YUKON NORTH SLOPE
BASELINE ECOLOGICAL AND CULTURAL CONSERVATION ASSESSMENT:

TRADITIONAL KNOWLEDGE-BASED MOOSE HABITAT MODEL

FINAL REPORT

PREPARED BY
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Introduction

The Inuvialuit Final Agreement (IFA) was legislated in 1984 and identifies that the management priority for the Yukon North Slope (YNS) is the conservation of the land, waters, wildlife and Inuvialuit traditional use. The IFA also formed the Wildlife Management Advisory Council (North Slope) or WMAC (NS) with the mandate to advise on all matters related to wildlife management on the YNS, including the preparation of a Wildlife Conservation and Management Plan. WMAC(NS) is currently in the process of updating the existing Wildlife Conservation and Management Plan ('Wildlife Plan') and is working closely with the Aklavik Hunters and Trappers Committee (Aklavik HTC) in developing the process, approach, and goals for the new plan. The revised Wildlife Plan will include climate-informed and spatially-explicit information and analyses of current and potential future conditions of the Yukon North Slope that affect the land, waters, wildlife and Inuvialuit traditional use. As part of these revisions, WMAC is working with Round River Conservation Studies in the development of a spatially-explicit Baseline Ecological and Cultural Conservation Assessment (BECCA) to support translating the conservation principles of the IFA to on-the-ground management guidance. This work includes developing habitat models and maps for focal fish and wildlife species identified by the Aklavik HTC.

The revisions to the Wildlife Plan will emphasize greater incorporation of Inuvialuit Traditional Knowledge (TK) and Traditional Use (WMAC and AHTC 2018b), including TK regarding important YNS fish and wildlife habitats (WMAC and AHTC 2018a). Inuvialuit TK of habitat for focal fish and wildlife species will provide the basis for developing habitat models and maps for selected focal species. The first of such TK-based habitat models is described here, for Yukon North Slope moose.

Moose are an ecologically and culturally important species across Canada, and many indigenous communities have traditionally relied on moose for subsistence purposes (Berkes et al. 1994, Wein and Freeman 1995). Moose are closely associated with habitats that support medium to tall shrubs, particularly willow, which is a primary forage for the species. Within the boreal, moose are typically found in greatest abundance in areas that provide abundant forage and are within proximity to forested areas that provide security and cover (McCulley et al. 2017a, 2017b). Both TK and wildlife monitoring indicate that moose are becoming more abundant in the northern periphery of the boreal and in regions north of the boreal forest including in the Richardson Mountains and the more coastal habitats of the YNS (WMAC and AHTC 2018a; M. Suitor, pers. comm.). Arctic landscapes have seen a notable increase in the abundance, distribution and height of willow (Fraser et al. 2014), and this is believed, in part, to be facilitating the potential expansion and increased abundance of moose into the most northern landscapes of the Yukon (Tape et al. 2016).

Inuvialuit hunters and trappers have a detailed understanding of moose habitat on the YNS, which has been gained through generations of wildlife harvesting and travel across the study area. This knowledge was the basis for a report on the habitats of important wildlife species across the YNS (WMAC and AHTC 2018a). This research builds from this TK to develop a habitat suitability index model and create maps of predicted moose habitat across the YNS.

Methods and Results

We based our modeling efforts on the observations of 18 Inuvialuit land-users who described moose habitat during wildlife habitat traditional knowledge interviews in October and November 2016 (WMAC and AHTC 2018a). Participants were asked to describe moose habitat across the range of seasons and locations for which they were familiar within the YNS planning region (Map 1). Interviewees had the option of verbally describing habitat, indicating specific locations on a map, or selecting photographs of traditional knowledge habitat classes (WMAC and AHTC 2018a).

Most interviewees described year-round habitat requirements, providing detailed descriptions of moose habitat on the YNS, and did not necessarily link observations to a specific season. These descriptions were based on observations made while land-users traveled throughout the study area including along the coast by boat and by snowmobile through inland regions. Interviewees were asked to describe the physical characteristics of areas where they observed moose, with an emphasis on the vegetation, topography, and hydrography of moose habitat. When possible, interviewees were asked to describe the specific value of habitats where moose were present (e.g., foraging or predator avoidance).

Most responses focused on the presence of willow or water when describing moose habitat. The presence of tall shrubs (primarily willow) or water in the form of rivers, lakes, or swamps were stated to be important for both foraging and predator avoidance. While interviewees acknowledged that moose could be found in a variety of terrain types, most responses described low-lying and flatter terrain, stating that moose are most likely to be found in river valleys, coastal flats, or swampy areas.

Participants did not typically indicate any major seasonal moose migrations, nor identify specific calving grounds, or seasonally specific resources. Some interviewees described differences between moose habitat in “coastal” versus “inland” areas and suggested there may be a seasonal movement between habitat types. Additionally, some participants described moose herding in large groups at specific locations during the winter or spring. However, these descriptions were not consistent enough among interviewees to build seasonal moose habitat models. Instead, we have focused our model on selecting the features that predict moose habitat year-around, while recognizing that moose may utilize a subset of these habitat features more prominently during specific seasons based on environmental conditions.

Moose habitat descriptions that could be mapped were identified from each interviewee transcript. The habitat descriptions across all interviews were combined to develop a list of mappable habitat queries with a relative weight that corresponded to the number of individuals describing the feature. We identified multiple different queries for willow and river habitat attributes based on TK descriptions of specific characteristics. To predict where different willow and riverine habitats occurred, we used available Predictive Ecosystem Mapping (PEM) of ecological communities combined with water and topographic features. This resulted in six separate categories for willow habitats and three separate categories for riverine habitats. We then added 19 additional habitat descriptors to our model, based interviewee photo selection or verbal descriptions.

Below we summarize these TK-based descriptions of important willow and riverine habitats and how these were characterized using available spatial data including the PEM, topographic and hydrologic data to predict the occurrence of these habitats across the YNS.

Willow Classification

All 18 participants incorporated willow into their description of moose habitat. We cross-walked willow habitat descriptions with available PEM spatial data for the study area to select mappable attributes that accurately reflected Inuvialuit descriptions of moose habitat. In the October 2016 habitat cross-walk workshop (WMAC and AHTC 2018a), many participants made clear that they refer to “willows” as all woody shrubs above knee height that are not coniferous. Therefore, we included non-willow vegetation, such as alder, in our selection of “willow” habitat types. Additionally, participants referred to willow-shrub (“above knee height”) species in their interviews, not ground cover species such as *Salix reticulata*. Therefore, we removed these dwarf willow species from our habitat selections for “willow” to reflect the definition of willow generated in our workshop. Based on the abundance and distribution of willow species within PEM units, we further refined “willow” habitats into “high quality” (dominant/abundant) and “low quality” (sparse) classes. We used the following PEM units to define high quality willow habitat: Dense Med-Tall Shrub, Herb – Willow Riparian, Dense Low-Med Shrub, Spruce-Alder (Willow), and Mesic Spruce. Low quality willow habitat was represented by the following PEM units: Shrub-Sedge Tussock, Sparse Shrub – Moss Tundra, Willow – Horsetail, Alder-Cottongrass Tussock, Subhygric Spruce Tussock, and Subhygrix Spruce Horsetail. Five interviewees described moose using willow generally (Table 1).

Several interviewees provided detailed descriptions that suggested specific willow communities are important for moose. To capture these willow community types, we further classified willow habitat descriptions based on topographic constraints mentioned by interview participants. Many interviewees spatially restricted their descriptions of willow habitat based on elevation or slope profiles, proximity to certain types of water, or location within the general study area. We built five additional classifications to reflect willow habitat descriptions that were more specific than “general willow habitat.”

Nine participants described moose habitat as river beds that contain willows. We mapped this “Willow in River Beds” habitat based on topography and ecological community, selecting ecological communities that met our definition of willow and were within areas identified as “Canyons”, “Shallow Valleys”, and “U-Shaped Valleys” in large-scale landform analyses (see Supplemental Information for details).

Two participants listed willows by swamps in their description of moose habitat. We selected any willows that occurred within 30m of an area classified as a swamp in the PEM.

One participant described moose habitat as anywhere there are willows in the mountains. We defined a polygon to represent the mountainous region of the study area (Map 2 and Supplemental Information for details) and selected all vegetation within this area that met our willow classification.

One participant described the importance of willows by lakes for moose habitat. We selected all willows that occur within 30 meters of a lake to represent this category.

One participant described moose habitat as flat areas with willows but did not tie the description specifically to riverbeds. We represented this category by selecting “Plains” from the large-scale landform analysis and clipping these features to areas where willows were present. We also selected “U-Shaped Valleys” to represent this classification, because interviewees were clear that flat areas with willow could be found in all regions of the study area. The “U-Shaped Valleys” best represent the broader flat areas that occur in the mountainous region of the study area.

River Classification

We classified rivers into three categories based on the descriptions of Inuvialuit land-users (Table 2).

Large Rivers were classified as rivers that were large enough to have obvious shorelines, contain mud bars, and flow through the “coastal” or flatter part of the study area. This classification included major rivers in the study area, such as the Firth, Babbage, or Running River and was restricted to the coastal plain, excluding mountain tributaries. We selected polygonal watercourse features from Natural Resources Canada’s National Hydro Network at a 1:50,000 scale to represent these rivers. We buffered selected river features by 100m to account for the braided nature of large rivers and the seasonal change in river size and flow pattern.

Mountain Creeks represented the rivers that run through the higher relief sections of the study area. These rivers were selected based on participants’ descriptions of high banks or hillsides on either side, which created distinct river valleys. Participants described moose traveling through and foraging in the bottom of river valleys, often standing in the rivers themselves. We selected these river features by querying any river that had greater than ten percent willow cover within a 100m buffer of the stream bed and occurred in landforms classified as canyons/deeply incised streams and midslope drainages at moderate scales (at scales of 200m-1000m). These features were then clipped to the mountainous area and used to identify relevant 1:50,000 catchment areas. These catchments were used to extract the valley landform within each drainage to represent not only the river, but adjacent habitat described by interviewees.

During the interview series, participants also used the terms river or creek to refer to low lying areas with thick vegetation. These descriptions of rivers were largely vegetation and topography driven, with individuals referring to thick willows in tight drainages. To create this layer, we selected for rivers that had greater than 50 percent willow cover within a 30m buffer of the streambed, as well as a soil moisture level (Compound Topographic Index, Buttrick et al. 2015) in the top 50 percent. Of these streams, we further selected those that fell in narrower valleys (50m – 200m scale of analysis), identified the associated catchments, and extracted the valley landforms based on those catchments. This final river classification refers to the numerous small creeks and drainages throughout the study area. Interviewees indicated that the relevant habitat characteristic of these rivers related less to water or water flow and more to the surrounding topography and vegetation. These creeks were always low lying when compared to surrounding topography but were not part of a large river valley. They always contained willow.

Additional Habitat Characteristics

We included 19 additional habitat features in our weighted table, based on photo identification of PEM or TK habitat classes and verbal descriptions of moose habitat (Table 3). Many of these habitat features overlapped with areas indicated as willow or river habitat but were documented independently. For example, four interviewees selected a photo of the TK habitat class “Rivers and Creeks” to describe moose habitat. These photos represent PEM units that typically contain both water and willow and likely overlap with areas selected based on verbal descriptions of willow or river habitat. However, the photos contained specific characteristics that generated responses (such as landscape topography, willow height, or additional vegetation). Therefore, these selections were included in our model as their own attribute class. This category also includes important attributes that have less overlap with willow or rivers, such as swamps or standing water.

Habitat Model Weighting Table

Each habitat attribute was given a weight based on the number of interviewees selecting the attribute (Table 3). In many cases, an individual may have indicated multiple habitat attributes, some of which overlapped. For example, some participants described the importance of willow and water generally, and then went on to select a specific photo to represent streamside habitats. In these instances, we gave a weight to each habitat descriptor; willow, water, and the TK habitat class represented in the photo. While this may have double-counted the regions in the study area where two or more of these attributes overlap, we believe it is the most accurate way to portray the knowledge of participants in a quantitative sense. Classifying as many descriptions of moose habitat as possible ensures that unique areas that may only be described by limited participants are represented in our weighting table, while allowing for areas of high value habitat to be selected multiple times.

Habitat Suitability Index Model and Mapping

To develop the YNS moose habitat model, we created raster (grid) spatial layers for each of the specific habitats identified by the interviewees, with each layer attributed with the interview weight for that specific habitat (Table 3) at a resolution of 6m (PEM resolution). The layers were then combined by summing their weights and the summed score was rescaled to range from 0 to 1 by dividing by the maximum value. This rescaled layer was classified into 10 quantile bins (approximately equal area bins) to produce a final map with values of 1 – 10, with 1 indicating the lowest quality habitat and 10 the highest (Map 3).

The TK-based habitat model indicates a strong gradient in moose habitat across the YNS, with areas of high quality habitat clearly associated with the concentration shrubby willow habitats that occur in linear features along stream and river drainages and valleys or in association with wetland and standing water features. Reflecting the TK, the highest quality moose habitat is both spatially limited locally to these features but geographically widespread across the YNS (Maps 3, 4, 5 and 6). Additionally, moderate and lower quality habitats are abundant across the region. This suggests moose may have opportunities to travel between high quality habitat using these lower quality features to provide forage and security and supporting connectivity of moose across the YNS. Within more mountains regions, this connectivity would primarily be along the drainage systems.

Although our BECCA study area extent includes parts of Alaska and the Northwest Territories, the final extent of the moose habitat model was limited to the Yukon portion of the ISR based on the extent of the existing PEM.

External Review and Validation

The moose habitat model was reviewed by Yukon Government and Parks Canada biologists, resulting in refinements to how different habitat characteristics were translated into GIS layers and leading to improvements in the model performance as measured by validation using available independent moose location data. We evaluated three versions of the habitat model, each differing primarily in how willow and river valley systems were defined based on the PEM and topographic characteristics. The final model presented here was selected based on performing best based on validation.

Independent data to validate the model were provided by the Yukon Government and included gps locations of moose observed during moose population surveys in the Richardson Mountains and in Ivvavik National Park between 2010 and 2019 (M. Kienzler and M. Suitor, pers. comm.). During surveys, GPS locations were recorded of observed moose when the helicopter was immediately over the animals, providing an acceptable level of accuracy. A total of 138 GPS locations were recorded within the YNS study area, representing 343 moose. Additionally, we were provided moose GPS collar data from western Ivvavik containing 3,856 locations for an unknown number of individual moose.

To select the best performing model, we calculated the correlation between area-adjusted counts of survey observations and area-adjusted counts of observed moose numbers by habitat class rank (Boyce et al. 2002). In all cases of survey data, the lower quality habitat classes had too few (1-2 observations) to include so the correlations represent class 5 or 6 through 10. We conducted the same correlation validation using the GPS collar locations. While all considered models validated well across the suite of different validation data, the selected model consistently has the highest validation correlations across the three models for each of the 5 sets of validation metrics we used (Table 4).

If high value habitat is assumed to be represented by Classes 8, 9, and 10, 80% of the moose locations (83% of moose) were identified within the TK-defined high quality habitat, which covers only 27% of the landscape. Additionally, evaluation of the remaining GPS locations indicates that they are in close proximity to the highest value habitats, with 16 of the 28 within 30m of Class 8, 9 or 10 and 10 oif the remaining 12 locations within 100m of Class 8, 9 or 10 habitat. This suggests that the TK-based moose habitat model does an excellent job of identifying where the high value moose habitat is located.

While sample size is limited to evaluate regional differences in the model performance, we separated moose observations within the mountainous and coastal portions of the YNS as an initial assessment of each region. We calculated correlation between area-adjusted counts of survey observations and area-adjusted counts of observed moose numbers by habitat class rank within the coastal (37 observations with 109 moose counted) and the mountainous (101 observations with 234 moose counted) portions of the study area. The lower quality habitat classes had too few (1-2 observations) to include so the correlations represent class 5 or 6 through 10. The model within the mountainous portion of the study area validated better than the model in the coastal plains region. Validation correlation in the mountains was 0.93 and 0.92 between the habitat class rank and the area-adjusted total observations and total count, respectively. While the validation is still acceptable in the coast, the correlation is lower at 0.79 and 0.84 between the habitat ranks and the area-adjusted total observations and total count respectively.

Supplement Information: Mapping Data Sources, Scales, and Buffering

Ecological Communities

We based our mapping of ecological communities on the combined Predictive Ecosystem Maps for Ivvavik National Park and the Eastern North Slope. The Ivvavik PEM (Ponomarenko et al. 2011) was resampled from 5m to match the resolution of the Eastern North Slope PEM at 6m resolution. The combined PEM was passed through several filters to remove lone pixels and null value areas, which were replaced by majority filtering.

Some individual ecotype classes and TK subclasses were lost after the revisions to the Eastern North Slope PEM that occurred after our TK interviews were completed or when the Eastern North Slope PEM was cross-walked with the Ivvavik PEM. TK classes in which there was little change from the original classification (i.e. Timber, Rivers and Creeks) were retained; however, some TK classes were dropped entirely and as a result the TK Habitat Classification can no longer be mapped as wall-to-wall coverage. We used this final cross-walked PEM to map verbal descriptions of vegetation as well as map the remaining TK Habitat Classes that were selected through photo-identification.

Landcover products outside the ISR (Alaska to the west, Northwest Territory to the east, and a buffer to the south) were investigated with the goal of creating a wall-to-wall vegetation layer for the BECCA planning area which is larger than the YNS, as this would provide valuable information for connectivity models and additional landscape values. However, this would require six different landcover products to model the entire extent -- both PEMs, the North Slope Science Initiative (NSSI) PEM [Alaska], the National Landcover Dataset [Alaska], the

Canadian Northern Landcover circa 2000, and the more general Canadian Landcover circa 2000. These six products all varied drastically in both spatial and ecotype resolution, and cross-walking them would degrade the PEM data we have within the Yukon ISR. Therefore, we decided to model the most relevant areas in which the best data exists, limiting modelling to the Yukon North Slope.

Landscape Features

We based our terrain mapping on 1:50,000 Canadian Digital Elevation Data (CDED) tiled Digital Elevation Models (DEMs). The CDED dataset was chosen over other potential elevation sources because it was continuous into the Northwest Territories and presented fewer anomalies along seamlines after mosaicking. Because many participants referenced the "mountains" (higher elevation, steeper terrain) and the "coast" (rolling hills and flat plains) in their habitat descriptions, we used this elevation data to spatially differentiate these landscapes in our analysis. Potential existing definitions (bioclimate zones, ecoregions, etc.) were too coarse in scale to apply to our data but were used as general guidelines. After testing different input variable combinations, we were able to define the mountainous region using elevation (Elevation > 250m) and terrain complexity (Terrain Ruggedness Index (TRI; Riley et al 2007; @ 1,000m > 300). These two variables were merged, and the resulting layer was simplified to removed holes, islands, and other anomalies to create a smooth, wall-to-wall classification. The small area of the Mackenzie Delta that passes through the northeastern corner of the YNS was digitized to identify it, so that descriptions specific to the delta system could be queried in the future (Map 2).

To identify landforms described in TK interviews (i.e. "steep banks", "rolling hills", etc.) we mapped the Topographic Position Index (TPI; Weiss 2001), which identifies a pixel's location on a landscape relative to neighboring pixels (i.e. ridge top, valley, etc.), at a variety of scales between 50 – 3,000 m. We then combined TPI's from smaller and larger scales to produce a map of 10 landform classes that provide a richer interpretation of the landscape (Figure 1). Landforms were mapped at four different scales (50 – 300m, 200 – 1,000m, 500 – 2,000m, and 700 – 3,000m) utilizing eight scales of TPI. When selecting terrain features that occur within the mountainous region of the study area, we used larger-scale landforms (700 – 3,000m). When selecting terrain features that occur in the flatter region of the study area, we often supplemented the larger-scale landform definitions with higher resolution (50 – 300m) ones when necessary to capture the small-scale topographic differences that influence habitat on the coastal plain.

Hydrological Features

For base hydrologic inputs (rivers, watercourses, waterbodies, hydro junctions), we used Natural Resource Canada's National Hydro Network (NHN) at a scale of 1:50,000. First order streams were identified based on initial junction-to-junction relationships, but higher stream orders could not be further delineated. Because the NHN includes neither a coarse-scale nor a fine-scale watershed layer, we used the catchments data generated by the Boreal Ecosystems Analysis for Conservation Networks (BEACONs) Project for analyses requiring such a layer. These catchments are generated from modified NHN stream layers, with the fine-scale catchments roughly equivalent to a 1:50:000 scale and the larger ones 1:250,000. Neither fine-scale nor coarse-scale catchments provided wall-to-wall coverage of our study area, so a combination was used – fine scale where available, supplemented by coarse scale in the eastern part of our study area (Map 8). These catchment boundaries were used to clip landform features to make them more specific to certain local stream networks (e.g., Mountain Streams and Vegetation-Driven Streams).

Buffering

During our interviews, many participants noted the importance of habitat features that provided camouflage or protection from predators. Interviewees noted that moose were not always found in these features but were typically nearby, either due to travel across the landscape or predator avoidance. To account for the value of being in proximity to habitat types that aid in predator avoidance, we buffered security habitat by 30m. Areas defined as security habitat were all tall willows, deep standing water (lakes), swamps, river beaches, and timber.

We buffered the Large Rivers habitat class at 100m. The available polygonal dataset that represents these rivers does not account for their greater zone of influence. Because these rivers are frequently changing size and path, based on environmental conditions such as precipitation or temperature, we treated them with a larger buffer to better capture their presence in the study area.

Mountain Streams and Vegetation-Driven streams were “buffered” by the associated Valley landform class at the appropriate scale. This captured both the importance of the river itself, and the associated adjacent habitat in which moose are often found. Buffering by a “valley” rather than a set buffer distance from the stream provided a smoother, more ecologically-relevant definition of the features described in the interviews.

Projection and Resolution of Habitat Model

The modeling relied on three main inputs: vegetation (cross-walked PEM), hydrology (rivers, lakes, and watercourses from the NHN), and derived terrain variables (calculated from the CDED). The NHN and the CDED are both produced in the NAD 1983 geographic coordinate system. The final TK moose model was produced in NAD83 UTM Zone 7N projection. We chose this projection because it is the same projection in which the original PEM was produced, making it consistent with most of the inputs into the model. All analyses of the rivers and terrain features were done in the native NAD 1983 coordinate system to minimize distortion and projected into UTM as the last step of processing before input into the model.

The final resolution of this model is 6 m, which matches the spatial resolution of the cross-walked PEM. All vector layers were rasterized using this resolution and snapped to the PEM. Terrain data was mostly used for queries, and therefore kept in its native resolution (~16m) but any terrain features that went directly into the model were resampled to a resolution of 6m. This was done so as not to degrade the accuracy of the PEM.

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Tables, Figures and Maps

Table 1. Willow classifications based on Traditional Knowledge of the Aklavik Inuvialuit describing moose habitats on the Yukon North Slope, number of interviewees describing each kind of willow community is the weight (wt), and how these descriptions were mapped for developing a moose habitat model.

Willow Classification	Wt	Description	Spatial Query
General Willow Habitat	5	Any vegetation that is consistent with Inuvialuit definitions of willow	PEM Classifications: High Quality (weight of 5) Dense Med-Tall Shrub, Herb – Willow Riparian, Dense Low-Med Shrub, Spruce-Alder (Willow), and Mesic Spruce; Low Quality (weight of 3) Shrub-Sedge Tussock, Sparse Shrub – Moss Tundra, Willow – Horsetail, Alder-Cottongrass Tussock, Subhygric Spruce Tussock, and Subhygrix Spruce Horsetail, buffered 30m
Willow in River Beds	9	Willow in any “valley” landform, both inland and coastal	Willow vegetation classification that occurs in any “valley” landform classification (Canyons, Shallow Valleys, U-Shaped Valleys at 700 – 3,000m, supplemented by 50m – 300m in the coastal plain), buffered 30m; High Quality weighted 9, Low Quality weighted 5
Willow in Flats	1	Willow in any flat expanse, not specifically a river valley	Willow vegetation classification occurring in “Plains” and “U-Shaped Valleys” at 700 – 3,000m, buffered 30m; High Quality weighted 10, Low Quality weighted 5
Willow by Swamps	2	Willow that occurs nearby swamps	Willow vegetation classification occurring within 30m of a swamp, as defined by the TK Habitat class (note: this classification does not include the swamp itself), buffered 30m; High Quality weighted 2, Low Quality weighted 1
Willows in Mountains	1	All vegetation that is consistent with Inuvialuit definitions of willow and occurs within the mountainous region of the study area	Willow vegetation classification occurring in the mountainous region of the study area (defined by terrain complexity and elevation), buffered 30m; both High and Low Quality weighted 1
Willows by Lakes	1	Willows that occur near lakes	30m buffer surrounding lakes, selected all willows within this zone (note: this classification does not include the lake itself), buffered 30m; both High and Low Quality weighted 1

Table 2. River classifications based on Traditional Knowledge of the Aklavik Inuvialuit describing moose habitats on the Yukon North Slope, number of interviewees describing each kind of willow community is the weight (wt), and how these descriptions were mapped for developing a moose habitat model.

River Classification	Wt	Description	GIS Query
Mountain Creeks	10	Steep banks, large valleys, running through mountainous terrain	Streams in mountains areas with some presence of willow (> 10%), occurring in and represented by two valley landforms: Canyons and Shallow Valleys, at 200 – 1,000m, supplemented by 50m – 300m in the coastal plain
Large Rivers	9	Have discernible coastline, contain mud bars and braided deltas, run through coastal plain	Polygonal watercourse features in the coastal plain, buffered 100m
Vegetation Driven	5	Areas of thick willow, not large enough to create a valley but representing smaller creeks and channels throughout the study area	Streams with > 50% willow cover and high soil moisture, occurring in and represented by narrower valleys (TPI of 100 – 200m, supplemented by 50m in the coastal plain)

Table 3. Final habitat attributes weighted and mapped to model moose habitat (includes willow and river categories described in Tables 1 and 2), based on Traditional Knowledge of the Aklavik Inuvialuit describing moose habitats on the Yukon North Slope and number of interviewees describing each kind of willow community which is the weight (wt).

Habitat Classification	Wt	GIS Query
PEM Class Hydric Sedge	11	PEM Class
Mountain Creeks	10	Streams in mountains with some presence of willow (> 10%), occurring in one of two valley landforms: Canyons/deeply incised streams or Midslope drainages/shallow Valleys, @ 200 – 1,000m
Larger Rivers	9	Polygonal watercourse features, buffered 100m
Willows in River Beds	9	Willows in any "valley" landform (Canyons, Shallow Valleys, U-Shaped Valleys at 700 – 3,000m, supplemented by 50m – 300m in the coastal plain), buffered 30m; High Quality weighted 9, Low Quality weighted 5
Water generally (including standing water)	8	Waterbodies (Lakes), buffered 30m
PEM Class Herb Willow Riparian	6	PEM Class
Vegetation Driven Rivers	5	Streams with > 50% willow cover and high soil moisture, occurring in and represented by narrower valleys (TPI @ 100 – 200m, supplemented by 50m on coastal plain)
Willows Generally	5	PEM Classifications: High Quality (weight of 5) Dense Med-Tall Shrub, Herb – Willow Riparian, Dense Low-Med Shrub, Spruce-Alder (Willow), and Mesic Spruce; Low Quality (weight of 3) Shrub-Sedge Tussock, Sparse Shrub – Moss Tundra, Willow – Horsetail, Alder-Cottongrass Tussock, Subhygric Spruce Tussock, and Subhygrix Spruce Horsetail, buffered 30m
TK Habitat Class: Rivers and Creeks	4	TK Habitat Class (PEM Classes Dense Low-Med Shrub, Herb Willow Riparian, & Dense Med-Tall Shrub), buffered 30m
TK Habitat Class: Tundra/Low Flatlands	4	TK Habitat Class (PEM Classes (Shrub) Sedge Fen & Tussock)
PEM Class Dense Med Tall Shrub	4	PEM Class
PEM Class Dense Low Med Shrub	4	PEM Class
PEM Class Shrub Sedge Fen	3	PEM Class
Willows by Swamps	2	Willows that occur within 30m of a swamp (PEM Classes “Hydric sedge” and “Non-vegetated peat”), buffered 30m; High Quality weighted 2, Low Quality weighted 1
Sides of Lakes	2	Areas within 30m of a lake
TK Habitat Class: Rocky Mountain Ridges	1	TK Habitat Class (PEM Classes Rock-Lichen, Subxeric Sparse Dwarf Shrub Tundra & Heather Nivation Slope)

TK Habitat Class: Timber	1	TK Habitat Class (PEM Classes Subhygric Spruce Tussock, Subhygric Spruce Horsetail, Sub-mesic Spruce, Mesic Spruce & Spruce-Alder (Willow)), buffered 30m
Willows in Mountains	1	All willows in area designated "mountains," buffered 30m; both High and Low Quality weighted 1
Willows by lakes	1	Willows within 30m of a lake, buffered 30m; both High and Low Quality weighted 1
General Hillsides	1	"Open Slopes" landform at 500m – 2,000m
Coastal Beaches		PEM Class "Alluvial non-vegetated coarse texture" w/in 150m of coast
River Beaches	1	PEM Class "Alluvial non-vegetated coarse texture" more than 150m from coast + PEM Class "Alluvial non-vegetated fine texture", buffered 30m
PEM Class Mesic Spruce	1	PEM Class
PEM Class Sub Mesic Spruce	1	PEM Class
PEM Class Heather Nivation Slope	1	PEM Class
PEM Class Tussock	1	PEM Class
PEM Class Alder Cottongrass Tussock	1	PEM Class
Willows in Flats	1	Willows that occur in U-shaped Valleys and Plains at 700 – 3,000m, buffered 30m; High Quality weighted 10, Low Quality weighted 5

Table 4. Validation results for the three versions of the YNS moose habitat model based on area-adjusted counts within modelled habitat classes from moose survey data and moose GPS collar data.

Validation Data Source	**Selected Model**	**Alternate Model 1**	**Alternate Model 2**
Ivvavik Survey Observation Count	0.93	0.86	0.88
Ivvavik Survey Moose Count	0.92	0.90	0.88
Richardson Survey Observation Count	0.94	0.91	0.90
Richardson Survey Moose Count	0.94	0.91	0.83
2007-2008 GPS Collar Locations	0.80	0.48	0.80

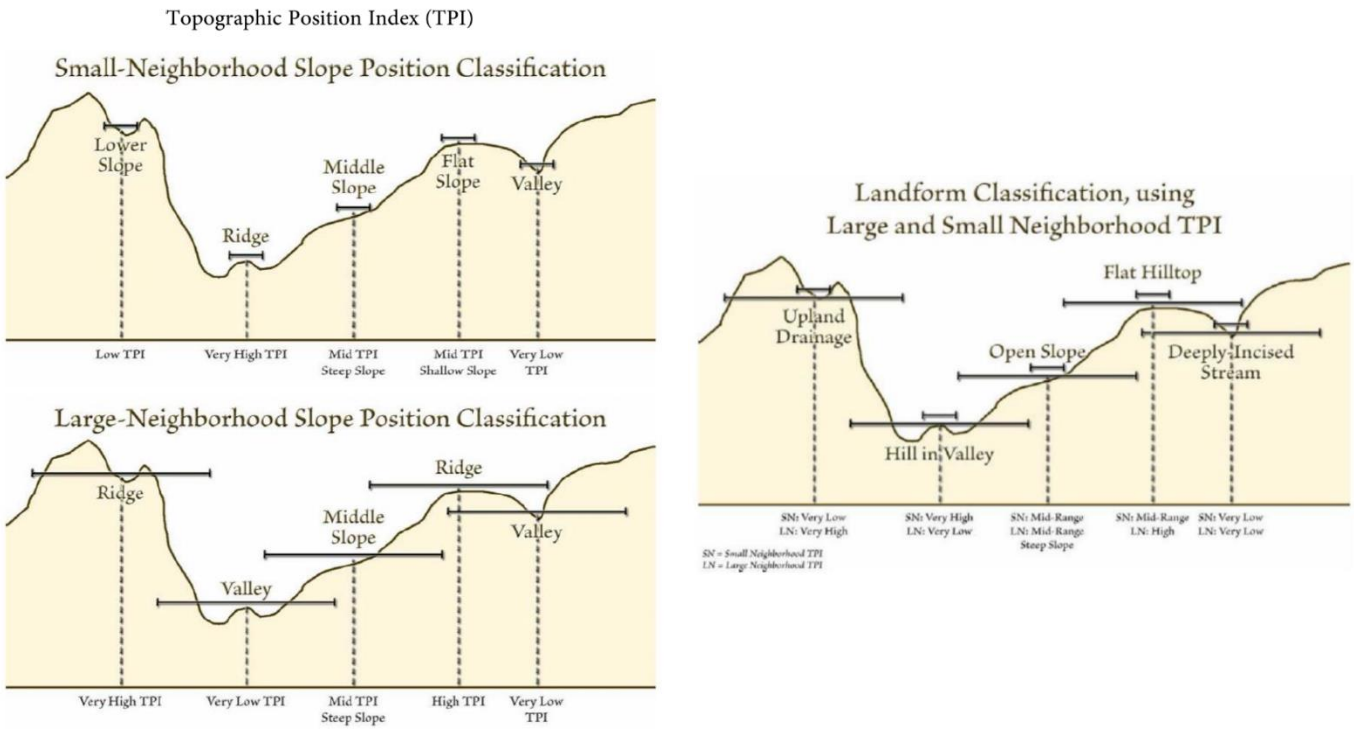
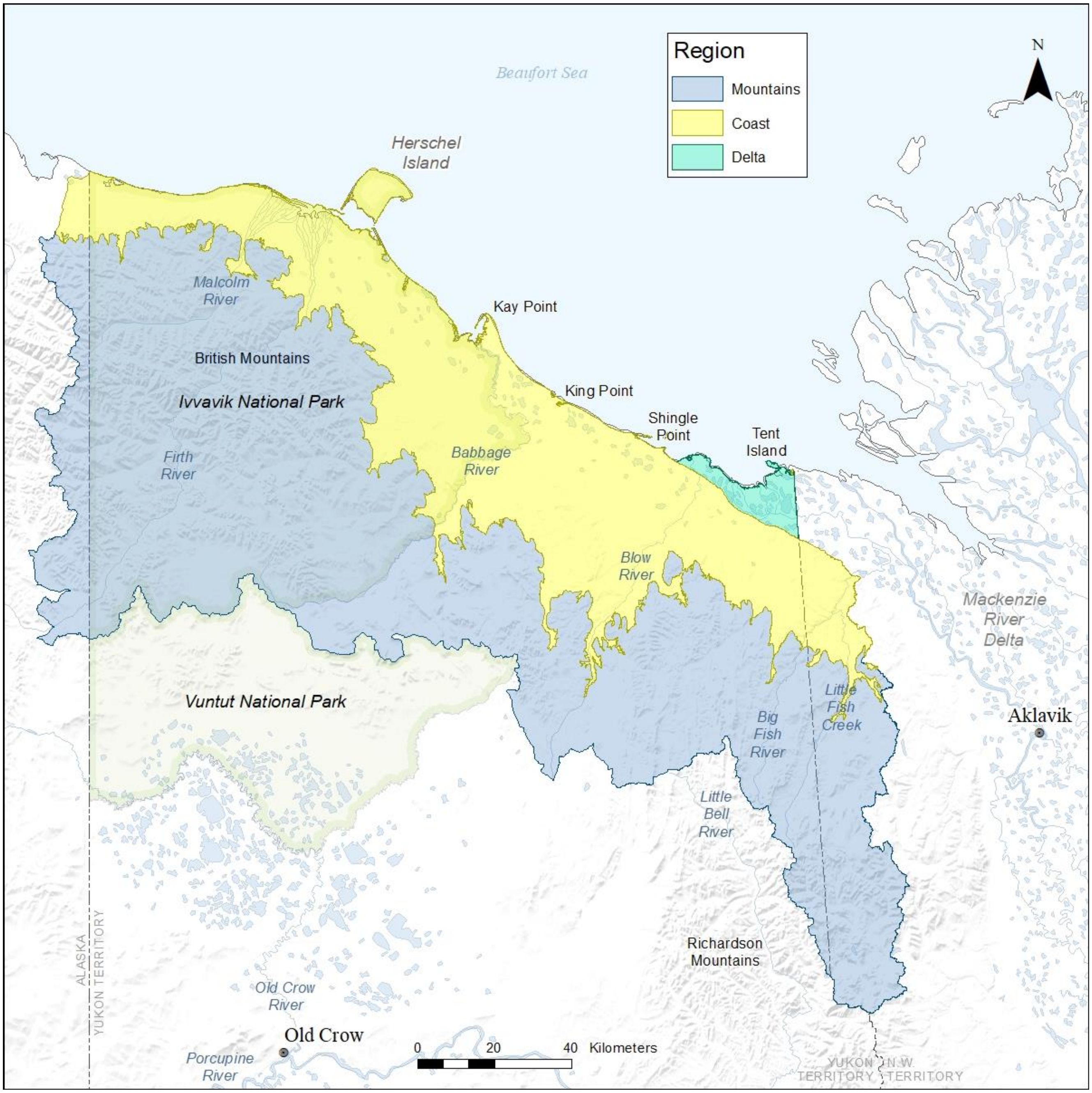
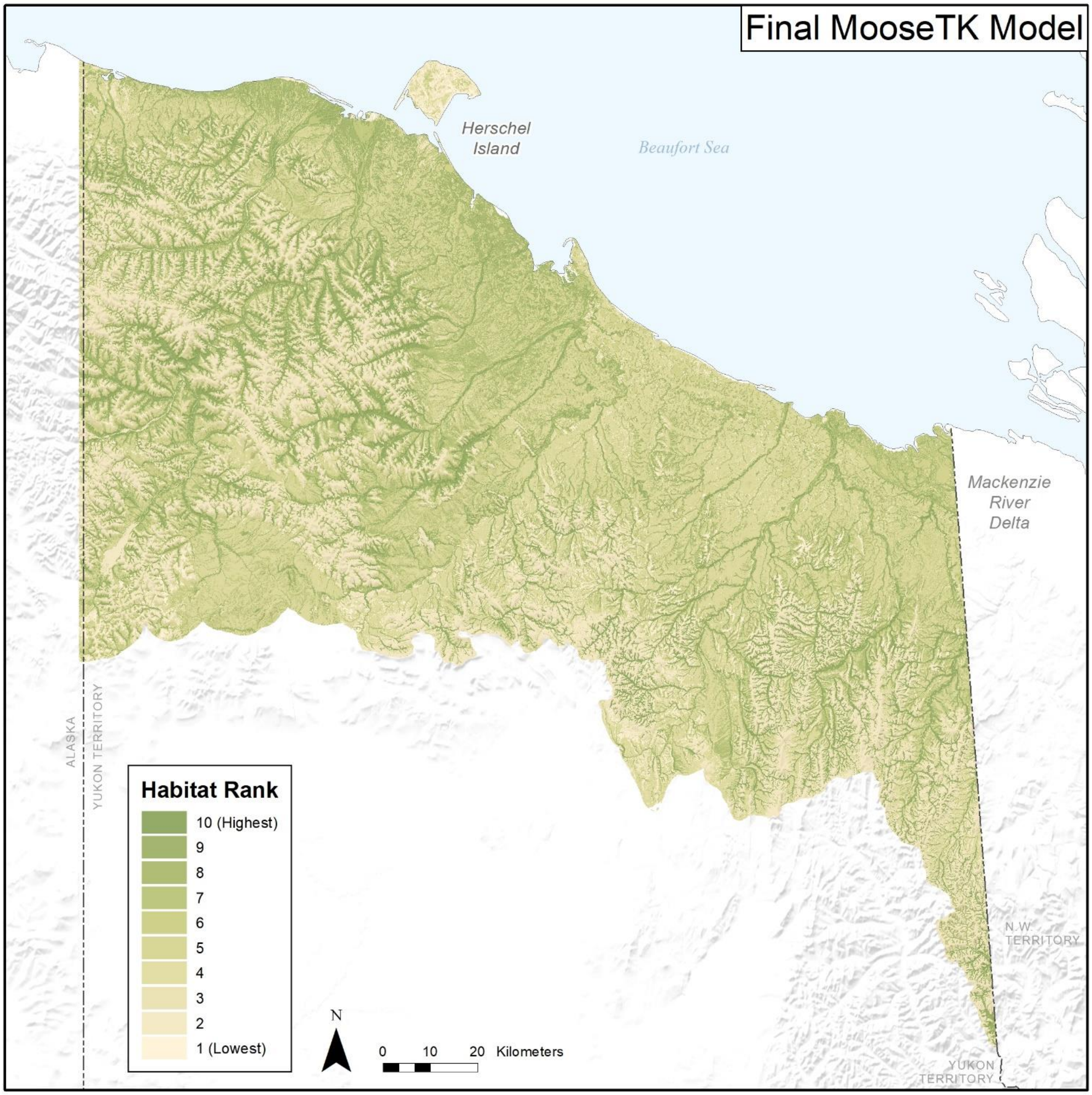


Figure 1: Interpretation of Topographic Position Index (TPI) at small and large scales, and subsequent landform classification (from Jenness 2006) used in identifying different types of willow and riverine habitats for the TK-based moose habitat model.

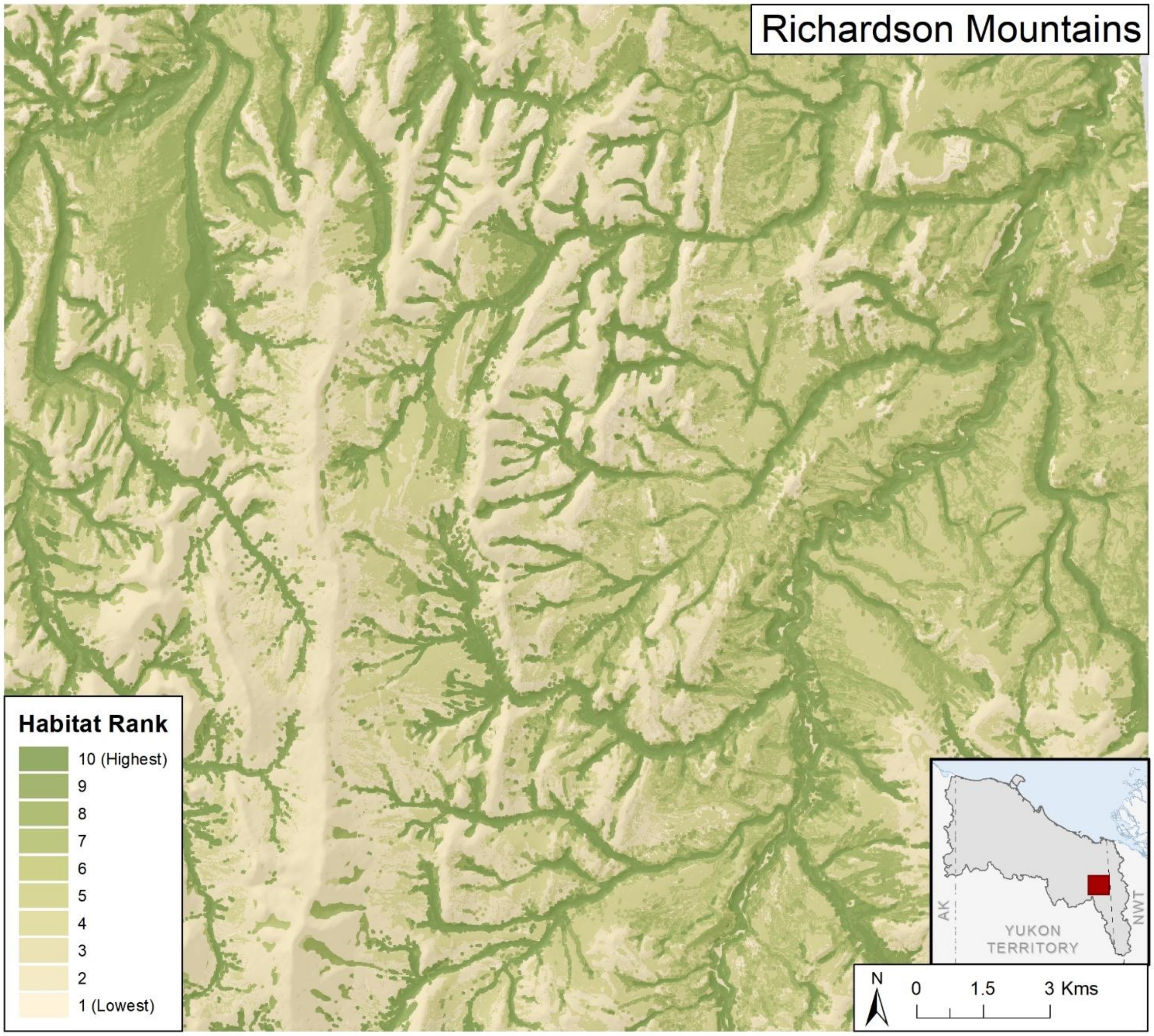
Map 1. Yukon North Slope Baseline Ecological and Cultural Assessment study area, showing the extension of the study area beyond the Yukon North Slope (YNS) boundaries; the moose habitat model is limited to the Yukon North Slope extent itself due to data limitations beyond the YNS.



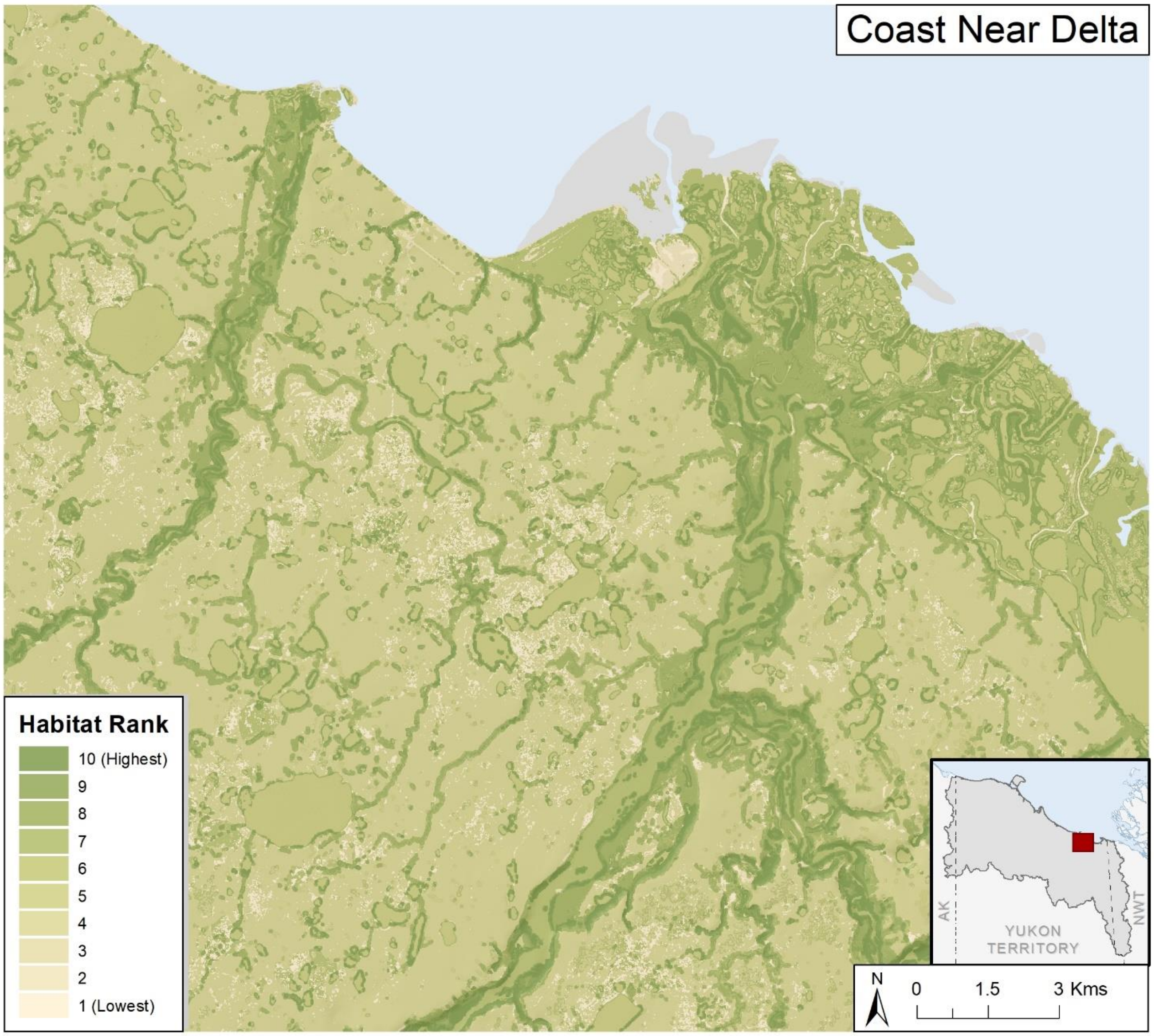
Map 2. The study area divided into mountainous, coastal and delta regions to support moose habitat modeling.



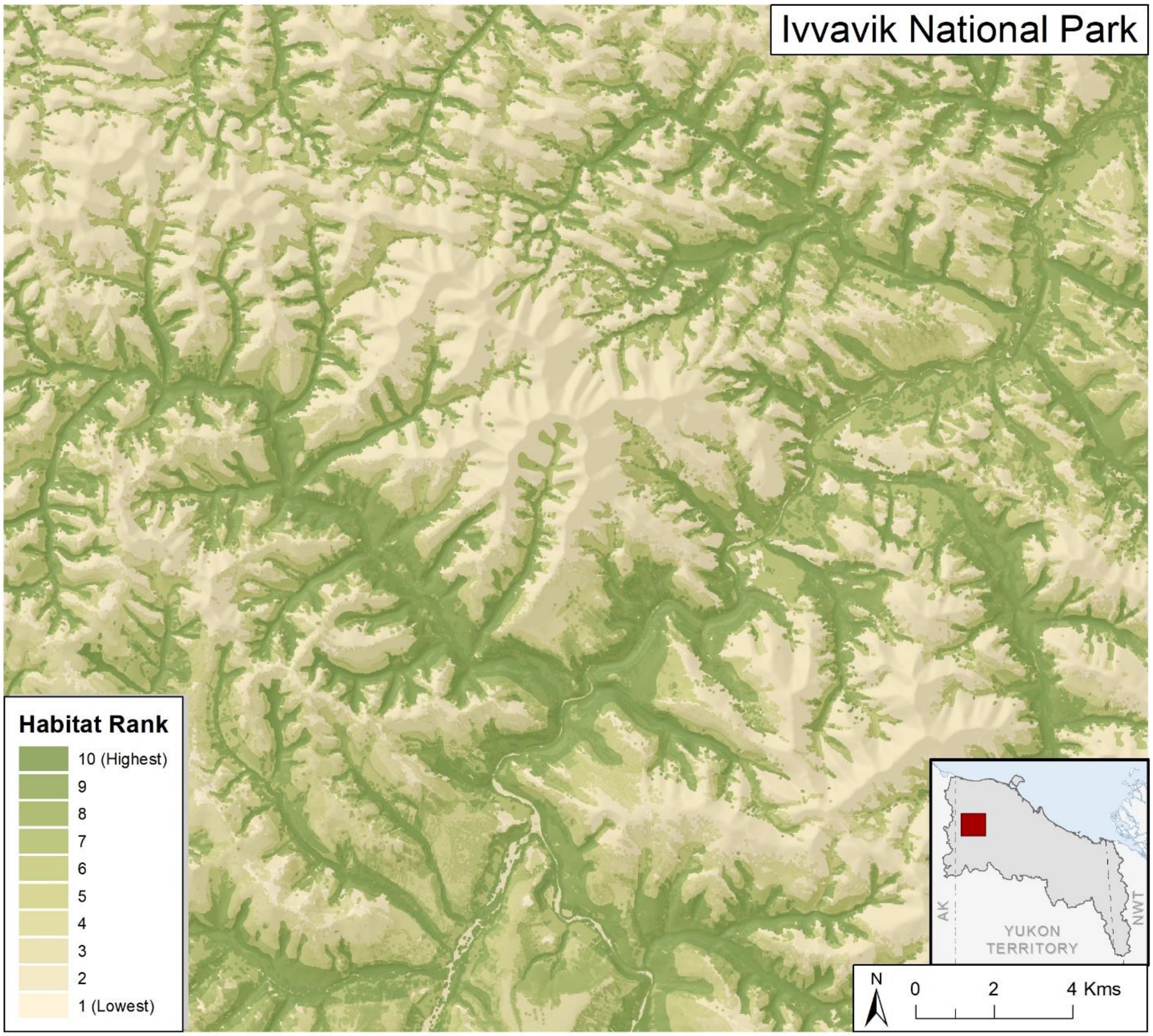
Map 3. Traditional Knowledge-based moose habitat model developed from TK research with Aklavik Inuvialuit land user descriptions of important moose habitat characteristics; based on this model, the higher habitat ranks indicate higher quality habitat.



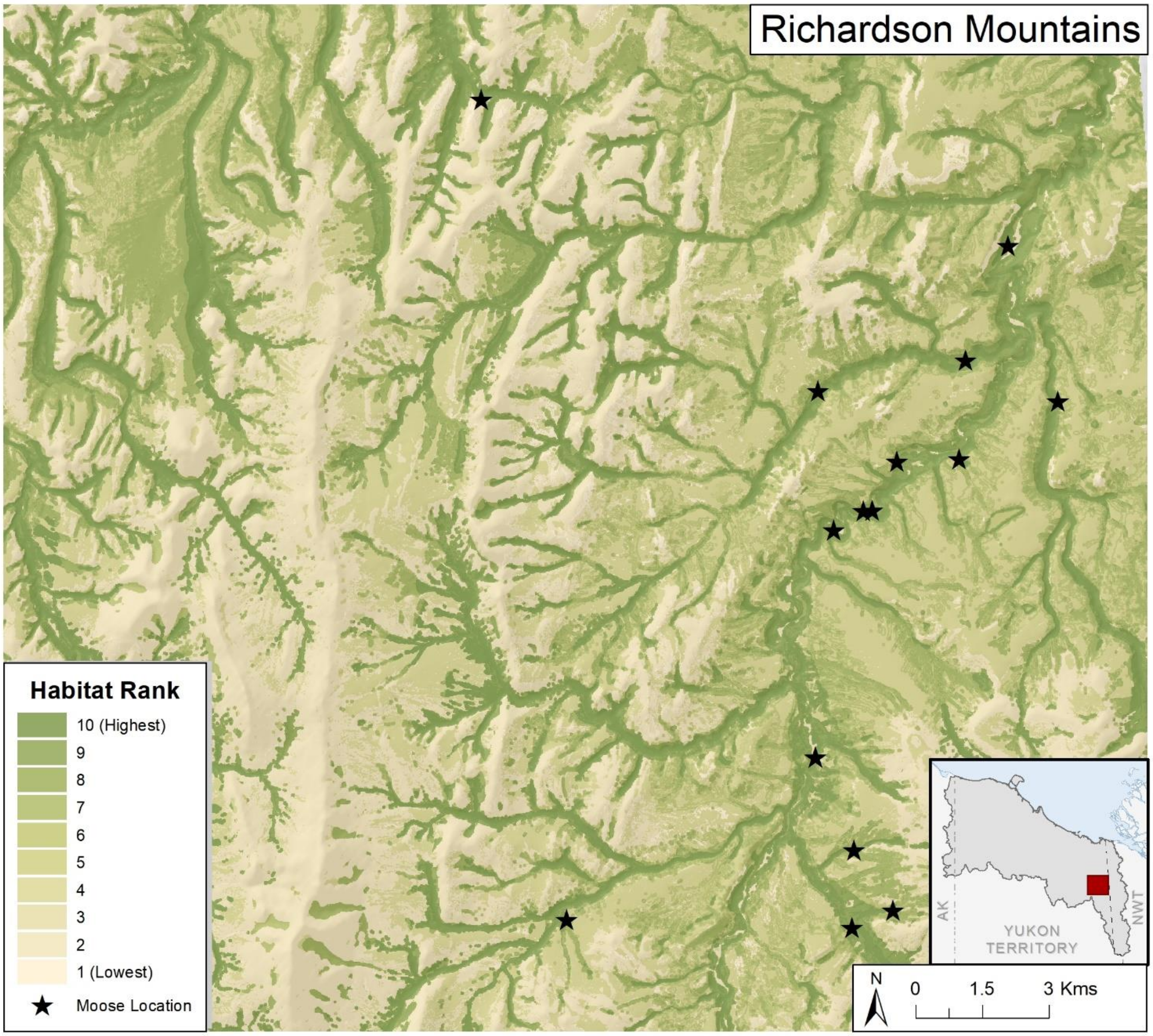
Map 4. A zoomed in map of a portion of the Richardson Mountains of the Yukon North Slope showing the TK-based habitat model classes.



Map 5. A zoomed-in map showing a portion of the coast region of the Yukon North Slope displaying the TK-based habitat model habitat classes.



Map 6. A zoomed-in map showing a portion of the western Yukon North Slope TK-based moose habitat model.



Map 7. A portion of the TK-based habitat model classification showing the location of some validation points.

Map 8. Fine and course scale catchment boundaries used to delineate water features from the BEACONS project (Vernier and Lisgo 2011).