting from interactions among the hydrologic regime, surficial geology and geomorphology, and biotic communities, such as plants.

In the absence of disturbance, wetlands can self-regulate, keeping water table near the land surface (Somers and McKenzie 2019). Both open water (streams and lakes) and wetland systems are integral components of surface-water and groundwater flow systems, influenced by bedrock geology and topography (Somers and McKenzie 2019, Winter 1999). Wetlands in mountain systems charge groundwater, slow the longitudinal movement of water from higher to lower elevations, and buffer periods of high flow (Somers and McKenzie 2019).

Building on the scientific literature, Somer and McKenzie (2019) developed a conceptual model of groundwater flow in high mountains that highlights the interconnectedness of wetlands with the hydrology of the surrounding landscape, including mountain peaks, mountain plateaux, steep canyons, U-shaped valley bottoms, and rivers and lakes. Their model describes how groundwater flow in mountain regions is influenced by snow and glacier melt, permafrost, recharge from alpine lakes, discharge from groundwater and springs, bedrock and surficial geology and permeability, topography, and the nature and distribution of wetlands, rivers, and lakes (Somers and McKenzie 2019).

In northern regions, permafrost maintains many wetlands when it is rich in ground ice as permafrost is impervious to water flow. Permafrost helps sustains a high water table that supports the growth of wetland vegetation, and also stores thousands of years of frozen water, minerals, nutrients, and contaminants (Woo & Young 2012).

Given the interconnectedness of the hydrologic regime in mountain systems, alteration to any single feature within a mountain drainage will impact the hydrology of the system, which in turn impacts the linked biotic conditions of wetlands and floodplains.

Conceptual model of groundwater flow in mountains. From Somers and McKenzie (2020):

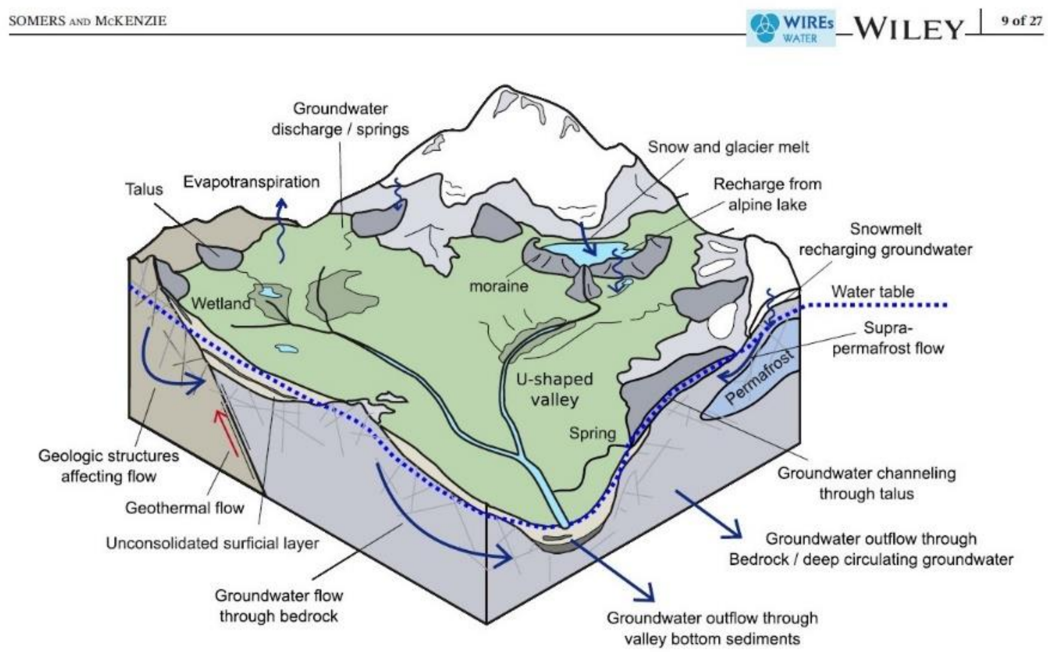

FIGURE 4 Conceptual model of high mountain hydrogeological processes including groundwater flow through subsurface features, such as talus slopes, moraines, valley bottom sediments, and bedrock, and the influence of permafrost and geological structures. Modified from Somers et al. (2019)

Hydrology and carbon cycling in northern peatlands

Hydrological feedbacks in northern peatlands are complex (Waddington et al. 2015). A comprehensive model incorporates processes, outcomes, and positive and negative feedbacks related to: plant cover, productivity, and rates of transpiration; moisture retention within moss and sphagnum; peat deformation and decomposition; and lateral and vertical hydrologic gradients and drainage, among others (Waddington et al. 2015). Through these complex hydrologic feedback systems northern peatlands have 'self-regulation' capacity that functions to moderate water table changes. Thus, through internal feedback processes, undisturbed northern peatlands are critical for maintaining ground water levels and buffering periods of extreme drying or wetting due to climatic conditions.

Carbon and water budgets are closely linked in northern peatlands as water table level influences the ecological and biogeochemical processes that in turn regulate the carbon cycle (Waddington et al. 2015). In particular, below-ground microbial diversity is critical for carbon cycling (Andersen et al. 2013) and indirect disturbance to peatlands, particularly alteration of pH and hydrology, can affect microbial communities and their capacity to sequester carbon. Thus, any disturbance within a hydrological drainage that alters water quality and quantity can affect the capacity of undisturbed peatlands to sequester carbon.

Ecosystem services of wetlands

Wetlands provide many important ecosystem services including: storage of precipitation and water inflows, flood mitigation, water filtration, and storage of contaminants. Wetlands reduce peak stream flows and downstream flooding by absorbing water and slowly releasing it back to the watershed (Philips et al. 2011). They slow water movement, creating fish habitat, and preventing destructive flood events. By removing sediment, nutrients and minerals from aquatic systems, wetlands are filters whose functioning has implications for both humans and aquatic life, including salmon.

Boreal wetlands are long-term carbon sinks (Trumbore et al. 1999; Mitsch et al. 2013). Northern peatlands contain about 20% of the soil organic carbon in the world, approximately 500 ± 110 Gt C (Yu 2012).

Wetlands mitigate climate change by rapidly accumulating both herbaceous and moss-derived peat, and by storing large amounts of carbon in partially decomposed organic deposits. These wetlands, in particular fens and swamps, are influenced by lateral water movement, or water sources that have been in contact with a nutrient-rich surface or groundwater, making them productive and biologically diverse. Wetlands can be a sink for atmospheric and terrestrial contaminants (aka "carbon sinks").

Wetlands fed by large groundwater flow systems, such as peatlands, are buffered from climate-change influences and thus maintain lower temperatures compared with the surrounding landscape peatlands (Stralberg et al. 2020). Peatlands in particular have high refugial potential and will play important roles as refugial ecosystems in Canada's boreal under a changing climate and thus for the survival of subarctic and boreal biotic communities (Stralberg et al. 2020).

However, the increase in average annual air temperature of 3–5 °C predicted for northern Canada by the end of this century will result in the degradation of frozen peatlands in the Subarctic and northern Boreal wetland regions and severe drying in the southern Boreal Wetland Region (Tarnocai 2006), with implications for their potential as climate refugia for peatland biodiversity.

Wetland classes have unique biodiversity

Yukon recognizes the 5 wetland classes of the Canadian Wetland Classification system: marshes, swamps, fens, bogs, and shallow open water. The defining characteristics of the classes are well documented, including for the Indian River in Yukon (e.g. https://yukon.ca/sites/yukon.ca/files/emr/emr-forms/emr-mapping-classifying-wetlands-indian-river-valley-yukon-final-report.pdf)

Biodiversity varies both among wetland classes (e.g. between marshes and fens), and among wetlands within a single class, particularly among different sub-classes (e.g. shrubby vs treed bog), which has significant implications for wetland management and conservation.

Many plant and animal species are specialized to occupy just a single or small number of wetland classes or sub-classes. Peatlands, in particular, have highly specialized plants and insects, and many taxa are restricted to this single habitat type (Minayeva et al. 2017). While peatlands may have lower numbers of species than other wetland types, they contain 'a high incidence of unique species, a broad spectrum of morphological forms, and a high diversity of ecosystem types at various scales', and thus make important contributions to regional biodiversity.

Fens generally support a greater number of plant species than bogs, however they differ in plant community composition and dominance (Warner and Asada 2006, Whitehouse and Bayley 2005). Fens contain more herbs, ferns, and bryophytes while bogs contain more different species of trees and lichens. Herbs contribute most to the richness of the plant communities of fens in contrast to bogs, whose plant community is dominated by bryophytes (Warner and Asada 2006). Over half of the species in treed fens and bogs in boreal Alberta are nonvascular species (Whitehouse and Bayley 2005).

Insects are the most abundant animal group in wetlands, particularly in bogs (Spitzer and Danks 2006). Different wetland classes contain distinct insect communities, including species that are specialists of only a single wetland class including bogs and fens (Spitzer and Danks 2006, Warner and Asada 2006). Insect communities in peatlands tend to be much more diverse than animal taxa, and peatland specialists may be sensitive indicators of disturbance. To ensure conservation of the unique diversity of insect fauna associated with peatlands, Spitzer and Danks (2006) recommend preservation of the regional water table, i.e. avoiding disturbance that influences water table levels both immediately surrounding a bog 'island' but also at a watershed scale.

The unique and diverse plant and insect communities of wetlands provide abundant opportunities for nesting and foraging by birds. As such, many bird species are wetland specialists, depending on wetlands for nesting, foraging, overwintering, and/or as stopover sites to rest and refuel during migration. This is true for Yukon's wetlands, which are used by an over 100 species of waterfowl, waterbirds, shorebirds, songbirds, grouse, and raptors during the breeding season alone, and are the most important habitat type to overall bird diversity and abundance in Yukon's boreal (Cooke *unpublished data*, Sinclair et al. 2003, ECCC 2013).

Distinct bird communities are associated with different classes and sub-classes of wetlands (Brazner and Achenback 2020, Calme et al. 2002, Morisette et al. 2018). For example, Morissette et al. (2013) found distinct bird communities in marshes, treed fens, shrubby fens, thicket swamps, and conifer swamps in boreal Manitoba, and each wetland class supported several species unique to that class. Birds are the most diverse vertebrate group in peatlands and several species are specialists of these unique habitats (Calme et al. 2002).

Wetland complexity and diversity at multiple scales

The biodiversity of wetlands is driven by complexity at multiple scales, for example, from a network of wetlands of different classes and sizes within a drainage, to a single 'wetland' comprised of rings of marsh, treed fen, and treed bog surrounding a pond, to the fine-scale variability that exists between the individual hummocks in a peatland (Minayeva et al. 2017, Spitzer and Danks 2006, Whitehouse and Bayley 2005). It is this complexity of wetlands at multiple scales that delivers higher biodiversity and wetland functions and greater resilience to climate change over time.

Regional biodiversity associated with wetlands is most strongly influenced by two features: area and hydrology (Lehmitz et al. 2020). Hydrology is the single most important driver of wetland functions and values, and wetland biodiversity responds to changing moisture and water table levels at multiple scales from a few metres (Lehmitz et al. 2020) to across an entire drainage (Minayeva et al. 2017, Somers and McKenzie 2020).

Reduction of wetland area, either a single wetland class or a wetland complex composed of multiple classes, affects the number of microhabitats, which affects the diversity and abundance of vascular and non-vascular plant communities and by association insect communities, which ultimately affects breeding and foraging habitat all vertebrate species, including birds, amphibians, and mammals.

Indicators of wetland biodiversity for a monitoring framework

A multi-taxa, long-term monitoring framework is necessary to assess biodiversity responses to disturbance and reclamation at site (i.e. claim) and watershed scales (Lehmitz et al. 2020, Strobl et al. 2020).

In comparison to taxonomic groups that respond rapidly to changing ecological conditions of peatlands, such as spiders and beetles, vegetation (cover, composition) is an inadequate indicator of short term changes in water table levels associated with peatlands (Lehmitz et al. 2020). Sphagnum can survive through drought periods and may remain 30 years after a peatland is drained and thus a visual assessment of a peatland is insufficient to determine status of ecological integrity (Bayley and Mewhort 2004, Whitehouse and Bayley 2005, Lehmitz et al. 2020). Thus, in a drainage with placer mining, fens and bogs adjacent to mined areas may look functional and intact based on a visual assessment of vegetation, but more detailed investigation would reveal moisture stress and cascading impacts on invertebrates and other taxa (Lehmitz et al. 2020).

Thus, a monitoring framework should include indicator species and groups that include plants, insects, birds, and mammals that reflect both undisturbed and disturbed wetland conditions, a full suite of functional guilds, both mobile and immobile species (which influences their ability to respond to changing conditions), and a full range of wetland functions, e.g. groundwater recharge, and values, e.g. biodiversity (Lehmitz et al. 2020).

IMPACTS OF PLACER MINING ON WETLAND BIODIVERSITY

Several Yukon Species At Risk (SAR) are vulnerable to placer mining

Habitat loss and disturbance as a result of placer mining may impact several federally listed species-at-risk: Rusty Blackbird (*Euphagus carolinus*); Olive-sided Flycatcher (*Contopus cooperi*); Bank Swallow (*Riparia riparia*); Spiked Saxifrage (*Micranthes spicata*); and Hudson Bay Sedge (*Carex heleonastes*). Submissions by Environment and Climate Change Canada in YESAB applications provide a more complete summary of the potential risk of placer mining to SAR.

The timing of placer mining impacts bird populations, including Species At Risk

The Migratory Bird Act prohibits the incidental take (killing or destruction) of birds, nests, and eggs. Habitat destruction during the nesting season is a significant risk to migratory birds and a violation of the MBA. To avoid predation, birds conceal nests in vegetation, which are only identified through intensive field surveys (which is discouraged as this intense activity can also disturb nesting activity). Avoidance of nests during vegetation removal is not feasible when activities are conducted during the nesting season.

Submissions by Environment and Climate Change Canada on individual project assessments outline the risk of violating the MBA and regulations, and YESAB generally recommends the following terms and conditions for placer mining: The Proponent shall not conduct land-clearing, ground-disturbing, or vegetation-clearing activities during the typical bird-nesting period for Yukon (May 1 to August 15). However, final Decision Documents issued by Yukon Government frequently remove or alter this condition arguing that it is inconsistent with current statues, which prohibit disturbance or destruction of nests and eggs and not land clearing or vegetation removal.

While enforcement of MBA regulations is under federal jurisdiction, subsection 79(2) of the Species At Risk Act (SARA) requires the responsible authority to determine the effect of a project on listed wildlife that is direct, indirect, and cumulative; to ensure that effects are mitigated in a way that is consistent with recovery strategies and action plans; and, that the actual adverse effects on the listed species or its critical habitat be monitored. A precautionary approach is recommended when the likelihood or possible significance of adverse effects is unknown. Habitat destruction during the nesting season will have clear adverse effects on two species at risk, Rusty Blackbirds and Olive-sided Flycatchers, and should be accounted for in permitting and licensing of placer mining.

Risk to fish and aquatic systems

Yukon placer mining activities involve the stripping of surface vegetation, and the thawing of overlying permafrost soils and gravels which can erode into wetlands and rivers increasing levels of suspended sediments and impacting water quality and important fish habitat (Kokelj et al. 2013; Chin et al. 2016).

Peatlands with flowing water are very sensitive to anthropogenic pressure, particularly to roads and linear features acting like dams to moving water. Hydrology can be impacted for kilometers on either side of the road (Willer 2017).

Cumulative Effects

The cumulative effects of placer mining and climate change (e.g., permafrost thawing) on wetland ecosystems are largely unknown.

Many jurisdictions, including Yukon, have regulatory policies that protect only one of a few wetland classes (e.g. forest management standards, Indian River interim approach) and further may only protect the wetland (e.g. IR interim policy) or the wetland plus an undisturbed buffer of varying width (e.g. FM). These approaches neglect the cumulative impacts of wetland loss across a watershed on wetland functions and values (Morissette et al. 2019). Thresholds for impacts at a drainage or watershed scale are unknown for wetlands and placer mining and thus require application of the precautionary principle.

To evaluate cumulative effects in Yukon wetlands, the evaluation must be bounded by the spatial and temporal boundaries of the environmental resources of concern (Bedford et al. 1988). First, the total value of a wetland must be determined (i.e., functions and other ecosystem services – provisional, regulatory, or cultural and amenity services), and boundaries for different functions may occur. Once the spatial and temporal scales have been chosen, appropriate variables must be selected for the evaluation. Some variables are easier to measure than others (e.g., pollutants versus water storage). Then, spatially explicit or long-term studies are needed of wetland watersheds conducted in association with controlled field manipulations, laboratory studies, and modeling efforts (Bedford et al. 1988).

MANAGEMENT AND CONSERVATION OF WETLANDS IN YUKON

Review of the Yukon Government Strategy for Management of Wetlands in Yukon

In the Water Board Hearings in Public Interest, the Yukon Government advanced a 3-pronged approach to managing wetlands in the Yukon.

<u>#1 – Development of a Wetland Policy</u>

WCS Canada has been an active member of the Yukon Government's Wetland Policy roundtable and has recently submitted comments on Draft 6 (Appendix 1).

In brief, we support the following aspects of the draft Policy: a process to nominate and identify Wetlands of Special Importance; a mitigation hierarchy for managing impacts to wetlands. Our primary critique of the draft Policy is that it does not provide a means for the protection of Wetlands of Special Importance, and in fact by setting up a mitigation hierarchy for management of WSI the Policy is effectively allowing for their complete destruction if the first stages of the hierarchy (avoid, minimize) cannot be achieved.

<u>#2 Regional Land Use Planning</u>

Application by application review is occurring in absence of regional land use planning. As noted previously, regional land use planning is critical to ensuring values are protected and cumulative effects are mitigated.

<u># 3 - Interim Approach to Managing Placer Mining in the Indian River</u>

The Yukon Government's interim policy for wetland management in the Indian River drainage includes a quantum of preservation on a claim block basis: 100% of bog area and 40% of fen area must remain <u>physically</u> undisturbed. The Yukon Government's approach is to avoid direct impact and does not require an undisturbed buffer zone surrounding the peatland, despite the acknowledged benefit to wetland functioning.

No scientific evidence has been provided to support this management approach to protecting peatland functions and values in this drainage.

Given the complex abiotic and biotic processes within peatlands), and between peatlands and the surrounding environment (Somer and McKenzie 2020), removal of 60% of a peatland will disrupt the complex hydrology and carbon cycling of the remaining 40%, effectively resulting in impacts to 100% of fens and bogs and subsequent alteration of functions and values. In fact, this approach is likely to be more detrimental as it leaves small vulnerable wetland patches, within which ecosystem functions are degraded and biodiversity values are diminished.

Review of Select Approaches to Wetland Management in Yukon

Department of Fisheries and Oceans (DFO) Watershed Authorization Model

This 'authorization' by DFO allows for 'harmful alteration, disruption or destruction of fish habitat' resulting from placer mining in the Indian River watershed. Similar authorizations exist for watersheds across Yukon, with potentially significant impacts on salmon populations.

The existing authorization model is singly focused on fish and fish habitat and thus is inadequate to manage wetlands at any scale. Measures intended to protect aquatic systems and fish populations are usually inadequate for other taxonomic groups reliant on wetlands (e.g. Cooke and Tauzer 2020).

A condition of the DFO authorization for destruction of fish habitat in the Indian River and other drainages in Yukon is that proponents must adhere to the Fish Habitat Design, Operation and Reclamation Workbook. The approach in the Workbook is aimed to protect fish and fish habitat and is grossly insufficient to protect riparian and wetland values for the following reasons:

1) No designated riparian zone (page 125).
2) A 30m threshold for activities (page 125), which is at worst insufficient for many ecological values, and at best is unsupported by regional scientific information.
3) No setback (i.e. physical buffer between anthropogenic disturbance and the aquatic ecosystem) is required in 'Water Quality Zones' (Section C – Riparian Zones) but rather a constructed 'berm' is used to protect fish habitat from adjacent activities.
4) No restrictions on surface vegetation clearing in Water Quality Zones.

Yukon Forest Management Branch Planning Standards

Two standards manage impacts to riparian and wetland ecosystems in the context of forestry: Riparian Management on Streams and Lakes Standards and Guidelines; Wetlands Riparian Management Standards and Guidelines.

Yukon's riparian management standards include five reserve zone widths based on stream and wetland size: 40 m (maximum reserve width for small streams < 5 m); 60 m (maximum reserve width for large streams 5 to 20 m and for wetlands >1 ha); 80m (maximum reserve width for streams > 20 m); 100 m (maximum combined reserve and management zone for streams < 5 m); and 200 m (maximum combined reserve and management zone width for the large streams and rivers and wetlands).

These standards provide some protection for wetland functions and values through the use of an unharvested reserve zone (or buffer) of varying widths adjacent to marsh and shallow open water wetlands. However, these standards do not require a reserve or buffer zone for fens, bogs, and swamps. While it might be assumed that forestry activities are unlikely to occur around these types of wetlands, a WCS Canada study of bird communities in harvestable, mature riparian spruce forest in Southern Lakes included 7 of 15 study sites adjacent to fens and 6 adjacent to swamps; the remaining 2 were associated with marshes (Cooke and Tauzer 2020). We identified 9 bird species that preferred riparian habitat associated with streams and wetlands. Based on their use of the riparian area and adjacent forest, only the maximum unharvested reserve zone in Yukon's riparian management standards (200 m) may be sufficient for these species. The narrowest reserve zone of 40m is sufficient for only 1 riparian bird specialist.

Thus, our recommendations for forest management, and which applies to all resource management activities in the Yukon, is that all wetland classes should be protected by management standards such as an unharvested reserve zone.

Wetland Reclamation Following Placer Mining

Conversion from peatland wetlands to pond, marsh, and upland deciduous forest represents a net loss in wetland area as deciduous regrowth on constructed 'hills' replaces fens and bogs. Further, when created ponds are deeper than 2 m they are no longer functioning as shallow open water wetlands.

Both within class and between individual peatland heterogeneity means that each destroyed peatland is a loss of a regionally unique ecological community, perhaps even with unique genetic composition (due to long history of development and isolation as habitat islands). Loss of diversity at all levels of biological organization (genetic, species, community) has implications for ecological resilience to change.

Appendix 2 provides a detailed review of the study of avian communities in the Indian River drainage study commissioned by the Klondike Placer Miners Association (KPMA), implemented by consultant Anne Chevreux, and analyzed and reported on by the consulting company EDI (EDI 2017). One of the co-authors of these comments (HAC) is an avian ecologist with more than two decades of experience conducting avian field research and publishing peer-reviewed scientific papers, including a study of riparian bird communities in Yukon's Southern Lakes, and conducting peer reviews of avian studies for scientific journals.

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Appendix 1. WCS Canada Comments on draft Wetland Policy #6

Department of Environment
PO Box 2703
Whitehorse, Yukon
Y1A 2C6

RE: Yukon Government Wetland Policy Draft 6

September 30, 2020
Dear Amy Law and Tyler Kuhn,

Thank you for the opportunity to provide feedback on Yukon Government Wetland Policy Draft 6. The draft Policy has two major tools for the protection and management of wetlands in Yukon: designation and protection of Wetlands of Special Importance and management of wetlands using a mitigation hierarchy (it also recognizes the role of regional planning and designation of protected areas in wetland protection in Yukon).

The effectiveness of these tools in achieving the Policy goal – ensuring the benefits of Yukon's wetlands are sustained for all – depends on: 1) completion of a Territory-wide wetland inventory at the level of the 5 classes (fens, bogs, swamps, marsh, shallow open water) and 2) consideration of multi-dimensional connectivity with terrestrial and aquatic ecosystems in wetland delineation and impact assessment.

While the role of the mitigation hierarchy is to first avoid and then minimize impacts, etc., the premise is that loss of wetland function and benefits is allowed to occur as a result of development and other human activities. Disturbance and loss from development activities and disruption of functioning due to climate change will both continue with watershed-level implications for wetland functions and benefits. Meanwhile, regional planning and designation of protected areas or land management units with protection of wetlands proceeds slowly. Protection of Wetlands of Special Importance (WSI) is critical to ensure important ecological, social, and cultural values are not lost in the interim.

A Wetland Policy that ensures protection of Yukon's wetlands and wetland complexes and their associated values using the WSI tool requires: a set of clear and comprehensive criteria for listing WSI; area targets for protection of representative wetland classes as WSI at the ecozone level; a transparent process for review and listing of WSI by Department of Environment, without interference from other Departments; and full protection for WSI and prohibition on activities within the watershed that disrupt or impact functions.

Please find attached more detailed comments on the draft Policy.

Sincerely,

Dr. Hilary Cooke, Associate Conservation Scientist, Wildlife Conservation Society (WCS) Canada

WCS Canada Comments on Yukon Government Wetland Policy Draft 6

Policy Goal

The draft Policy states that a supporting document will include much of the content in the Introduction of the previous version. While recognizing the preference for brevity in the Policy, the introductory statements could be expanded to provide more context for the Policy Goal and thus allow it to function better as a 'stand-alone' document. For example, the previous version included an Acknowledgements section that broadly outlined wetland functions and benefits. Key points to include are that wetlands: support unique and abundant biodiversity; provide ecosystem services to society, with water and carbon storage among the most critical; are interconnected with aquatic and terrestrial ecosystems within a watershed; and connect people to places where food and medicine is plentiful.

Previous draft versions of the Wetland Policy included a set of Guiding Principles which were supported by many roundtable partners. In my submitted comments on Roundtable Report #4 I state that the summary on the discussion of Guiding Principles 'provides little information on which principles were generally supported by members (#1 - wetlands essential for ecosystem health; #4 – importance of considering cumulative effects; #6 – importance of adaptive management)'. These themes resonated with many partners and were raised consistently at the roundtables. The themes of the Guiding Principles that had broad support should be reinstated in the text of the Policy, either as Guiding Principles or perhaps within a Preamble that includes key background information as suggested above.

Indigenous Context

We strongly support the three concepts outlined in this section as guiding principles for the Policy. The relevant terms should be included in the Definitions section.

Definitions

The following terms should be added to this section: stewardship; respect; reciprocity; holistic; mitigation hierarchy. Each of the 5 wetland classes should also be described in this section to provide the necessary context (without having to rely on the more detailed supporting documents).

Building Knowledge

The Policy states that 'there are gaps in our current knowledge which may limit the scope and implementation of this policy' (p3). In the absence of sufficient knowledge to manage wetlands to protect benefits and functions, the Policy should adopt the Precautionary Principle. The Convention of Biological Diversity applies the Precautionary Principle as follows "… where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat" (https://www.cbd.int/convention/articles/?a=cbd-00). While the Precautionary Principle is consistent with the first stage of the mitigation hierarchy – avoidance – it goes further in stating that lack of knowledge should not be rationale for skipping this stage. Including the Precautionary Principle as one of the Guiding Principles for the Wetland Policy was raised and supported by many roundtable partners (e.g. page 7 in 'Wetlands Roundtable #4: March 26-27, 2019 – Workshop Report'). In this draft, the

Policy does not comply with the Precautionary Principle given that it explicitly allows for knowledge gaps to limit scope and implementation of a Policy aimed to 'ensure the benefit of Yukon's wetlands for all', and therefore allows for the potential for harm to, or loss of, wetland functions and benefits due to management activities.

Benefits & Functions

This section describes wetland functions and benefits related to land, water, air, and cultural. The 'land' category would more appropriately be labelled 'ecosystem'.

This section should acknowledge that each of the 5 wetland classes has distinct functions and benefits, including carbon storage capacity and unique biological communities. More detailed information can be provided in the supporting documents but the importance of wetland class to determining functions and benefits should be stated here.

Wetland Inventory

The Policy commits the Yukon Government to supporting a territory-wide wetland inventory and detailed inventory where needed. The territory-wide inventory should be to the level of the 5 classes otherwise key aspects of the mitigation hierarchy cannot be achieved. For example, a guiding principle for managing wetlands under the mitigation hierarchy is that 'Cumulative wetland loss will be kept well below the ecological thresholds for the watershed'. As noted previously different wetland classes provide different functions and benefits so the cumulative effects of wetland loss should be considered by class. A complete inventory for all wetland classes allows for pro-active planning and management to minimize risk of cumulative effects to different wetland classes while also providing certainty to proponents and timeliness of project assessment and permitting.

<u>Wetlands of Special Importance (WSI)</u>

Nomination of WSI

Greater clarity is needed about the review process for nominated WSI. Will departments other than Environment have input into the review process? If the criteria are followed, Environment should have complete independence in review and listing of WSI. The review and listing process should also be made transparent to the public through a summary of information considered in the review and those factors that determined the decision on listing.

Criteria

Several of the criteria for a WSI have high thresholds that are applied at an International or National level (as noted in the text of this section). These criteria have low likelihood of being met for more than a small number of wetlands or wetland complexes yet many more wetlands or wetland complexes provide significant value – ecologically, culturally, etc. – when considered regionally. Thus, wetland importance should be considered at the scale of a First Nation traditional territory or Yukon territory-wide.

Critical Habitat is defined in the federal Species at Risk Act (SARA) as 'the habitat that is necessary for the survival or recovery of listed extirpated, endangered, or threatened species, and that is identified as Critical Habitat in a recovery strategy or action plan." (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/critical-habitat-descriptions/identification-toolbox-guidance.html). WSI have the potential to fill important gaps in protection for species at risk in Yukon. However, because Critical Habitat is defined during the preparation of a recovery or action plan, it lags behind (usually for many years) the listing of a species. Wetlands known to provide habitat to species-at-risk should be considered for listing as WSI regardless of whether CH has been defined.

Greater clarity is needed on the criteria 'it provides habitat required for the continued survival of a wildlife species in Yukon'. How is 'survival' defined? Currently it is improbable that any given wetland in the Territory is not being 'used' for one or more life stage by multiple wildlife species and thus contributes to their survival. Is survival to be assessed at a population level? We recommend protection of wetlands to ensure survival of ecologically functional populations of wildlife that are dependent on wetlands for at least one part of their life cycle.

The criteria that a WSI 'contributes to protection of ecologically representative set of wetlands in each ecozone' is an important part of a comprehensive strategy to protect wetlands and their functions and benefits in Yukon. The Policy should set targets for protection, i.e. what percentage of wetlands by class will be protected? Presumably 'ecologically representative' refers to the 5 wetland classes, which will require a Territory-wide inventory as previously recommended. Lack of knowledge should not be rationale for delayed implementation of this part of the Policy.

The following criteria should also be considered for identifying and protecting WSI:

- Significant contributions to regional biodiversity
- High carbon storage
- Important contribution to connectivity of wildlife habitat
- Potential refuge from climate change
- High risk from climate change

Listing of WSI

Prior to the Wetland Policy roundtable engagement process Yukon Government, working with the Wetland Committee (which included representatives from Canadian Wildlife Service, ENGOs, and Yukon University), had invested a considerable amount of effort compiling a database of more than 100 wetlands of special importance in the Yukon based on existing knowledge of their ecological value. These should immediately be considered for listing as WSI (after review and consideration by the relevant First Nation(s)). As noted previously, the review and decision should be transparent and publicly available.

Mitigation requirements of WSI

This and other sections of the Policy treats wetlands as single discrete entities without recognition that they occur at an interface of land and water, and that their benefits and functions cannot be maintained in isolation of management activities throughout the watershed. The draft Policy does not describe how a wetland will be delineated, yet this is critical for all aspects of the Wetland Policy. Adequate protection of wetlands and associated functions and benefits requires consideration of hydrologic, terrestrial, and biotic linkages in multiple dimensions: upstream, downstream, lateral, and temporal (Reis et al. 2017). Ideally, wetlands are protected as part of an integrated 'river-basin management plan to ensure conservation of freshwater ecosystems and the services they provide'. This would include upland parts of the catchment as well as streams, rivers, lakes, and other wetlands linked hydrologically to the WSI.

The Policy allows for development or other activity in and around WSI yet claims that mitigation action will be taken to ensure 'No Loss' of wetland benefits. It is unlikely that development or other activity in and around a WSI will be able to avoid disrupting the processes occurring at the aquatic-terrestrial interface that drives wetland functions and produce wetland benefits. To ensure 'No Loss' of wetland benefits, no development or activity that will disrupt or alter wetland functioning should be allowed in or around a WSI once it is listed.

Protection of WSI from all development activities is particularly important given that the following section – Managing Human Impacts – lays out a process by which any wetland outside a protected area (of any designation) may be impacted by development or other activity. The draft Policy currently puts wetlands into two classes – those that are nominated as WSI and those that fall under the mitigation hierarchy. The latter allows for complete loss of existing function and benefits by including the provision that a wetland may be reclaimed to a different wetland class. Protection of WSI is the only means to guarantee protection of high-value wetlands outside protected areas and thus no development activities should be allowed.

Appendix 2. Review of KPMA Study of Avian Communities in the Indian River drainage

Dr. Hilary A. Cooke, WCS Canada

Background

In 2014 I met with Anne Chevreux at her request and provided recommendations for study design to achieve the objective of comparing bird communities of undisturbed wetlands with post-mining reclaimed wetlands. My primary recommendation was to treat the Indian River drainage as a 'disturbed' or 'mined' site and compare it to an intact or unmined site with similar pre-disturbance ecological characteristics (see rationale under 'Study Design'). Based on her description of the objectives of the study I concluded that a comparison of the avian community of the Indian River drainage with a nearby, ecologically similar but undisturbed drainage would be a more appropriate study design to determine the impact of placer mining and wetland reclamation on avian communities than comparison of individual locations along the Indian River. The resultant study design reflects the logistical constraints of conducting field research in the Yukon and not the commitment and effort by the consultant, Anne Chevreux, to implement a scientifically-robust field study in a remote northern region.

Interpreting the results of a study of bird communities in different habitats (such as mined vs unmined areas within the Indian River) requires a detailed understanding of:

1. The influence of study design on data collection.
2. The influence of data analysis on results and interpretation of results.
3. The habitat preferences and associations of species within the broader region within which the study is conducted; and,

Study Design

- The entire valley has been disturbed and 'unmined' sites are in close proximity to mined sites. Thus, the study design does not allow for a comparison of avian communities in disturbed and undisturbed systems but rather a comparison among sites within a disturbed drainage. This is acknowledged in the EDI report: "Post-mined and unmined sites in this study area were dispersed within a matrix of placer mining activity. As a result, habitats and bird communities from unmined areas may not be representative of truly undisturbed conditions for this region." (page 23).
- The challenge of designing a study that examines mined and unmined sites within a single drainage is clear in Figure 6 of the EDI report. Removal or disturbance of natural ecosystems has increased in the Indian River drainage from 1971 to present. Panel (d) in Figure (6) clearly demonstrates the widespread habitat loss and destruction due to placer mining within this drainage by 2013. This reinforces the need to compare drainages with a multi-decadal history of mining with intact, unmined valleys to truly understand the cumulative impact of mining on all taxa (microbes, plants, inverts, birds, mammals) AND processes (hydrologic regimes, nutrient cycling, carbon cycling).

- Study design and methods is not appropriate for all species included in analysis, and therefore not all conclusions are supported by the study. In particular, the study design is not appropriate for surveying species with territory sizes greater than 1-5 ha, such as some shorebirds and songbirds. It is also not appropriate for species that make daily movements between nest and foraging sites of more than a few hundred metres, such as Common Nighthawk and Bank Swallow. These species may use an area or defend a territory encompassing multiple survey locations so there is risk of double-counting individuals and inferring 'use' of a site based on an observation of an individual travelling between nesting and foraging areas. The spatial scale of sampling is not appropriate for two species identified as significant indicators of unmined sites: gray jays and Wilson's Snipe.
- Although the data collected in this study does not describe the avian communities of undisturbed valleys or drainages in the Klondike gold fields, it can provide a 'picture' of the occurrence or distribution of many songbirds (with smaller territories, such as warblers and sparrows) at mined and unmined sites within a drainage with active placer mining and reclamation activities.

<u>Data Analysis</u>

- Birds, particularly songbirds, are often detected by vocalizations during surveys. Multiple factors can affect whether an individual of a given species is detected during a survey including how frequently the species sings, how far away a song or call can be heard in the absence of barriers and in different habitats (e.g. open grassland vs shrubland vs forest). Habitat type can also influence the likelihood of a visual detection of an individual. Differences in species detectability were not evaluated in this study. Based on studies of bird detectability over the past several decades in North America, we would expect all factors to have influence detectability in this study and these can have significant impacts on the results and conclusions.
- The analysis of songbird communities used multiple metrics that are standard in the scientific literature for avian research (2 diversity indices, Indicator Species Analysis, and Detrended Correspondence Analysis). While diversity indices do not provide information on community composition, particularly the occurrence of habitat specialists (e.g. require shrubby wetlands for nesting) versus generalists (e.g. can nest in shrubby areas, including alongside roads, at forest edges, in the subalpine, and in wetlands). Habitat specialists are more likely to be at risk and declining due to habitat loss, such as old-growth forest, wetlands, and floodplain forests. Species composition is important consideration. Species richness does not differentiate a community that is rich in habitat specialists (i.e. completely dependent on one or a few habitat types and therefore at greatest risk due to habitat loss) from one composed of widespread and abundant habitat generalists (i.e. able to use numerous habitat types throughout Yukon).
- Conservation scoring used by EDI is based on North American assessment, not regional conservation priorities. What was not appropriate is the measure of 'Conservation Value' to

compare mined and unmined sites. The index of Conservation Value used was developed at a continental scale based on priorities for bird conservation at national scales (i.e. Canada and the United States). It does not incorporate or account for regional priorities for bird conservation in the Yukon as identified by Canadian Wildlife Service in the Conservation Plan for this region (ECCC 20xx). In addition, it's noteworthy that the Conservation Value index is very strongly correlated with species richness and so does not actually contribute to our understanding of differences in conservation value between mined and unmined sites beyond differences in number of species. The use of the index in this study is misleading regarding the actual conversation value of post-mined and unmined sites.

Interpretation of Results and Conclusions

- Greater species richness does not necessarily equate to greater ecological value.
  - Species composition is an important consideration. Species richness does not differentiate a community that is rich in habitat specialists (i.e. completely dependent on one or a few habitat types and therefore at greatest risk due to habitat loss) from one composed of widespread and abundant habitat generalists (i.e. able to use numerous habitat types throughout Yukon).
  - While species occurrence does not necessarily reflect breeding productivity and other important life cycle activities, this is a not an issue novel to this study. Most studies rely on species occurrence to make inferences about habitat use and management and conservation practices, including by Cooke and Tauzer (2020) in southern Yukon.
- Occurrence of Species At Risk within the study area
  - The study concludes that several Species at Risk use the Indian River drainage during the breeding season, including Bank Swallow, Rusty Blackbird, Red-necked Phalarope, and Horned Grebe. The data supports this but, with the exception of Horned Grebe which were observed with chicks at post-mined ponds, this study did not examine nesting success. Habitats modified by human activity are often 'sink' habitats for breeding birds, meaning they select the site for breeding but due to various factors (poor food quality, increased predation) they are unsuccessful at nesting. In addition, species observed foraging (Bank Swallow) in the area may have nesting outside the drainage (as noted in the report). One example of unsupported conclusion is that there were more threatened species in post-mining sites. These species (including Rusty Blackbird, Common Nighthawk) occupy territories at scales greater than individual site; many likely move among areas along the Indian River.
- Response of waterfowl to post-mining reclamation
  - The study found higher use of post-mined sites by waterfowl. This would be expected because post-mining reclamation created ponds (16% vs <1% open water at mined vs unmined sites). However, 84% of the ponds were within post-mined areas; only 8 ponds at unmined sites were surveyed. There is a large body of scientific literature

demonstrating the effect of sampling or survey effort on species richness and species abundance. Meaning, the more ponds sampled, the more waterfowl will be counted, which leads to inflated measures of the importance of ponds in mined versus unmined areas. To fairly compare the value of ponds in mined and unmined areas would require surveys at an equal number of ponds in each. **The report by EDI clearly states that "comparisons based on mining history were not feasible" (page 6).**

- While there are several waterfowl species of conservation concern in Yukon (example) due to conservation efforts of last 50 years, waterfowl populations have been steadily increasing (150%) since 1970. Species with declining populations include wetland specialists.

Habitat Preferences of Indicator Species

- Indicator Species Analysis is a statistical technique to determine if one or more species has stronger 'associations' with a habitat type or condition; in this case, mined vs unmined sites. Species identified as 'significant indicators' are statistically more likely to have been observed both at higher abundances in one type versus another AND at more sites of one type than another. For example, Lincoln's Sparrow were identified in this study as significant indicators of unmined sites. This means they were observed across more unmined than mined sites AND at higher abundances at unmined and mined sites. The stronger the statistical association, the stronger the connection between the species and the habitat type.

- The study identified several significant indicators of unmined sites within the Indian River drainage. It is important to note that the sampling design was inappropriate for drawing conclusions about the association of two indicators - Gray Jay and Wilson's Snipe - with mined or unmined sites so we will not address those results. The following known habitat associations of the other indicator species can provide insight into interpretation of the results of the study.

    - Lincoln's Sparrows are commonly associated with shrubby and treed wetlands, particularly spruce–willow bogs (Machtans and Latour 2003; Ryder 2015; Sinclair et al. 2003). It is noteworthy that it is the only avian indicator species in this study that has a specific association with peatland habitat.

    - Savannah Sparrows are common in grassy and low shrub habitat throughout Yukon (Sinclair et al. 2003).

    - Common Yellowthroats are found in shrubby (willow and birch) wetlands throughout the Yukon (Sinclair et al. 2003).

- The study identified several significant indicators of post-mined sites within the Indian River drainage. Sampling design was inappropriate for drawing conclusions about the association of one indicator of post-mined sites - Spotted Sandpiper – so will not be addressed here. Overall, the avian indicators of mined sites identified in this study tend to select deciduous shrubby and treed habitats for nesting in the Yukon but can be distinguished by those that select shrubby habitats in moist locations, such as Northern Waterthrush and Yellow Warbler, from those that select deciduous habitats, both shrubby and treed, in a variety of locations, such as Wilson's and Orange-crowned Warbler, Fox Sparrow, and Hermit Thrush.

- Northern Waterthrush selects treed and shrubby habitats associated with water across its boreal breeding range (Whitaker and Eaton 2014), including in Alaska (Bent 1953) and the Yukon (Sinclair et al. 2003). Northern Waterthrush is a significant indicator of riparian-forest edge habitat in Yukon's Southern Lakes region (Cooke and Tauzer 2020).
- Wilson's Warbler breeding habitat in the northwest boreal region of Canada has been described as primarily tall shrubby habitat, including associated with riparian areas of streams and wetlands, but also in subalpine and burns (Kardynal et al. 2015; Sinclair et al. 2003; Theberge 1976). Although a significant indicator of riparian-forest edge habitat in Yukon's Southern Lakes, Wilson's Warblers are found breeding in shrubby habitat throughout Yukon. In some arid regions Wilson's Warbler are considered a riparian and/or wetland specialist.
- Yellow Warblers are associated with shrubby, particular willow, habitats throughout their range. In Yukon, this bird species is found in moist to wet deciduous shrubby and forested habitats at all elevations (Sinclair et al. 2003). In some arid regions Yellow Warbler are considered a riparian and/or wetland specialist (Cooke 2003).
- Orange-crowned Warblers are found in deciduous tree and shrub habitats at most elevations in Yukon (Sinclair et al. 2003) and so while frequently found in wetlands in Yukon, they are not a specialist of this habitat.
- Familiar to most Yukoners, American Robin generally prefers habitat with some deciduous cover by trees and/or shrubs (Sinclair et al. 2003) but is a habitat generalist and thus not an indicator of wetland condition in the Yukon.
- Fox Sparrows are also associated with deciduous shrubby areas, including gin wetlands, burns, and open forests of the Yukon (Sinclair et al. 2003). Therefore, while this species may select wetlands for nesting it is not a wetland specialist, i.e. not limited to breeding in shrubby wetland habitats.
- Hermit Thrush – Generally associated with deciduous tall shrub and woodland habitat in western boreal Canada, Hermit Thrush are described as using two distinct habitats in Sinclair et al. (2003): open mixed forest near treeline, including along creeks, wet draws, and gullies; and, trembling aspen forests at lower elevations. Thus, not strongly associated with wetland habitat, occurrence of this species in post-mined sites is likely associated with higher cover of deciduous shrubs and woodlands.