Aerial Abundance Estimates and Trends of the Barren-Ground Caribou (*Rangifer tarandus groenlandicus*) of Baffin Island Nunavut – March 2024 and 2025

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ᑕᕝᕙᓂ ᐅᓂᒃᑳᒥ, ᐅᖃᐅᓯᖃᖅᐳᒍᑦ ᓄᑖᙳᕆᐊᖅᓯᒪᔪᓂᒃ 2014-ᒥ ᐅᓄᕐᓂᖏᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓯᒪᔪᑦ ᖃᓄᐃᓕᕙᓪᓕᐊᓂᖏᓐᓂᒡᓗ ᕿᑭᖅᑖᓘᑉ ᑐᒃᑐᖏᑦ. ᖃᖓᑕᓲᒃᑯᑦ ᖃᐅᔨᓴᓚᐅᖅᐳᒍᑦ ᐅᓄᕐᓂᖏᓐᓂ ᓇᓚᐅᑦᑖᖅᓱᑕ ᓇᐹᖅᑐᖃᙱᑦᑐᒥ ᑐᒃᑐᖏᑦ ᕿᑭᖅᑖᓗᖕᒥ ᖃᓂᒋᔭᖏᓐᓂᓪᓗ ᕿᑭᖅᑕᐃᑦ ᐊᕐᕌᒎᖕᓄᑦ ᒪᕐᕉᖕᓄᑦ (2024, 2025), ᒪᕐᕉᖕᓂᒃ ᖃᐅᔨᓴᖅᑎᖃᖅᓱᑎᒃ ᐊᑕᐅᑦᑎᒃᑯᑦ ᐅᖓᓯᒌᖕᓂᖓᓂᒡᓗ ᖃᐅᔨᓴᕈᑎᓕᖕᒥᒃ. ᑕᒪᕐᒥᒃ ᖃᐅᔨᓴᕈᑎᑦ ᐱᐅᓯᕆᐊᖅᑕᐅᓚᐅᖅᐳᑦ ᐊᔪᓇᖅᒎᔾᔨᔨᖃᖅᓱᑎᒃ ᓄᓇᓕᖕᓂ ᖃᐅᔨᒪᔪᒥᒃ ᐃᓚᓕᐅᔾᔨᓪᓗᑎᒡᓗ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓂᒃ ᖁᓕᓂᑦ ᕿᑭᖅᑖᓗᖕᒥ ᓄᓇᓕᖕᓂᙶᖅᑐᓂᑦ.

ᒫᔾᔨ 2024−ᒥ ᐊᒻᒪ ᒫᔾᔨ 2025−ᒥ, ᖃᐅᔨᓴᓚᐅᖅᐳᒍᑦ ᕿᑭᖅᑖᓘᑉ ᓂᒋᐊᓂ, ᐊᒻᒪ ᐅᐊᖕᓇᖓᓂ ᐊᒻᒪ ᕿᑎᖅᐸᓯᐊᓂ ᕿᑭᖅᑖᓘᑉ ᑐᒃᑐᖏᑕ ᐅᓄᕐᓂᖏᓐᓂᒃ ᐊᑐᓂ. ᒫᔾᔨ 2024−ᒥ 3,843−ᓂᒃ ᑕᑯᓚᐅᖅᐳᒍᑦ ᐃᒻᒥᒎᖅᑐᓂᒃ ᐃᑳᖅᑎᓪᓗᒋᑦ ᕿᑭᖅᑖᓘᑉ ᓂᒋᐊᓂ. ᒫᔾᔨ 2025−ᒥ 3,656−ᓂᒃ ᑕᑯᓚᐅᖅᐳᒍᑦ ᐃᑳᖅᑎᓪᓗᒋᑦ ᕿᑭᖅᑖᓘᑉ ᐅᐊᖕᓇᖓᓂ ᕿᑎᖅᐸᓯᐊᓂᓗ. ᑲᑎᖦᖢᒋᑦ (ᑕᒪᐃᓐᓂ ᐊᕐᕌᒍᓂ ᖃᖓᑕᕝᕕᒋᔭᓕᒫᖏᓐᓂᓪᓗ), ᑕᑯᓚᐅᖅᐳᒍᑦ 7,635−ᓂᒃ ᑐᒃᑐᓂᒃ. ᒪᕐᕉᖕᓂᒃ−ᖃᐅᔨᓴᖅᑎᖃᓚᐅᖅᐳᒍᑦ ᐊᑕᐅᑦᑎᒃᑯᑦ ᐅᖓᓯᖕᓂᖓᓂᓪᓗ ᖃᐅᔨᓴᕈᑎᓕᖕᒥᒃ ᓴᖅᑭᑎᔪᒪᓪᓗᑕ ᐅᓄᕐᓂᖏᓐᓂᒃ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᒥᒃ ᖃᖓᑕᕝᕕᐅᔪᓕᒫᓂᑦ ᑕᒪᐃᓐᓂ ᐊᕐᕌᒎᖕᓂ ᐊᒻᒪ ᕿᑭᖅᑖᓗᓕᒫᒧᑦ. ᓇᓚᐅᑦᑖᓚᐅᖅᐳᒍᑦ 24,162 (95% CI = 21,595-27,034; CV =5.7%) ᐃᓐᓇᐃᑦ, ᓄᕐᕋᐃᑦ, ᐊᒻᒪ ᑎᕿᑐᕋᐃᑦ ᑐᒃᑐᐃᑦ ᕿᑭᖅᑖᓘᑉ ᓂᒋᐊᓂ ᒫᔾᔨ 2024−ᒥ ᐊᒻᒪ 25,026 (95% CI = 21,182-29,568; CV =8.5%) ᐃᓐᓇᐃᑦ, ᓄᕐᕋᐃᑦ, ᐊᒻᒪ ᑎᕿᑐᕋᐃᑦ ᕿᑭᖅᑖᓘᑉ ᐅᐊᖕᓇᖓᓂ ᕿᑎᖅᐸᓯᐊᓂᓗ ᒫᔾᔨ 2025−ᒥ. ᑲᑎᖦᖢᒋᑦ, ᒫᔾᔨ 2024−ᒥ ᐊᒻᒪ 2025−ᒥ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᑦ ᓴᖅᑭᑦᑎᓚᐅᖅᐳᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓯᒪᔪᓂᒃ ᑲᑎᖦᖢᒋᑦ 48,681−ᓂᒃ (95% CI = 43,973-53,893; CV =5.2%) ᐃᓐᓇᐃᑦ, ᑎᕿᑐᕋᐃᑦ, ᐊᒻᒪ ᓄᕐᕋᐃᑦ. ᖃᐅᔨᔭᕗᑦ ᓇᓗᓇᐃᖅᓯᕗᑦ ᑭᒡᓕᓯᓂᐊᖅᑕᐅᓯᒪᔪᓂᒃ ᐅᔾᔨᕐᓇᖅᑐᒥᒃ ᐅᓄᖅᓯᕚᓪᓕᖅᓯᒪᓂᖏᓐᓂᒃ ᒫᔾᔨ 2014-ᒥ ᕿᑭᖅᑕᓕᒫᒥ

ᖃᐅᔨᓴᖅᑕᐅᓚᐅᖅᑐᒥᑦ, ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ 4,645 ᐃᓐᓇᐃᑦ, ᑎᕐᑭᑐᕋᐃᑦ, ᐊᒻᒪ ᓄᕐᕋᐃᑦ (95% CI=3,667-5,884, CV=12.1%).

ᖃᓄᐃᓕᕙᓪᓕᐊᓂᖓᓂ ᖃᐅᔨᓴᓚᐅᖅᐳᑦ ᐊᑐᖅᖢᑕ ᐊᔾᔨᒌᓂᒃ ᖃᖓᑕᕝᕕᐅᔪᓂᑦ 2012, 2014, ᐊᒻᒪᓗ 2024/2025 ᐊᑯᓐᓂᖏᓐᓂ. ᑖᒃᑯᐊ ᖃᐅᔨᓴᕈᑎᑦ ᓇᓗᓇᐃᖅᓯᕗᑦ ᐅᓄᖅᓯᕙᓪᓕᐊᓂᖏᓐᓂᒃ ᑕᒪᐃᓐᓂᒃ ᖃᖓᑕᕝᕕᐅᓯᒪᔪᓂᑦ ᑭᓯᐊᓂ ᐳᒃᑭᑦᑐᔮᖅ ᕿᑭᖅᑕᕈᓗ, ᐅᓄᕈᓐᓃᖅᐹᓪᓕᓚᐅᖅᐳᑦ 75%−ᒥ 2014 ᐊᒻᒪ 2025 ᐊᑯᓐᓂᖓᓂ (ᐊᕐᕌᒍᓕᒫᒧᑦ ᐅᓄᕈᓐᓃᖅᐹᓪᓕᖅᑐᑦ 3%−ᒥ (CI=-8% ᑎᑭᖦᖢᒍ 2%)). ᖃᐅᔨᓴᓚᐅᖅᐳᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓯᒪᔪᑦ ᐲᖅᓯᕙᐅᓚᐅᖅᑎᓐᓇᒋᑦ ᐊᓯᔾᔨᖅᑐᓂᒃ ᐊᒻᒪ ᐊᕐᕌᒍᓕᒫᒧᑦ ᐊᓯᔾᔨᖅᐸᓪᓕᐊᔪᓂᒃ, ᖃᐅᔨᔭᐅᔪᑦ ᓇᓗᓇᐃᖅᓯᓪᓗᑎᒃ ᕿᑭᖅᑖᓗᖕᒥ ᑐᒃᑐᐃᑦ ᐅᓄᕐᓂᖏᑦ ᐅᓄᖅᓯᕚᓪᓕᓚᐅᖅᐳᑦ 11.2−ᒥᒃ ᒫᔾᔭ 2014 ᐊᒻᒪ 2024/2025 ᐊᑯᓐᓂᖓᓂ, ᒪᓕᒃᖢᑎᒃ ᐊᕐᕌᒍᓕᒫᒧᑦ ᐅᓄᖅᓯᕙᓪᓕᐊᔪᓂᑦ 25%−ᒥᒃ (CI=22-28%). ᑕᑯᔭᐅᔪᑦ ᐊᓯᔾᔨᖅᑐᑦ ᒫᔾᔭ 2014 ᐊᒻᒪ 2024 ᐊᑯᓐᓂᖓᓂ ᐅᔾᔨᕐᓇᖅᑐᒻᒪᕆᐅᓚᐅᖅᐳᖅ (t-ᖃᐅᔨᓴᕈᑎ =17.1; p-ᖃᔅᓯᐅᓂᖓ <0.001). ᖃᐅᔨᓴᕈᑎᕗᑦ ᓇᓗᓇᐃᖅᓯᕗᑦ ᑲᔪᓯᑦᑎᐊᕐᓂᖏᓐᓂᒃ ᖃᐅᔨᓴᖅᑕᐅᔪᑦ ᐊᒻᒪ ᐊᐅᓚᑦᑎᔾᔪᑎᑦ ᐊᐅᓚᑦᑎᔨᐅᖃᑕᐅᔪᓄᑦ ᓴᐳᔾᔨᓯᒪᓇᓱᒃᖢᑎᒃ ᐊᐅᓚᑕᐅᔪᑦ ᕿᑭᖅᑖᓗᖕᒥ ᑐᒃᑐᖏᓐᓂᒃ.

ᖃᐅᔨᓴᖅᐸᓪᓕᐊᔪᑦ ᐊᑐᓚᐅᖅᑐᑦ ᐅᑭᐊᒃᓵᒃᑯᑦ ᐅᐱᕐᖔᒃᑯᓪᓗ ᖃᓄᐃᓕᖓᓂᖓᓂ ᖃᐅᔨᓴᖅᑐᑦ ᖃᐅᔨᓚᐅᖅᐳᑦ ᐅᓄᕐᓂᖏᓐᓂᒃ ᑕᒪᐃᓐᓂᓪᓗ ᐊᒥᓲᓂᖏᓐᓂᒃ ᕿᑭᖅᑖᓗᖕᒥ ᑐᒃᑐᐃᑦ ᒪᓕᒃᖢᒋᑦ ᒫᔾᔭ 2014−ᒥ ᐅᓄᕐᓂᖏᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᓚᐅᖅᑐᑦ, ᐱᒋᐊᖅᑎᑕᐅᔪᒥᓪᓗ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐱᓕᕆᐊᖑᔪᓂᑦ 2014/2015−ᒥ ᑐᕌᒐᖃᖅᖢᑎᒃ ᐅᑎᖅᐸᓪᓕᐊᖁᓪᓗᒋᑦ ᕿᑭᖅᑖᓗᖕᒥ ᑐᒃᑐᐃᑦ. ᒪᓕᒃᑕᐅᔭᕆᐊᓕᑦ ᐲᕐᓗ ᑲᑎᖦᖢᒋᑦ ᐊᖑᓇᓱᒃᑕᐅᔪᓐᓇᖅᑐᑦ (TAH) ᐊᑐᓕᖅᑎᑕᐅᔪᑦ ᐊᒻᒪ ᑰᑕᖃᙱᑦᑐᑦ ᑭᒡᓕᖃᖅᑎᑕᐅᔪᑦ (NQLs), ᓴᖅᑭᑕᐅᓚᐅᖅᑐᑦ ᑭᐅᔾᔪᑕᐅᓪᓗᑎᒃ ᐅᓄᙱᓗᐊᕐᓂᖏᓐᓄᑦ ᐊᐅᓚᑕᐅᓪᓗᑎᓪᓗ ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖃᖏᓐᓄᑦ ᐊᒻᒪ ᖃᓄᐃᑉᐸᓪᓕᐊᓂᖏᓐᓂᑦ ᖃᐅᔨᓴᖅᐸᓪᓕᐊᔾᔪᑎᑦ, ᑐᙵᕕᐅᓪᓚᕆᒃᐳᖅ ᐃᓪᓗᖔᖓᓅᕈᑕᐅᓪᓗᓂ ᐊᑯᓂᐅᔪᖅ ᐅᓄᕈᓐᓃᖅᐸᓪᓕᐊᔪᓂᑦ. ᑖᒃᑯᐊ ᖃᐅᔨᔭᐅᔪᑦ ᑕᑯᒃᓴᐅᑎᑦᑎᕗᑦ ᑲᑐᔾᔭᖃᑎᒌᖕᓂᖅ, ᓇᓗᓇᐃᕈᑎᒃᓴᑦ−ᒪᓕᒃᖢᒋᑦ ᐊᐅᓚᑦᑎᓂᖅ ᖃᓄᖅ ᐊᓯᔾᔨᕈᓐᓇᖅᑎᑦᑎᓐᒪᖔᑦ ᐅᓄᕐᓂᖏᓐᓂᒃ ᐅᓗᕆᐊᓇᖅᑐᒦᓕᓚᐅᖅᑐᓂᑦ.

ᐅᖃᐅᓯᐅᓪᓗᐊᑕᕐᑐᖅ: ᑐᒃᑐᐃᑦ, ᓇᐹᖅᑐᖃᙱᑦᑐᒥ ᑐᒃᑐᐃᑦ, ᕿᑭᖅᑖᓗᒃ, ᐃᓗᐃᓪᓕᖅ, ᕿᑭᖅᑖᓘᑉ ᐅᐊᓐᓇᖓᓂ, ᕿᑭᖅᑖᓘᑉ ᓂᒋᐊᓂ, ᖃᖓᑕᓲᒃᑯᑦ ᖃᐅᔨᓴᕐᓂᖅ, ᓄᓇᒃᑯᑦ ᖃᐅᔨᓴᕐᓂᖅ, ᐅᑭᐅᑉ ᓄᙳᐊᓂ, ᑕᑯᒃᓴᐅᑎᒃᑯᑦ ᖃᐅᔨᓴᕐᓂᖅ, ᕿᑭᖅᑖᓗᖕᒥ, ᒪᕐᕉᖕᓂᒃ–ᖃᐅᔨᓴᖅᑎᖃᖅᖢᑎᒃ ᐊᑕᐅᑦᑎᒃᑯᑦ ᖃᐅᔨᓴᕈᑎᑦ, ᓇᓈᓐᓂᖏᑦ, ᓇᒧᙵᐅᕙᓪᓕᐊᓂᖏᑦ, ᐊᕐᖀᒍ ᐃᓚᖓᓂ ᐊᔾᔨᒌᙱᑦᑐᑦ ᐊᑐᖅᑕᐅᓲᑦ, ᐅᖓᓯᖕᓂᖓᓂ ᖃᐅᔨᓴᒐᒃᓴᑦ, ᓇᓈᓐᓂᖏᑦ, ᖃᔅᓯᐅᓂᖏᑦ, ᓄᓇᕗᒻᒥ, *Rangifer tarandus groenlandicus*, ᐅᓄᕐᓂᖏᓐᓂᑦ ᖃᐅᔨᓴᕐᓂᖅ, ᑐᒃᑐᐃᑦ ᐅᑭᐅᒃᑯᑦ ᓇᓂᑐᐃᓐᓈᕐᓂᖏᑦ.

ABSTRACT

In this report, we present an update to the 2014 abundance estimate and trend of Baffin Island Caribou. We conducted aerial surveys to estimate the abundance of barren-ground caribou on Baffin Island and ancillary islands over two years (2024, 2025), using double-observer pair and distance sampling methods. Both surveys were enhanced through the guidance of local knowledge and inclusion of Inuit Qaujimajatuqangit (IQ) from communities that hunt Baffin Island caribou.

In March 2024 and March 2025, we assessed South Baffin, and North and Central Baffin caribou abundance respectively. In March 2024, we observed 3,843 individuals on-transect across all South Baffin strata. In March 2025, we observed 3,656 caribou on-transect across North and Central Baffin strata. In total (across both years and all strata), we observed 7,635 caribou. We used double-observer pair and distance sampling analytical models to develop abundance estimates for all strata across both years and for the entire Baffin Island complex. We estimated 24,162 (95% CI = 21,595-27,034; CV =5.7%) adults, calves, and yearling caribou within South Baffin strata in March 2024 and 25,026 (95% CI = 21,182-29,568; CV =8.5%) adults, calves, and yearlings within North and Central Baffin strata in March 2025. Combined, the March 2024 and 2025 surveys produced an estimated total of 48,681 (95% CI = 43,973-53,893; CV =5.2%) adult, yearling, and calf caribou. Our findings confirm a statistically significant increase from the March 2014 whole-island survey, which estimated 4,645 adult, yearling, and calf caribou (95% CI=3,667-5,884, CV=12.1%).

We conducted trend analyses using matched strata between 2012, 2014, and 2024/2025. These analyses suggest increasing trends in all regions with annual increases of 15% to 36% except for Prince Charles Island, where abundance declined annually at a rate of 3% (CI=-8% to 2%)). We calculated estimates of gross change and annual change the results of which indicate that the Baffin Island caribou population increased by a factor of 10.5 between March 2014 and 2024/2025, corresponding to an average annual growth rate of 25% (CI=22-28%). The observed change between March 2014 and 2024 was highly significant (t-Test =17.1; p-value <0.001). The observed annual rate of increase of 25% parallels rates of increase observed on island populations with minimal predation, high productivity, and minimal harvest pressure. Our results highlight the success of research and management actions led by co-managers in safeguarding Baffin caribou.

Research monitoring using fall and spring composition studies tracked relative density and overall productivity of Baffin Island caribou following the March 2014 Island wide abundance estimate, and initiation of management actions in 2014/2015 aimed at recovering Baffin Island caribou. Measures such as the implementation of Total Allowable Harvests (TAH) and Non-quota Limitations (NQLs), introduced in response to critically low numbers and steered by IQ and demographic monitoring studies, have played a pivotal role in reversing the long-term decline in abundance. These findings demonstrate how collaborative, evidence-based management can restore resilience to a population once in jeopardy.

Key words: Caribou, Barren-Ground Caribou, Baffin Island, Melville Peninsula, North Baffin Island, South Baffin Island, Aerial Survey, Ground Survey, Late Winter, Visual Survey, Baffin Region, Double Observer Pair Method, Distribution, Movements, Seasonal Range Use, Distance Sampling, Spatial Affiliations, Population Structure, Nunavut, *Rangifer tarandus groenlandicus*, Population Survey, Caribou Late Winter Distribution.

TABLE OF CONTENTS

1.0 INTRODUCTION

The following report reassesses demographic estimates and trends in caribou abundance across Baffin Island by comparing strata flown in March 2014 (all of Baffin Island), March 2024 (South Baffin Island), and March 2025 (North and Central Baffin Island) (**Figure 1**). It provides estimates of herd size and region-specific densities, documenting changes since the 2014 island-wide survey and subsequent 2024 and 2025 abundance surveys. The report presents updated abundance estimates to support ongoing management discussions between the Government of Nunavut, Department of Environment (GN ENV), co-management partners, and stakeholders.

Caribou are circumpolar in their distribution and occur in the northern parts of Eurasia and North America. In Canada, caribou are represented by four subspecies: Peary (*R. t. pearyi*), Woodland (*R. t. caribou*), Grant's (*R. t. granti*), and Barren-ground (*R. t. groenlandicus*). Of the four subspecies, barren-ground caribou are the most abundant and can be further divided into two ecotypes: the taiga wintering migratory and the tundra wintering ecotypes (Nagy et al. 2011). Baffin Island barren-ground caribou are classified as a tundra wintering ecotype, generally occurring in smaller aggregations, exhibit limited migratory behaviour, and are confined to tundra environments. Baffin Island caribou movement behaviour is not fully understood; however, limited scientific knowledge and IQ suggest that known seasonal movements or migratory behaviour, differ amongst three generally accepted Baffin Island caribou groupings or sub-populations. Currently, the GN ENV, recognizes three (3) caribou sub-populations across Baffin Island (see **Figure 6**; 5.1 Baffin Island Populations/Subpopulations). These populations include the South, North, and Central Baffin Island sub-populations (Campbell et al. 2015).

Historical caribou abundance assessments on Baffin Island caribou have suggested that more than 100,000 caribou likely inhabited Baffin Island in 1985 (Williams and

Heard 1986). This status was updated in 1991 at which time it was believed that the caribou sub-populations across Baffin Island were stable, with 60,000 -180,000 in South Baffin, greater than 10,000 in Central Baffin, and between 50,000-150,000 in North Baffin (Ferguson and Gauthier 1992). These earlier estimates, however, were not based on whole Island quantitative demographic studies, but rather estimations based on more geographically restricted scientific observations and IQ, including various smaller scale quantitative aerial observations, and limited movement data made up of; 1- extensive tagging programs and 2- limited telemetry studies from the early 1990s and early 2000's (Ferguson 1988).

During the mid to late 1990s, local hunters across Baffin Island reported decreasing caribou numbers, with hunters having to travel further from their communities to locate caribou (Jenkins et al. 2012; Jenkins and Goorts 2013, Department of Environment 2013). These observations appeared to have continued up to the 2014 whole Island abundance survey estimate. During this period Baffin Island caribou harvesters continued to confirm general declines in caribou abundance Island wide (Jenkins and Goorts 2013, Department of Environment 2013). These concerning observations, quantitatively confirmed following the 2014 abundance survey, lead to the engagement of all stakeholders in the development of management and research actions with an eye to reversing the confirmed declining trend.

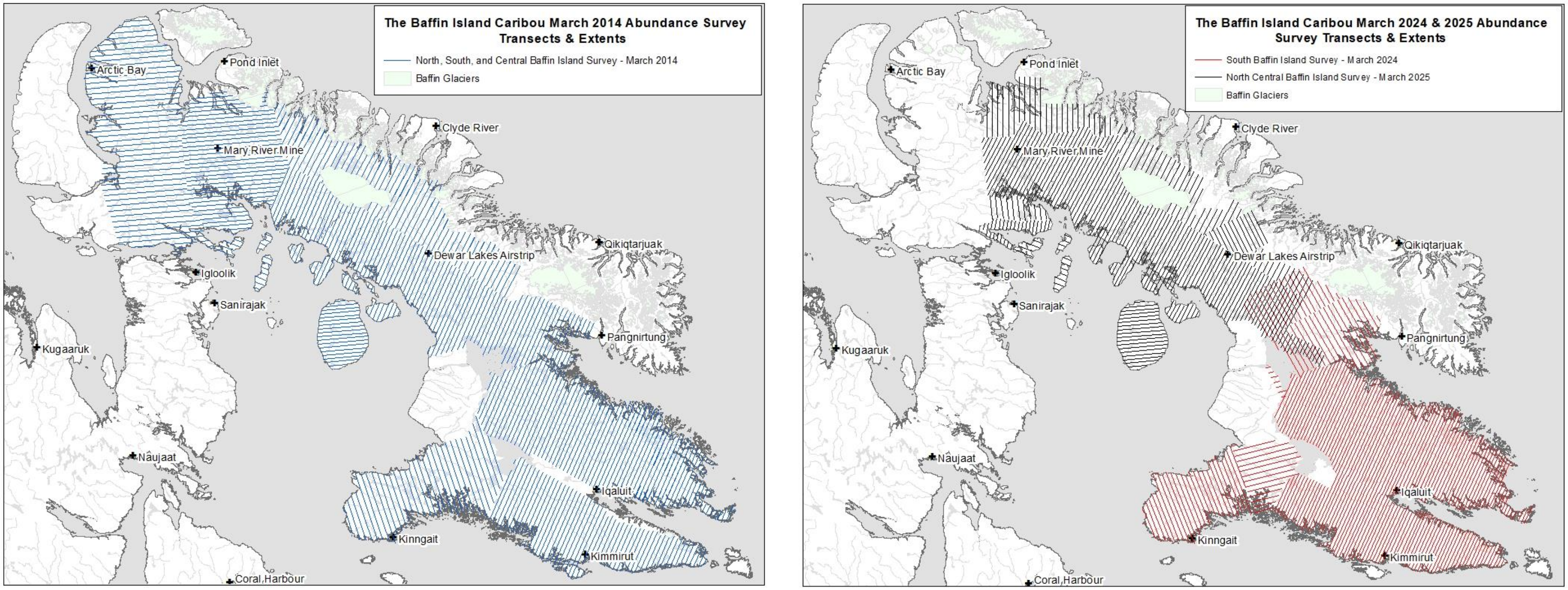

Figure 1. The north, central, and south March 2014 Baffin Island survey transects and extents (Left), and the March 2024 south Baffin and March 2025 north and central Baffin survey transects and extents (Right) side by side for comparison of survey extents. All survey extents and transects were developed through consultation with Hunters and Trappers Organizations (HTOs), Regional Wildlife Organization (RWO), and community meetings (Jenkins and Goorts 2013, Department of Environment 2013).

2.0 STUDY AREA

The Baffin Island complex, which includes all of Baffin Island and proximal islands (including Prince Charles Island), covers an estimated 543,746 square kilometres (excluding the areas of glaciers and ice fields). The Baffin Island complex exhibits variable relief, ranging from expansive lowlands near sea level (e.g., the great plain of the Koukdjuak east of Nettilling Lake, and Prince Charles Island), to the mountains of the North and South Baffin reaching elevations of 1,963 meters and 2,147 meters above sea level, respectively. The northeastern fifth of Baffin Island is within the Arctic Cordillera ecozone, while the remainder of the Baffin Island complex is wholly within the northern arctic ecozone (**Figure 2**). For detailed information on these ecozones and associated ecoregions (**Figure 3**), see (Campbell et al. 2015). Generalized indications of plant community productivity suggest that much of Baffin Island may not be suitable as caribou range suggesting more restrictive and predictable seasonal occupation of geographically specific areas by caribou (**Figure 4**) (Environment Canada 2001).

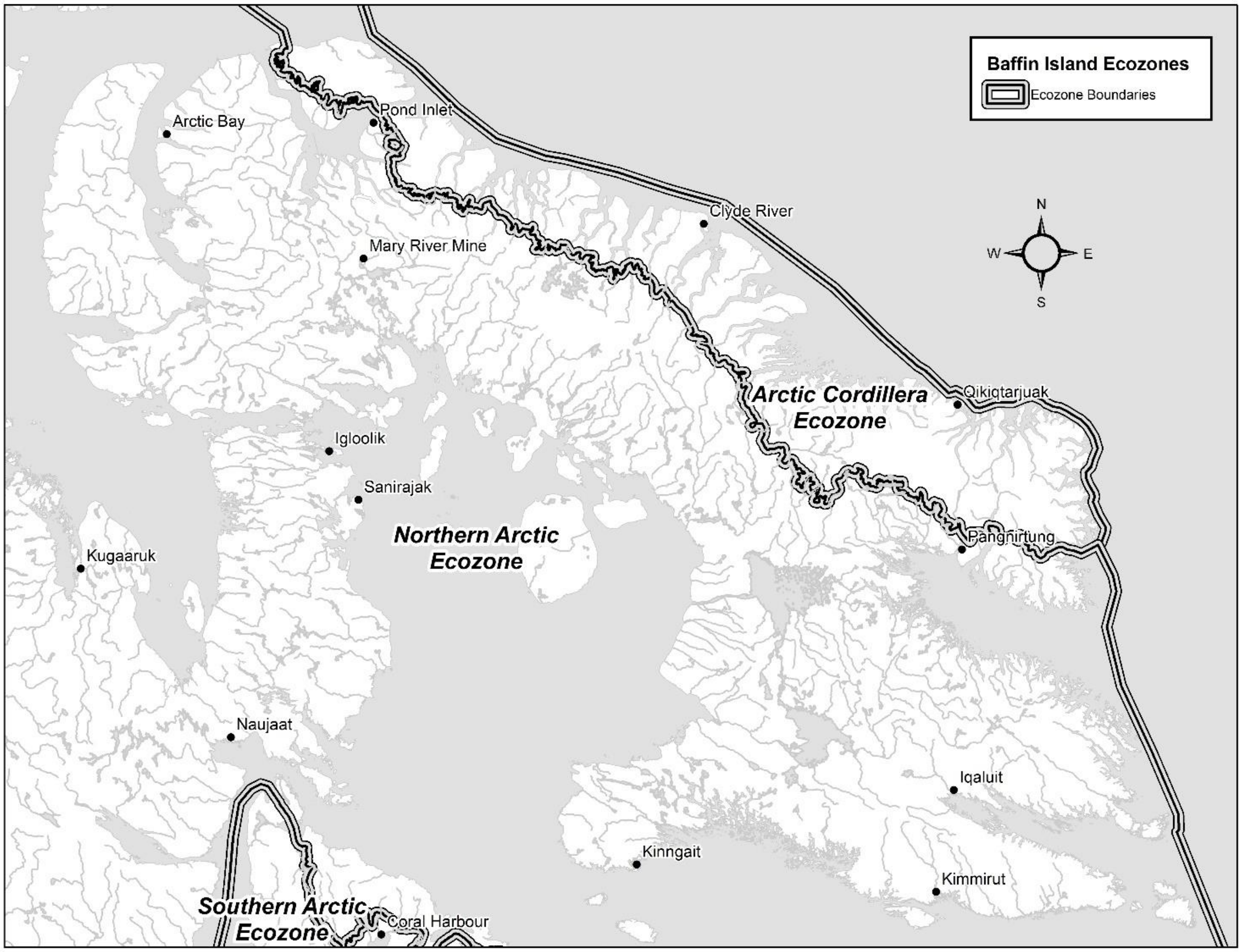

Figure 2. Ecozones of Baffin Island and proximal islands, and northern Melville Peninsula, Nunavut (after Environment Canada 2001).

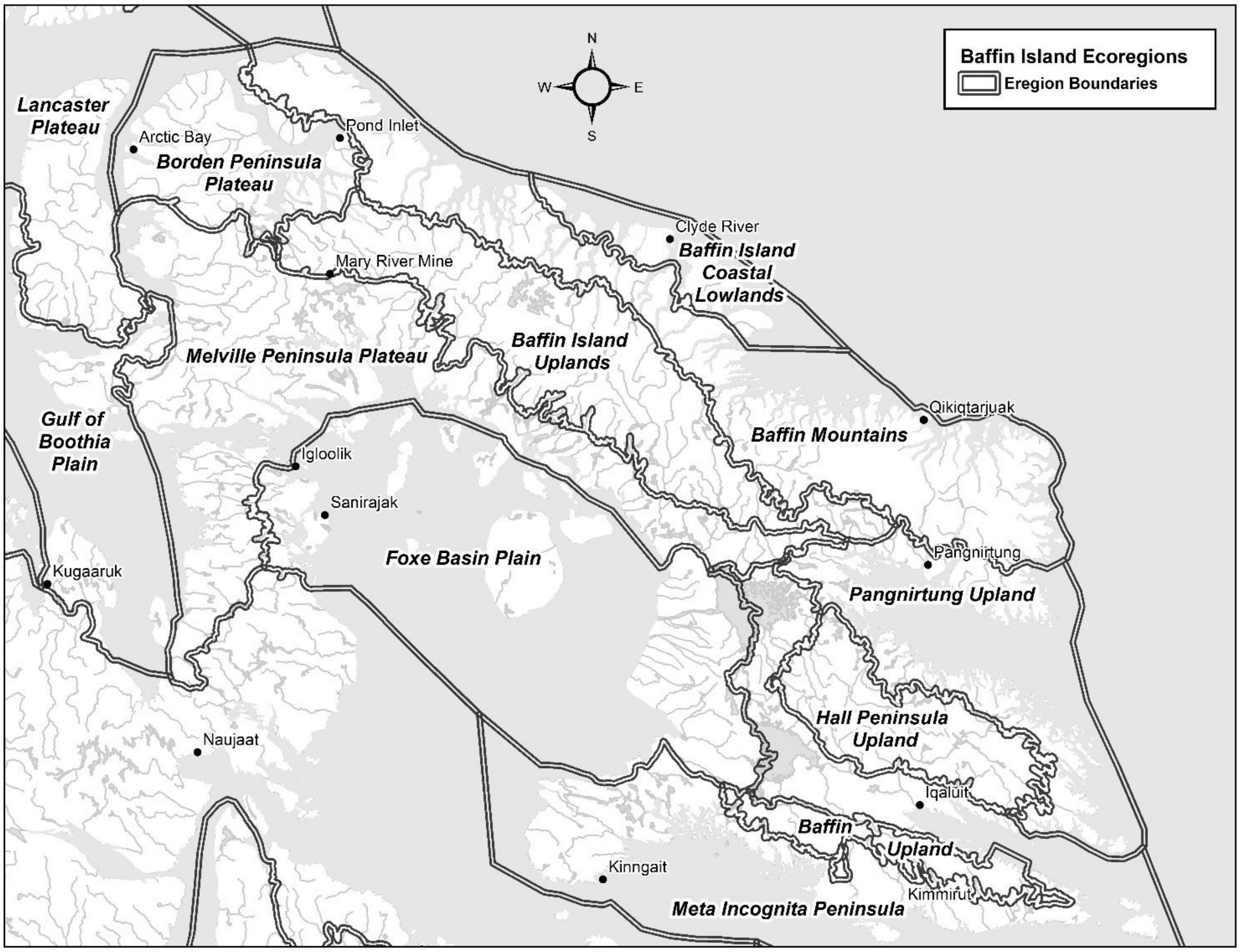

Figure 3. Ecoregions of Baffin and proximal islands, and northern Mellville Peninsula, Nunavut (after Environment Canada 2001).

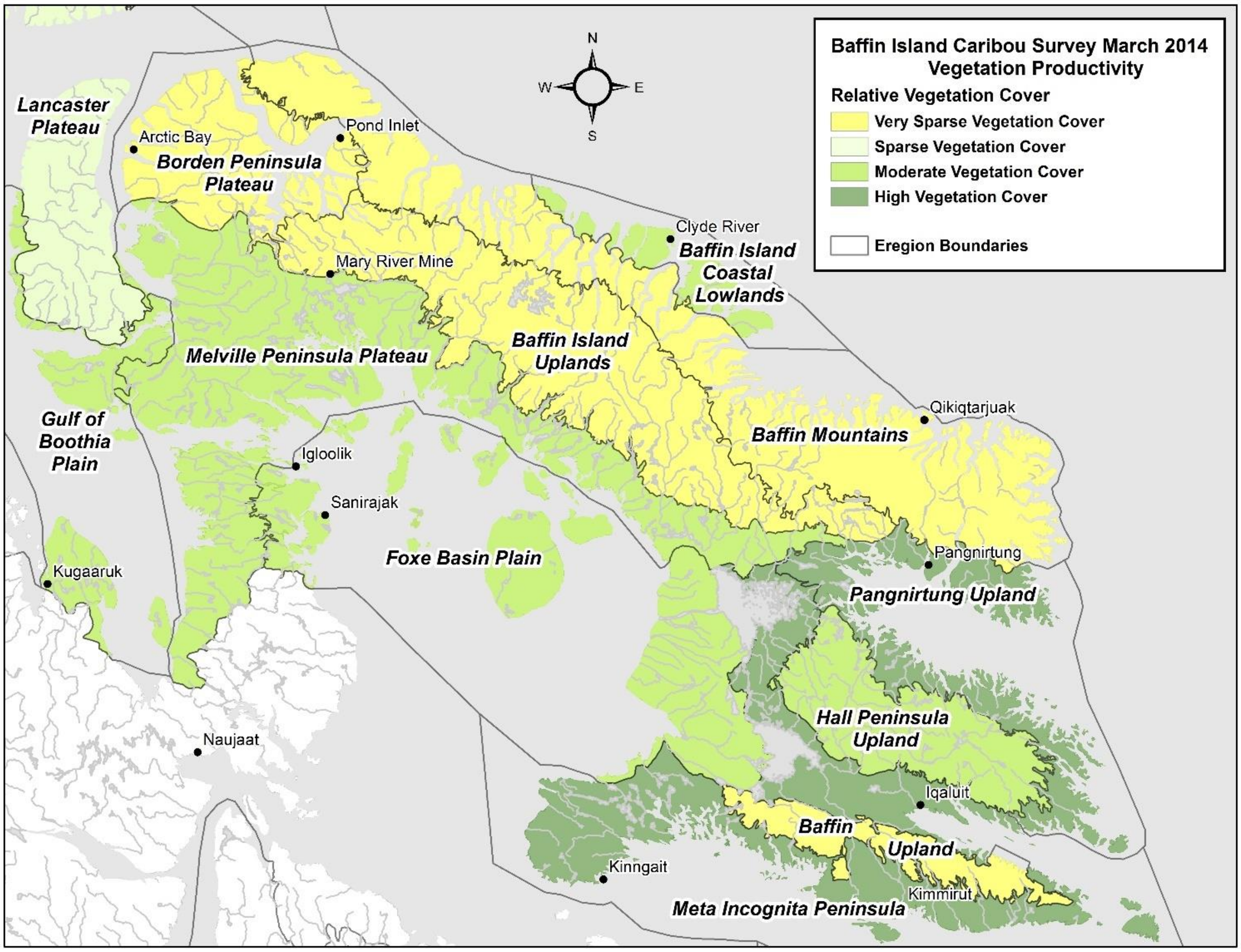

Figure 4. The relative productivity of plant communities within the ecoregions of the Baffin Island complex including northern Melville Peninsula. Productivity based on generalized plant species and cover assessments (after Environment Canada 2001).

3.0 METHODS

3.1 Abundance Survey Methods

The March 2024 abundance survey, which focused on South Baffin Island (*see 4.1 Sampling Summary and Data Segregation*), used two DeHavilland Twin Otter fixed wing aircraft and one Eurocopter B-2 helicopter and was based out of the communities of Iqaluit, Pangnirtung, and Kinngait. The March 2025 abundance survey, which focused on Central and North Baffin Island including Prince Charles Island (*see 4.1 Sampling Summary and Data Segregation*), also used two DeHavilland Twin Otter fixed wing aircraft and one Eurocopter B-2 helicopter and was based out of the communities of Iqaluit, Pangnirtung, Qikiqtarjuaq, Clyde River, and Igloolik, in addition to the Mary River Mine Site.

These abundance surveys used the same methods and similar strata (*see 4.1 Sampling Summary and Data Segregation*) used in the 2014 islandwide survey (Campbell et al. 2015; however, see discussion on helicopters, e.g., *4.2 Double Observer and Distance Analysis*). These methods are commonly and successfully used for barren-ground caribou surveys throughout Nunavut (Campbell et al. 2015, 2019, and 2022).

For the fixed wing portion of the surveys, we used a combined distance sampling and cooperative double observer pair mark-recapture approach. The double-observer pair configuration was used within all fixed wing aircraft to maximize sightability out of each of the left and right side of the aircraft, by adding one additional observer to each side (Campbell et al. 2012, 2015, and 2019). Additionally, the double observer pair configuration allowed each aircraft to maintain a minimum of two experienced wildlife observers on each of the left and right side of the aircraft throughout the survey, while providing training opportunities, when required, for community-based representatives within the remaining seats.

For the helicopter portion of these surveys, we used a modified approach whereby the pilot and data recorder served as observers that would remain in the same seats throughout the survey making this application of the double-observer component of the helicopter survey less robust than that of the fixed-wing. The helicopter survey, as detailed further later in this report, utilized a different observer platform and flight pattern, which involved flying to and way-pointing each observation rather than using wing strut bins to estimate distance as used on the fixed wing aircraft. As a result, it was useful to consider areas flown by helicopter as a distinct stratum to allow added modelling flexibility as well as evaluation of the effect of the different observer platform on survey estimates and associated precision.

Distance Sampling

The distance sampling component of the methods estimates the sightability of caribou groups in various distance bins. This is necessary to correct for declining detection probability with increasing distance from the survey plane. To accomplish this, we placed markers on the struts of the survey planes calculated using the formula from Norton-Griffiths (1978). These markers correspond with the following distance bins: 1) 0–200 meters, 2) 200–400 meters, 3) 400–600 meters, 4) 600–1,000 meters, and 5) 1,000–1,500 meters (Norton-Griffiths 1978).

Double Observer Pair

The dependent double observer pair component of the methods estimates the sightability of caribou groups between same side observers. This is necessary to reduce bias by accounting for animals missed by a single observer and provides more reliable abundance estimates. To accomplish this, we used two “primary” or “front” observers sitting in the left and right seats of the aircraft adjacent to the wing struts, and two “secondary” or “rear” observers sitting on the left and right side of the aircraft right behind the primary observers (**Figure 5**). The dependent double observer pair method adhered to five basic assumptions or steps.

1 - The primary observer called out all groups of caribou (number of caribou and wing-strut bin number) he/she saw within the 1- 0-200 meter, 2- 200-400 meter, 3- 400-600 meter, 4- 600-1000 meter, and 5- 1000–1500-meter wing-strut bins before they passed halfway between the primary and secondary observer (approximately at the wing strut). This included caribou groups that were between approximately 12 and 3 o’clock for right side observers and 9 and 12 o’clock for left side observers (**Figure 5**). The main requirement was that the primary observer be given time to call out all caribou seen before the secondary observer called them out.

2 - The secondary observer called out whether he/she saw the caribou that the primary observer saw, and observations of any additional caribou groups. The secondary observer also waited to call out caribou until the group observed passed halfway between observers (between 3 and 6 o’clock for right side observers and 6 and 9 o’clock for left side observers).

3 - The observers discussed any differences in group counts to ensure that they are calling out the same groups or different groups and to ensure accurate counts of larger groups.

4 - The data recorder categorized and recorded counts of caribou groups into “primary only”, “secondary only”, and “both”, entered as separate records.

5 - The same side observers switched places approximately halfway through each survey day (i.e. during refueling stops) to monitor observer position-based ability. The recorders noted the names of the primary and secondary observers and their side (left or right) and recorded group size and any assigned covariates.

In some cases, both same side observers missed a group of caribou, but the group was seen by the data recorder. It is expected that observer pairs may miss some caribou and naïve inclusion of data recorder observations could cause bias in estimates. However, in some cases a substantial number of caribou groups were missed by same side observer pairs indicating that they were weak observers. The concern in this case is that a substantial number of caribou would have 0 detection probabilities solely due to poor observer performance (in comparison to other observers). However, in this situation the dependent observer approach would not provide a valid estimate of the reduced detection probabilities. To address this concern graphical approaches were used to identify weak observer pairs, and in extreme cases, the weak observers were pooled as a single observer with the second observer being the data recorder. A covariate was used to model this modification of observer pairing. A sensitivity analysis was conducted to determine the effect of inclusion of data recorder observations.

Group size, topography, speed, snow cover, and cloud cover were also considered as covariates as with other surveys. Aircraft type was also considered. For the 2014 Baffin Island survey, 3 Cessna grand caravan fixed-wing aircraft and one Eurocopter B-2 helicopter were used, while during both the 2024 and 2025 Baffin Island surveys, 2 DeHavilland twin Otter fixed wing aircraft, and one Eurocopter B-2 helicopter were used.

Data Recorded

We used "*groups of caribou*", as opposed to individual caribou, as the sample unit for the survey. Recorders and observers were instructed to consider individuals to be those caribou that were observed independent of other individual caribou and/or groups of caribou. If sightings of individuals were influenced by other individuals, then the caribou were considered a group. In general, groups of caribou over an estimated 250 meters apart were considered independent groups. For each group of caribou recorded, additional covariates were recorded that can influence the sightability of caribou (**Table 1**). Due to heterogeneity variation in detection probabilities, it has been found that using just a mark-recapture approach overestimates sightability as distance from the survey plane increases, however, this approach was useful for estimation of sighting probability near the plane. This approach ensured a more robust estimate than using distance sampling methods alone which assume that the probability of detection of caribou groups at 0 distance from the plane is 1 (Borchers et al. 1998, Buckland et al. 2004, Laake et al. 2008a, Laake et al. 2008b, Buckland et al. 2010, Laake et al. 2012).

General Analytical Approach

Initially, we analyzed 2024 and 2025 data separately. For both years, we followed these general steps to conduct our analysis. First, we conducted exploratory analyses to assess detection performance in the double observer framework. This allowed us to identify weak or non-switching observer pairs that could bias the accuracy of estimates (*4.2.1 Double Observer and Distance Analysis (2024), Double Observer Summary; 4.2.2 Double Observer and Distance Analysis (2025), Double Observer Summary*). Second, we conducted exploratory analyses to assess detection patterns across the distance sampling framework and the impact of various covariates (*see* **Table 1**; *4.2.1 Double Observer and Distance Analysis (2024), Distance Sampling Summary; 4.2.2 Double Observer and Distance Analysis (2025), Distance Sampling Summary*). This was done to identify and account for any covariates that could influence the detection probabilities and thereby impact the accuracy of estimates. Covariates were also used to describe and model factors influencing the sightability of caribou (**Table 1**). These included observer pair given that the sample unit for dependent methods is pairs of observers as opposed to single observers. If observers were not paired, then they were pooled into a single multi-observer group.

After the exploratory analyses, we created double observer pair mark-recapture and distance sampling models for each year (*4.2.1 Double Observer and Distance Analysis (2024), Model Selection Fixed Wing, Helicopter Model Selection; 4.2.2 Double Observer and Distance Analysis (2025), Model Selection Fixed Wing, Helicopter Model*

Selection). We first built distance sampling models with the mark-recapture model parameters that held constant, and then vice versa for the double observer models. We then built a composite model using the most supported covariates from each of the component analyses. Estimates for strata were derived based on transect lengths and strata areas for the best fitting detection model. Estimates of variance were derived using estimators for a systematic sampling layout (Fewster 2011).

We evaluated the fit of these models using the Akaike Information Criterion corrected for small sample size (AIC_c). The model with the lowest AIC_c score was considered the most parsimonious (simplest), thus minimizing estimate bias and optimizing precision (Burnham and Anderson 1998). The difference in AIC_c values between the most supported model and other models (ΔAIC_c) was also used to evaluate the fit of models when their AIC_c scores were close. In general, any models with a ΔAIC_c score of less than 2 between them were considered to have equivalent statistical support. Overall model fit was also assessed using goodness of fit tests (Buckland et al. 1993, Buckland et al. 2004) as well as graphical comparison of detection functions with histograms of frequencies of observations from the surveys.

We then conducted sensitivity analyses for each year to assess how estimates were affected by analysis methods and model assumptions (*4.3 Analysis of 2024 & 2025 Models and Data*). We derived estimates using the Jolly strip-transect estimator (Jolly 1969, Krebs 1998) with the survey strip defined at 400 meters from the plane. This approach, which allows inclusion of all survey data (i.e. data recorder, etc) but assumes sightability, was equal to 1 in the 0–400-meter strip, provided a useful comparison with distance sampling estimates. In addition, distance sampling only, and double observer only (no distance sampling) within the 0–400-meter strip were considered.

Next, we derived estimates for both years (*4.4 Estimates*). In both years, abundance estimates were derived from the most supported MRDS model for both the fixed-wing strata and the helicopter strata (*4.4.1 March 2024 South Baffin Survey; 4.4.2 March 2025 Central and North Baffin Survey*). We then combined the 2024 and 2025 survey year estimates into a single islandwide estimate through re-analysis of the 2024 data set so that strata had zero (0) overlap with 2025 strata (*as detailed later in the report*).

The full island 2024-2025 combined estimate was then compared with the 2014 full island estimate (Campbell et al. 2015).

Finally, we undertook analyses to compare trends in applicable sub-regions (*Foxe Peninsula, Meta-Incognita Peninsula, Hall Peninsula, Central Baffin, and Prince Charles Island were also compared; 4.5 Trend Analysis*). Estimates were initially compared to the 2012 and 2014 estimates using a t-test to determine if the two estimates were significantly different (Gasaway et al. 1986). Confidence limits on yearly change were estimated assuming log-normal distributions of abundance estimates using a Monte Carlo simulation approach (Manly 1997).

We conducted our analyses in *R* (R Development Core Team 2009) using the following R packages: *ggplot* (Wickham 2009), MRDS R package (Laake et al.), *AICmodavg* (Mazerolle 2016), *lubridate* (Grolemund and Wickham 2011), and *ddply* (Wickham 2011). For GIS analyses, we used the R package *sf* (simple features) (Pebesma 2018) in addition to the software QGIS (QGIS Foundation 2020). The *MRDS* R package (Laake et al. 2012) was used to build double observer pair mark-recapture and distance sampling models.

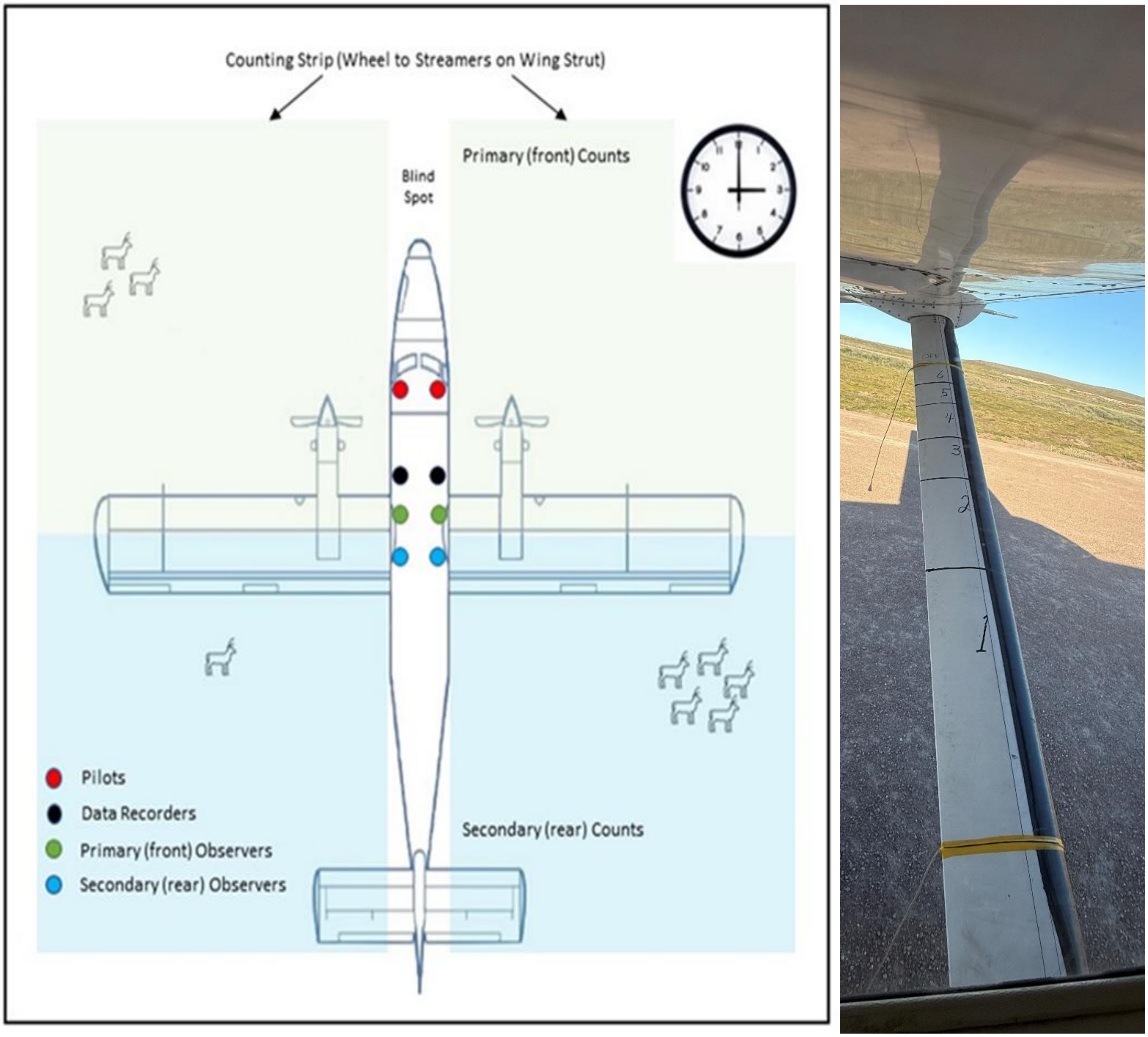

Figure 5 Observer position for double observer methods. The secondary (Rear) observer calls caribou not seen by the primary (Front) observer after the caribou has passed the main field of vision of the primary observer. Time on a clock is used to reference relative locations of caribou groups (e.g. “Caribou group at 1 o’clock”).

Table 1. The main co-variates (speed and topography were not used) used to model variation in sightability for dependent double observer pair analysis.

Covariate	Acronym	Description
Aircraft type	AirType	Helicopter vs fixed wing
Observer pair	obs	each unique observer pair
	Paired	Whether a pair switched places during survey
Data recorder observations	weakobs	Pairs who were assisted by the data recorder
Group size	size	size of caribou group observed
	Log(size)	Natural log of group size
Snow cover	snowf	snow cover (0,25,75,100)
	snow	continuous
Cloud cover	cloudf	cloud cover (0,25,75,100)
	cloud	continuous
Snow patchiness	SnowPatch	Continuous ordinal scale

3.2 Composition Studies

Since the 2014 survey, the GN ENV has conducted intermittent fall and/or spring aerial composition surveys from October and March 2015 to 2021 to monitor productivity and geographically specific relative densities of caribou across Baffin Island (Ringrose 2018, 2019, and 2021). The objectives of this monitoring program were to:

1) Estimate the overall composition of the subpopulations including the north Baffin grouping, south Baffin grouping, and central Baffin grouping (**Figure 6**); i.e., what proportion of the population are bulls, cows, yearlings, and calves.

2) Estimate the trajectory of abundance of the three main groupings of the Baffin Island caribou population, based on demographic composition as it relates most specifically to overwinter calf survival (March/April) and overall productivity (October; measured as calves per 100 cows) to develop an index of population trend.

3) Monitor the proportion of bulls in the population to ensure that predominantly bull harvests do not reduce their numbers to a level that could compromise breeding (rutting) success.

4) Build a database with which to estimate the current population trend through demographic modeling, utilizing all demographic composition data to project a trend from the 2014 population estimate.

5) Provide information geographically specific to relative abundance as it relates to ease of finding caribou and overall numbers of caribou observed, and to use this information for discussions of TAH and NQL appropriateness.

Surveys were conducted using a Eurocopter AS350 B2 helicopter, and a survey crew consisting of a biologist, wildlife technician, an observer, and a pilot. Study areas were selected based on previous aerial surveys and telemetry program observations as well as information gathered from hunters from each of the Baffin communities. Hunter information was collected during consultations conducted in 2012, 2013, 2014, and 2015 (DOE 2013, 2014, 2015a, 2015b *unpublished written records-In Prep*), across all Baffin Island (Ringrose 2018, Jenkins and Goorts 2013). Study areas were surveyed using two to three 5 km spaced transects bisecting identified high use areas by caribou, or until tracks were observed either on route to proposed high use areas, or while running transects through these same areas (Ringrose 2018). The method relied heavily on tracking groups and/or individual caribou until they were sighted, however, visual sighting methods were used when tracking was either difficult or not possible.

When tracks were encountered and the group located and classified, parallel transects through the study area would be tightened up to 1 to 2 km apart (depending on the density of tracks as it related to the ease to separate groups of tracks), with one transect run perpendicular to the track leading into the area and continued perpendicular to adjacent transects until tracks were no longer encountered (Ringrose 2018). This allowed classification crews to adaptively “high grade” search areas with caribou sign. The use of this adaptive search technique allowed for the most efficient use of the limited helicopter time and limited fuel caches, both the result of the geographical scale and resultant remote nature of the Baffin Island composition study areas. Additionally, this adaptive method allowed crews to take advantage of clustering behavior observed during previous survey and tracking studies, and described by Baffin Island caribou harvesters, whereby groups of Baffin Island caribou were more commonly observed in small geographic clusters generally associated with watersheds, during late winter and spring.

Once tracks were observed, they were followed until the group was located at which time caribou would be classified into 5 categories; 1) Cow (based on the presence of a visible vulva patch), 2) Calf (based on body size and characteristics), 3) Yearling (based on body size and characteristics), 4) Bull (based on absence of vulva patch, body characteristics and antler size) and when possible, 5) Young Bull (based on absence of vulva patch, body characteristics and antler size). Image stabilizing binoculars were used to reduce approach distances as much as possible to limit disturbance to animals. In cases where groups could not be located due to fuel and/or weather-related issues, and where time allowed, tracking was resumed the following day or after refueling.

When analyzing composition results, we used a logistic regression analysis (McCullough and Nelder 1989) to assess regional differences and overall trends in calf-cow ratios using surveys. An additive model was used (region+year) to assess differences in regions and explore if there was a regional increase in calf-cow ratios. Using logistic regression accounted for differences in sample sizes in surveys with the response being the count of calves divided by the count of cows in each survey. A quassi-binomial response model was used to account for likely overdispersion in the response data.

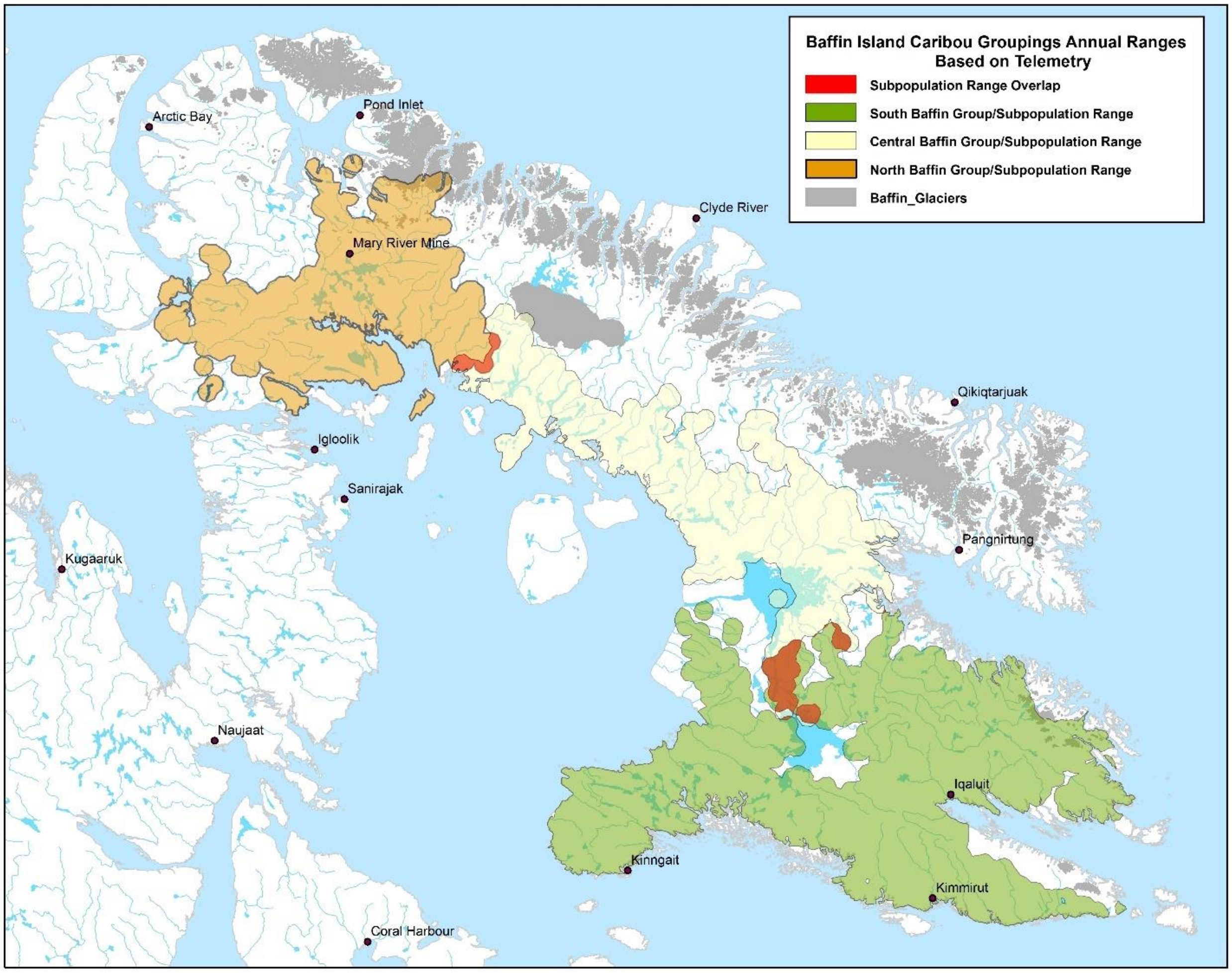

Figure 6. Caribou grouping annual range delineation based on telemetry studies from 1987 to 1994 (primarily South and Central Baffin), and 2008 to 2011 (North Baffin). Polygons created utilizing a kernel analysis of telemetry point data collected for 107 collars (North=35; Central = 17; South = 55) (Campbell et al. 2015).

4.0 RESULTS

4.1 Sampling Summary and Data Segregation

The Baffin Island March 2024 and 2025 abundance surveys included eight (8) south Baffin strata and six (6) north-central Baffin strata. The aircraft used within each strata varied according to topographic ruggedness with fixed-wing (FW) aircraft being delegated to less topographically rugged strata, and rotary-wing or helicopter (H) aircraft to more mountainous strata (**Figure 7**). The South Baffin strata included:

1- Foxe Peninsula low Density Fixed-Wing (**FP-LD-FW**)
2- Foxe Peninsula Medium Density Fixed-Wing (**FP-MD-FW**)
3- Hall Peninsula High Density Fixed-Wing (**HP-HD-FW**)
4- Hall Peninsula High Density Helicopter (**HP-HD-H**)
5- Meta Incognita Peninsula High Density Fixed-Wing (**MP-HD-FW**)
6- Niko Island Very Low Density Fixed-Wing (**NI-VLD-FW**)
7- Nettilling Lake Northeast Low Density Fixed-Wing (**NLNE-LD-FW**)
8- Nettling Lake North Low Density Fixed-Wing (**NLN-LD-FW**)

The North-Central Baffin strata included:

1- Gifford Fiord Medium Density Fixed-Wing (**GF-MD-FW**)
2- Neergaard Lake Low Density Fixed-Wing (**NL-LD-FW)**
3- North Central Baffin High Density Fixed-Wing (**NCB-HD-FW**)
4- North Central Baffin Medium Density Helicopter (**NCB-MD-H**)
5- Pond Inlet Low Density Helicopter (**PI-LD-H**)
6- Prince Charles Island-High Density Fixed-Wing (**PCI-HD-FW**)

7- Western Islands Low Density Fixed-Wing (**ISL-LD-FW**)

The helicopter survey, as detailed further later in this report, utilized a different observer platform (non-switching observers) and flight pattern, which involved flying to and way-pointing each observation rather than using wing strut bins to estimate distance as used on the fixed wing aircraft. As a result, it was useful to consider areas flown by helicopter as a distinct stratum to allow added modelling flexibility as well as evaluation of the effect of the different observer platform on survey estimates. **Table 2** summarizes strata and transect dimensions, groups, and caribou observed on each survey strata.

Like the 2014 Baffin Island caribou abundance survey, both the 2024 and 2025 surveys were flown over the same general dates in March, with the 2025 north-central Baffin survey extending further into March due to above-average weather cancellations (**Table 3**). Neither survey year violated the five-day maximum allowable weather delay based on an analysis of collar movements of north, central, and south Baffin caribou across the March 2024 and 2025 surveys (**Figure 8**). Additionally, collar movements over the period showed little directional movement and were consistent with non-migratory behavior expressed as less than five kilometers of directional movement per day (**Figure 9**).

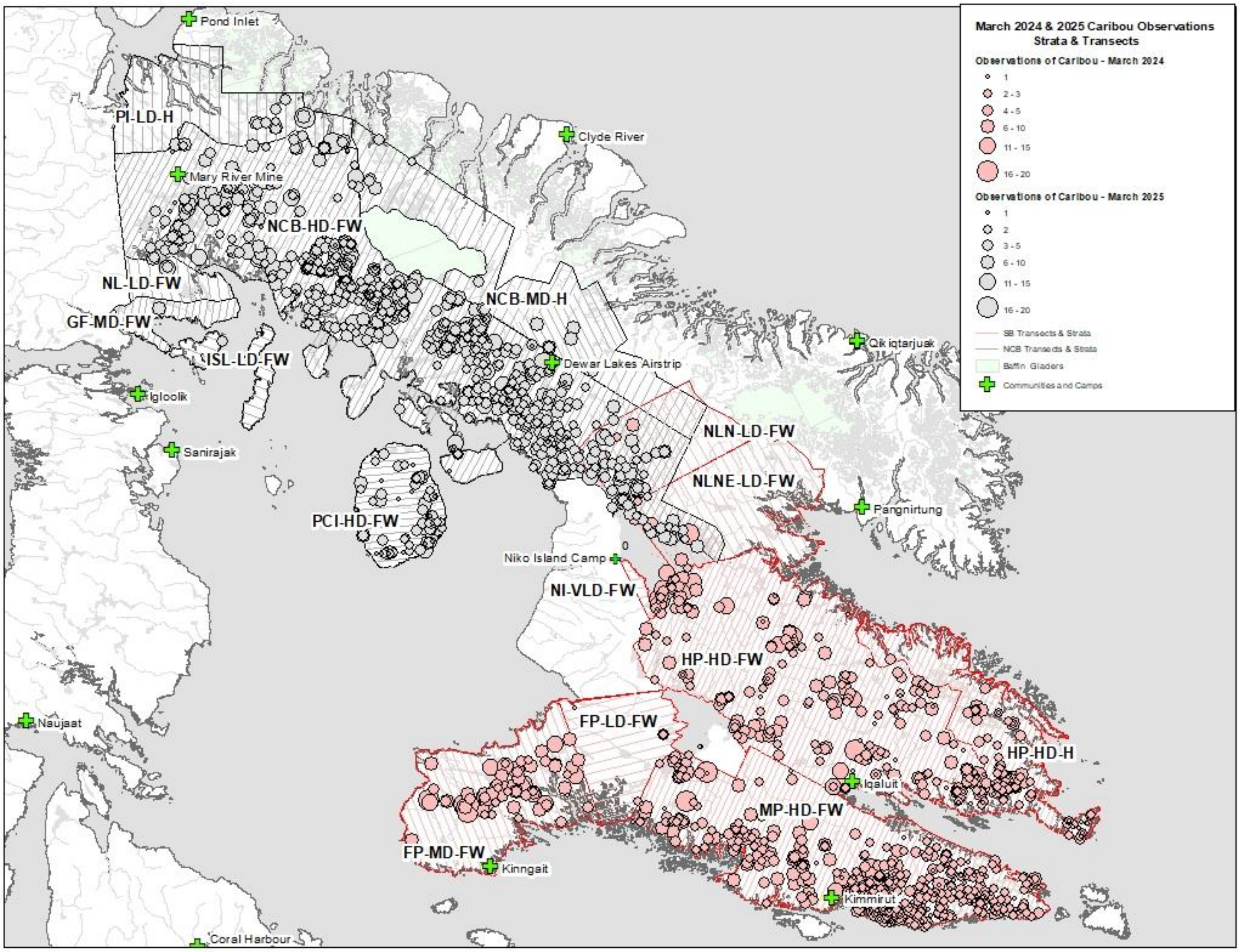

Figure 7 The 2024 South Baffin (Red) and 2025 North & Central Baffin Island (Grey) survey strata, transects, and caribou observations, used in this analysis. Helicopter stratum indicated with an "H" in their label, and fixed wing strata indicated with a "FW".

Table 2. Summary of strata dimensions and sampling. On-transect total caribou observations are listed for each stratum.

Strata	**Transects**	**Strata Area (km^2)**	**Total transects length (km)**	**Average transect width (km)**	**Baseline (km)**	**Coverage (1.5 km X 2 strip width (km2))**	**Caribou on transect**
2024							
FP-LD-FW	14	11,333	1,117	79.79	142.03	0.30	**11**
FP-MD-FW	26	21,635	2,654	102.09	211.92	0.37	**650**
HP-HD-FW	57	50,317	8,206	143.96	349.52	0.49	**909**
HP-HD-H	51	19,677	3,221	63.16	311.55	0.49	**433**
MP-HD-FW	73	41,801	6,879	94.23	443.61	0.49	**1,815**
NI-VLD-FW	7	752	81	11.55	65.1	0.32	**0**
NLNE-LD-FW	20	18,573	1,909	95.47	194.54	0.31	**66**
NLN-LD-FW	17	12,444	1,244	73.15	170.12	0.30	**24**
2025							
NCB-HD-FW	108	82,875	12,155	112.55	736.37	0.44	**3,223**
GF-MD-FW	25	3,160	453	18.14	174.25	0.43	**7**
ISL-LD-FW	15	2,800	301	20.07	139.57	0.32	**3**
NCB-MD-H	53	22,164	2,225	41.98	528.01	0.30	**18**
NL-LD-FW	11	3,819	395	35.93	106.32	0.31	**238**
PCI-HD-FW	19	9,529	1,349	71.01	134.20	0.42	**71**
PI-LD-H	24	15,809	1,238	51.57	306.56	0.23	**96**

Table 3. A comparison between the March 2024 and 2025 Baffin Island abundance survey timing (x = Flight Day, ***PR*** = Pilot Rest Day; ***WC*** = Flight cancelled due to weather).

Survey Type	**Date (2024)**																			
	Mar-06	Mar-07	Mar-08	Mar-09	Mar-10	Mar-11	Mar-12	Mar-13	Mar-14	Mar-15	Mar-16	Mar-17	Mar-18	Mar-19	Mar-20	Mar-21	Mar-22	Mar-23	Mar-24	Mar-25
Fixed Wing	**x**	**x**	**x**	**x**	**x**	**x**	***PR***	**x**	**x**	**x**	**x**	**x**	**x**	**x**						
Rotary Wing				***WC***	**x**	**x**	**x**	**x**	**x**	***WC***	**x**	**x**								
Survey Type	**Date (2025)**																			
	Mar-06	Mar-07	Mar-08	Mar-09	Mar-10	Mar-11	Mar-12	Mar-13	Mar-14	Mar-15	Mar-16	Mar-17	Mar-18	Mar-19	Mar-20	Mar-21	Mar-22	Mar-23	Mar-24	Mar-25
Fixed Wing	**x**	**x**	**x**	***WC***	**x**	***WC***	**x**	***WC***	**x**	**x**	**x**	***WC***	***WC***	***WC***	**x**	**x**	**x**	**x**	**x**	**x**
Rotary Wing									***WC***	**x**	***WC***	***WC***	***WC***	***WC***	***WC***	**x**	**x**	**x**	**x**	**x**

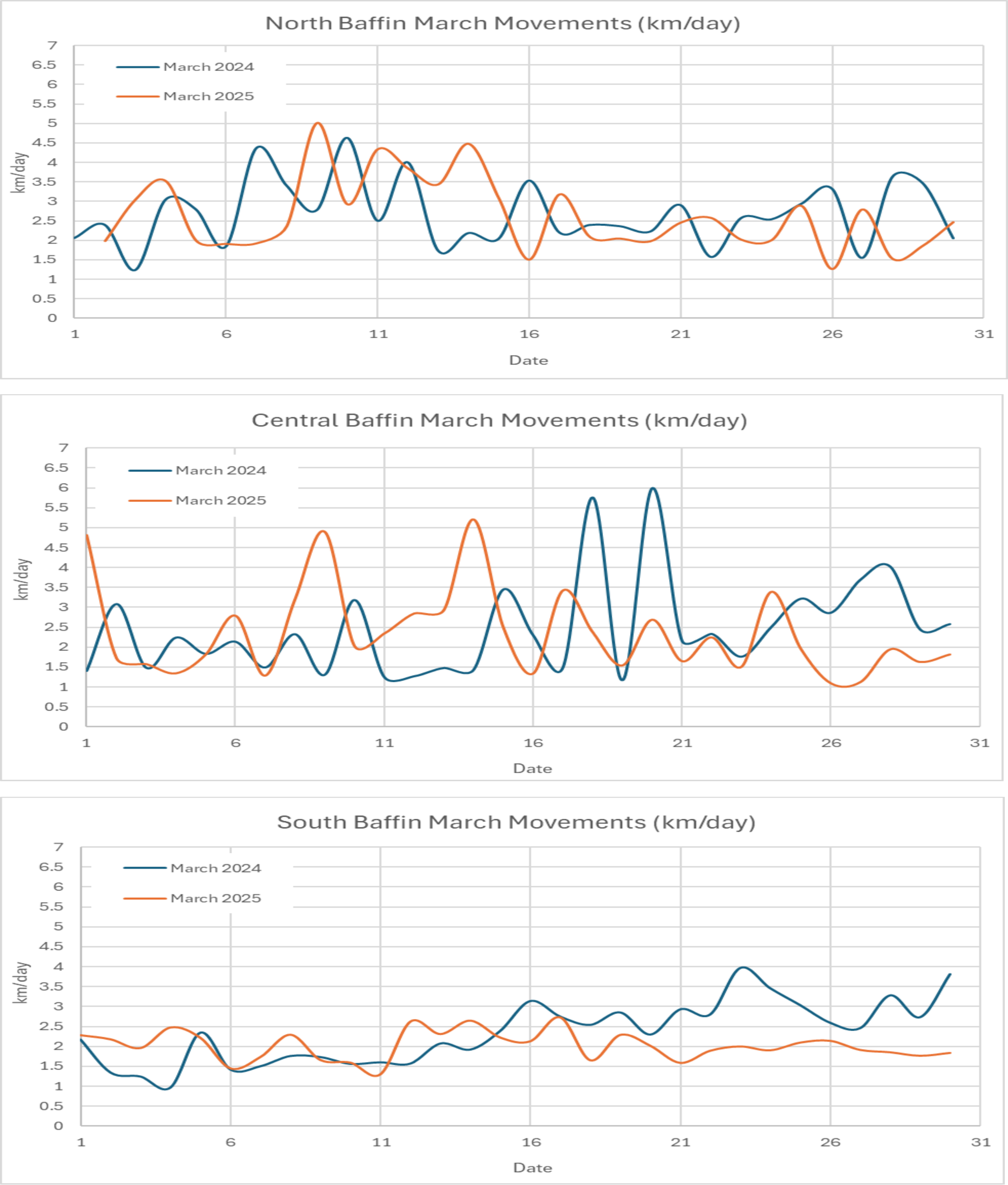

Figure 8. March daily movement rates of south Baffin collared caribou (2024), and north and central Baffin collared caribou (2025). Note that most collars tracked during the survey periods were under 5 km/day.

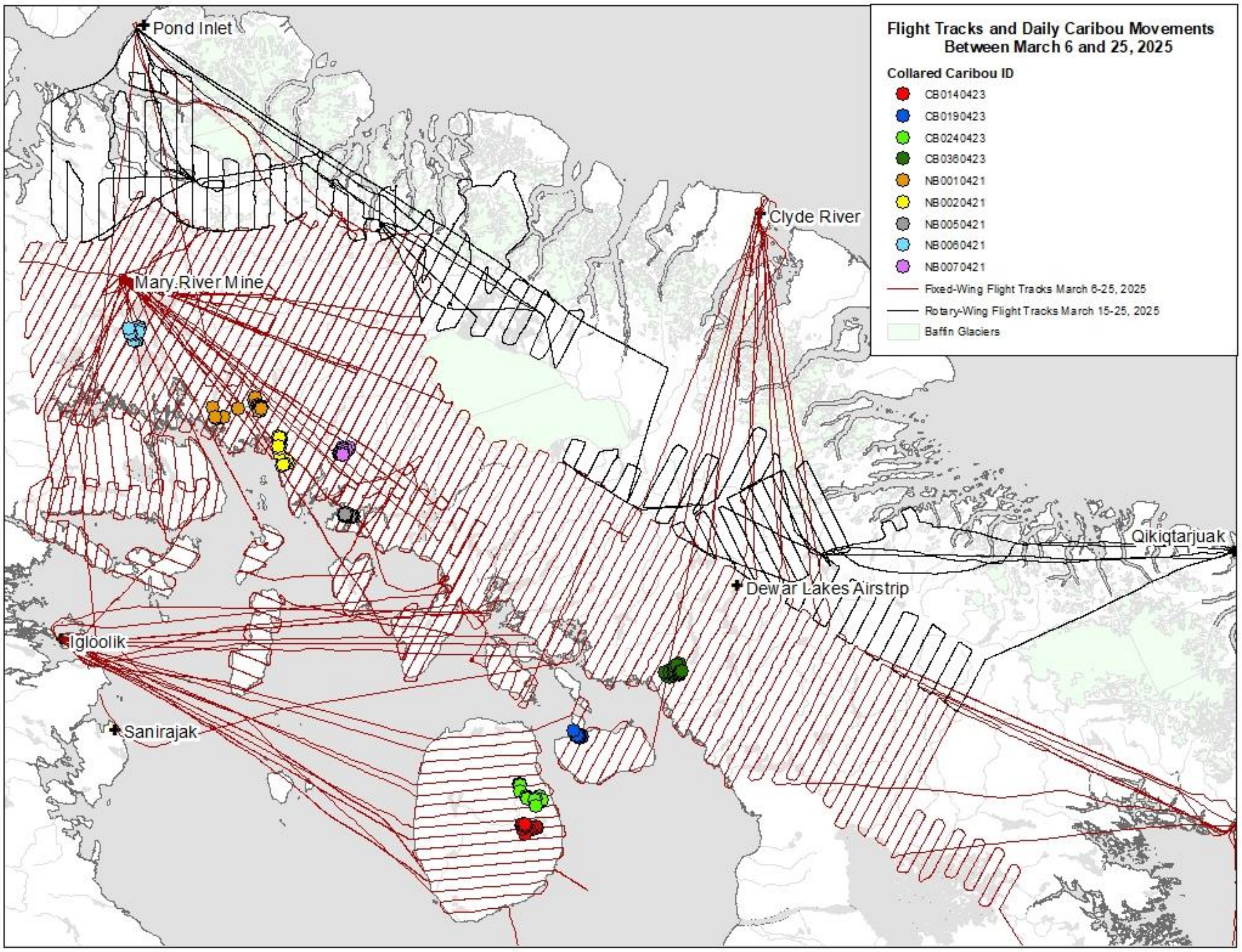

Figure 9. Survey flight tracks and collared caribou daily movements between March 6 and 25th, 2025. Note that movement rates of all collared caribou were very restricted during the survey period suggesting weather delays had little impact on cross-transect movements.

4.2 Double Observer and Distance Analysis

4.2.1 Double Observer and Distance Analysis (2024)

Double Observer Summary

Overall, there were 13 observer pairings of which 7 switched places (as required by the dependent observer method) (**Table 4**). Two of the pairings were in the helicopter where the pilot and data recorder were primary observers therefore not allowing switching. Pair number 11 was a data recorder who also served as a primary observer for some time periods again making it not possible to switch.

Of interest was the detection of weak observer pairs that missed a substantial portion of caribou as indicated by larger frequencies of observations only seen by data recorders. Data screening suggested that there were 2 pairs (5 and 6) that missed substantial frequencies of caribou as indicated by the relative difference of detection probabilities estimated with and without data recorder observations included. Often these pairs had higher double observer detection probabilities since often the pairs missed the same caribou (that were observed by the data recorder), therefore causing an unrealistically high detection probability estimate (given the number of caribou not observed compared to other pairs) (**Figure 10**). To offset this issue, the 2 observers were treated as a primary observer, and the recorder was treated as the secondary observer. This allowed inclusion of these observations for the weak observer pairs with a covariate to describe unique observer pair detection probabilities. Other data recorder observations from other pairs were not included in the analysis.

Another challenge to the analysis was low detection probabilities for the helicopter observer pairs (9 and 13). This was likely due to the pilots and data recorders being distracted by other factors and therefore not able to provide constant sighting effort. The challenge was that by not switching, the estimate of detection probabilities for the observer pair was based solely on the primary observers with the dependent method (which assumes equal primary and secondary observer probabilities). This likely caused a negative bias in detection probabilities and potentially a positive bias in estimates. Use of distance sampling only, which does not attempt to estimate detection based on double observer data, was used as a means to offset this issue.

An added challenge to the analysis was observer pair 11 which was a data recorder who also served as a primary observer. This observer pairing also had lower detection probabilities, which were hard to assess given that the primary observer never switched with the secondary observer. It is assumed in this case that this pair had lower detection probabilities than many of the other pairs (which were modelled using an observer pair covariate).

Table 4. Summary of double observer pair data. P1x is the single observer sighting probability and p2x is the double observer probability. Data is summarized for double observer only data and double observer with data recorder observations as indicated by _nodr and _dr suffixes respectively.

Pair	Switched?	Frequencies				Naïve detection probabilities			
		Front	Rear	Both	DataRec	P1x_nodr	P1x_dr	p2x	p2x_dr
2	yes	1	4	14	0	0.79	0.79	0.96	0.96
3	yes	17	20	92	13	0.84	0.77	0.98	0.95
4	yes	30	35	87	5	0.77	0.75	0.95	0.94
5	yes	27	4	99	37	0.97	**0.75**	1.00	0.94
6	yes	14	6	39	**45**	0.90	**0.51**	0.99	0.76
7	yes	4	6	15	2	0.76	0.70	0.94	0.91
8	no	1	1	6	0	0.88	0.88	0.98	0.98
9	no (heli)	18	32	18	0	0.53	**0.53**	0.78	0.78
10	no	5	6	21	0	0.81	0.81	0.96	0.96
11	no (data recorder & observer)	8	13	10	0	0.58	**0.58**	0.82	0.82
12	no	20	7	53	0	0.91	0.91	0.99	0.99
13	no (heli)	11	34	18	0	0.46	**0.46**	0.71	0.71

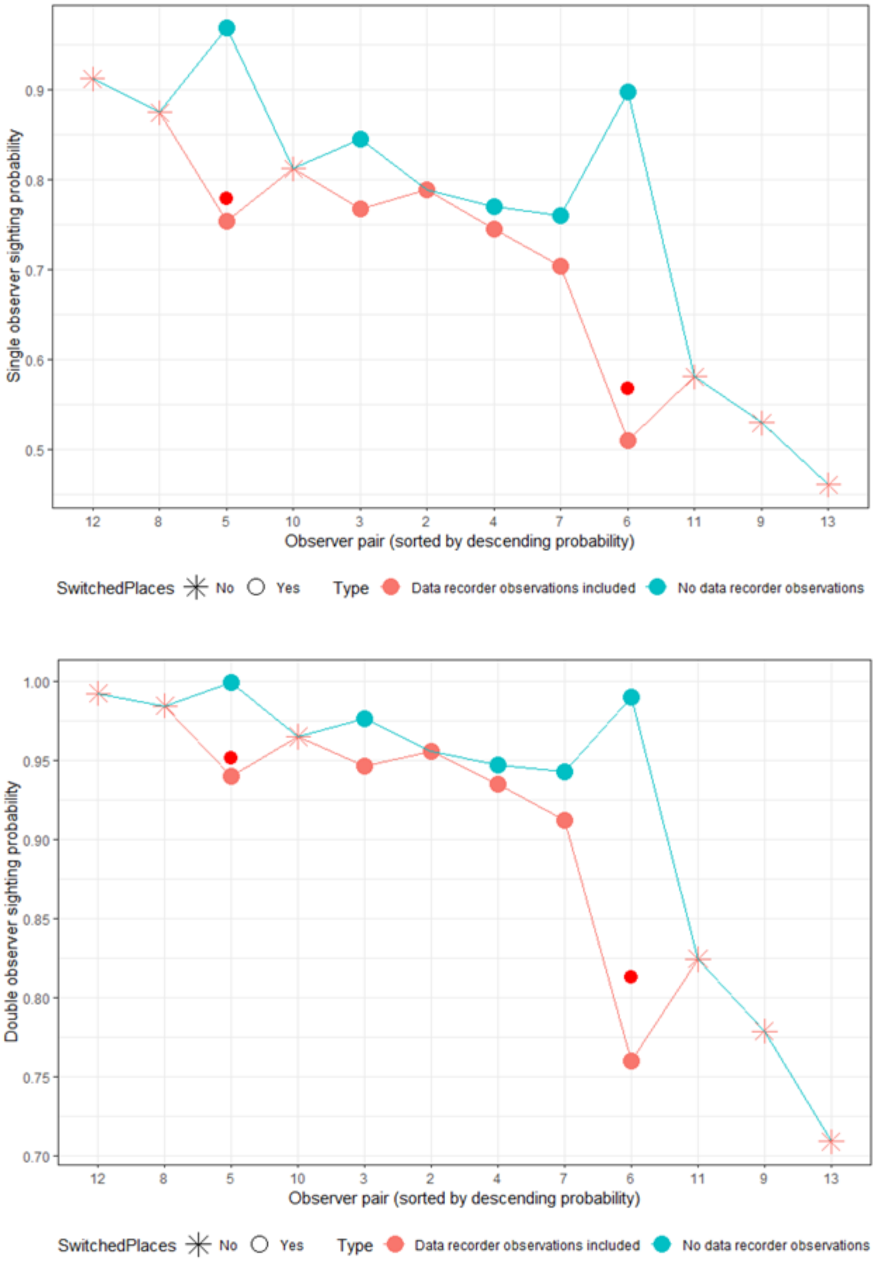

Figure 10. Graphical representation of double observer detection probabilities by observer pairs. The red dots indicate detection probabilities for applicable pairs where the 2 observers were primary, and the data recorder was considered the secondary observer.

Distance Sampling Summary

As would be expected, the detection histogram of observations was highest in the closest bin with a steady decline to the furthest bin. Detection histogram suggests that observers were attentive to the closest bin near the plane; an improvement from past surveys (**Figure 10**). The shape of detection histograms by aircraft type were different with a more pronounced shoulder for the helicopter which was likely due to clumping of caribou groups into small patches of suitable habitat but could also have been due to differences in the recording of caribou groups and associated coordinates (**Figure 11**). In addition, as noted earlier, most observations were only detected by a single observer for the helicopter in comparison to the twin otter fixed wing. This was likely due to the observer configuration. Due to the difference in both detection histogram shape and double observer data, it was decided to analyze the helicopter and fixed wing as separate data sets.

The effect of group size on detection histograms was less pronounced (**Figure 12**). Lower sample sizes made it more difficult to interpret helicopter observations. Cloud cover had a potential effect of broadening the detection histogram for fixed wing aircraft at higher cloud cover levels (**Figure 13**). A broadening of the detection shoulder with higher snow cover was also suggested, however the effect was minimal (**Figure 14**). The combined effect of snow and cloud is shown by the product of the two covariates. The detection histogram is flattened at higher levels of both cloud and snow cover (**Figure 15**).

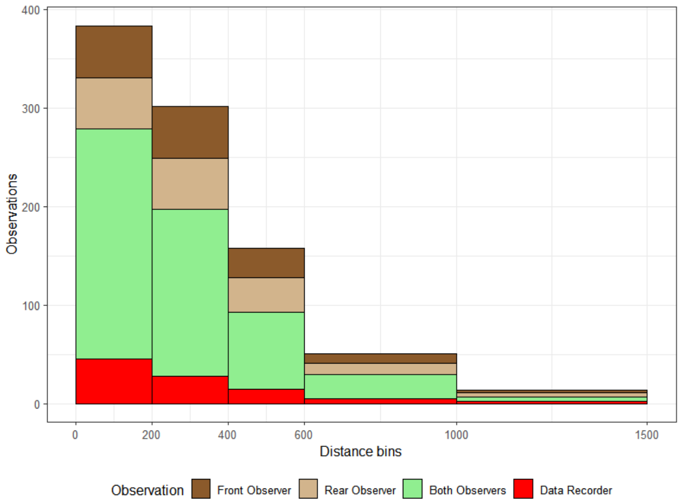

Figure 10. Histograms of detections as a function of distance from fixed wing aircraft. Observations are also color-coded by observation type. Observation frequencies are adjusted based on bin widths.

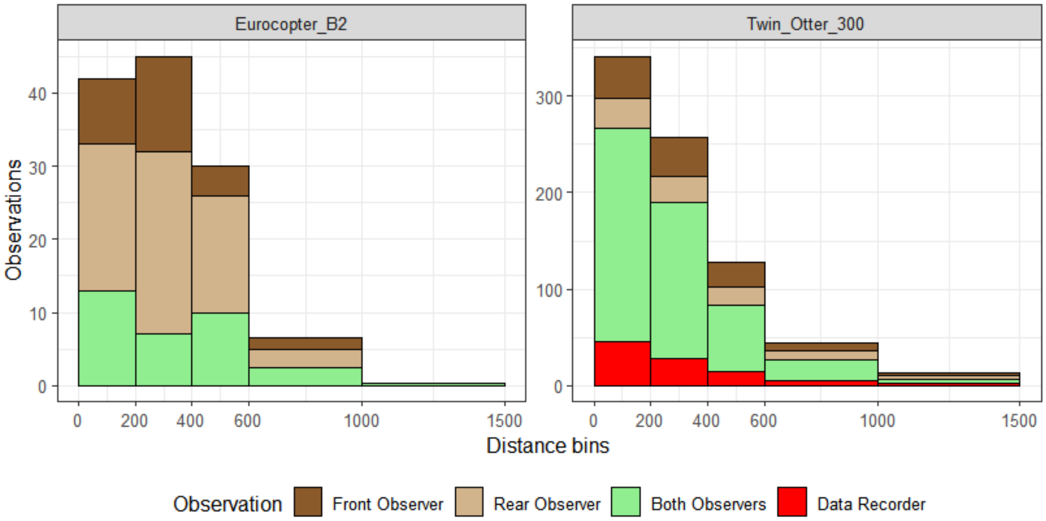

Figure 11. Histograms of detections as a function of distance from plane for aircraft type. Observations are also color-coded by observation type. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

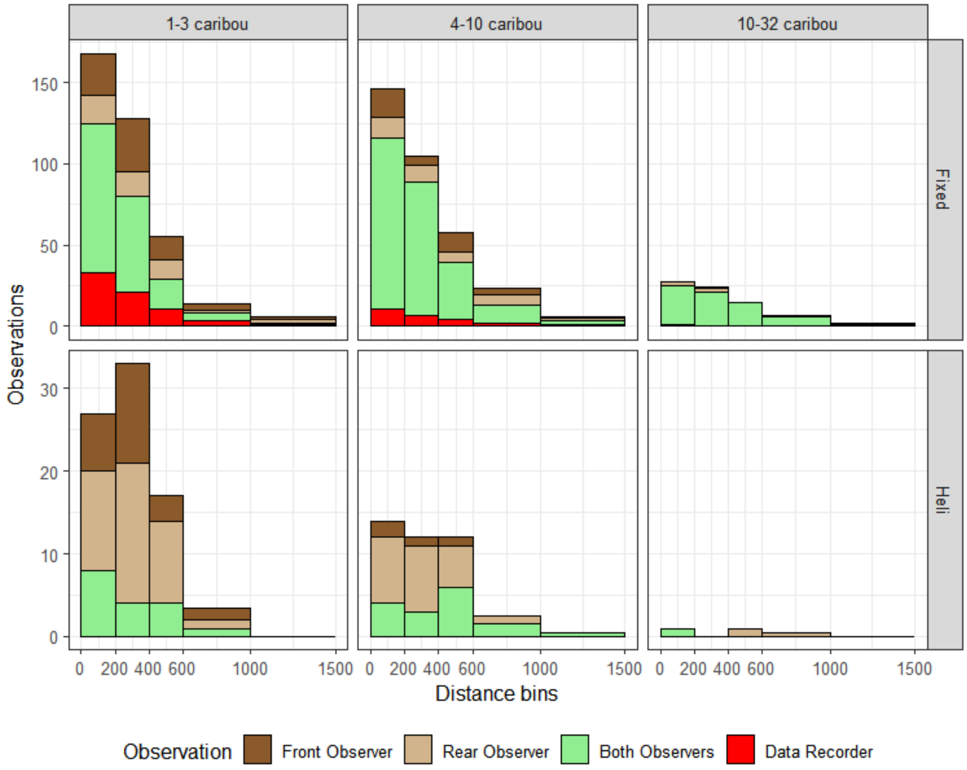

Figure 12. Histograms of detections as a function of group size and observation type. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

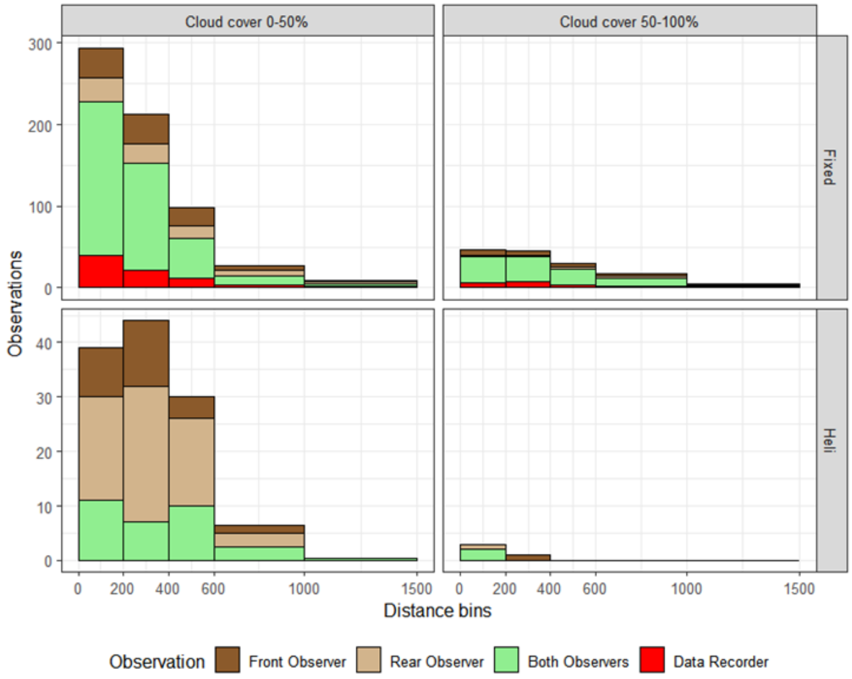

Figure 13. Detection histograms as a function of cloud cover. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

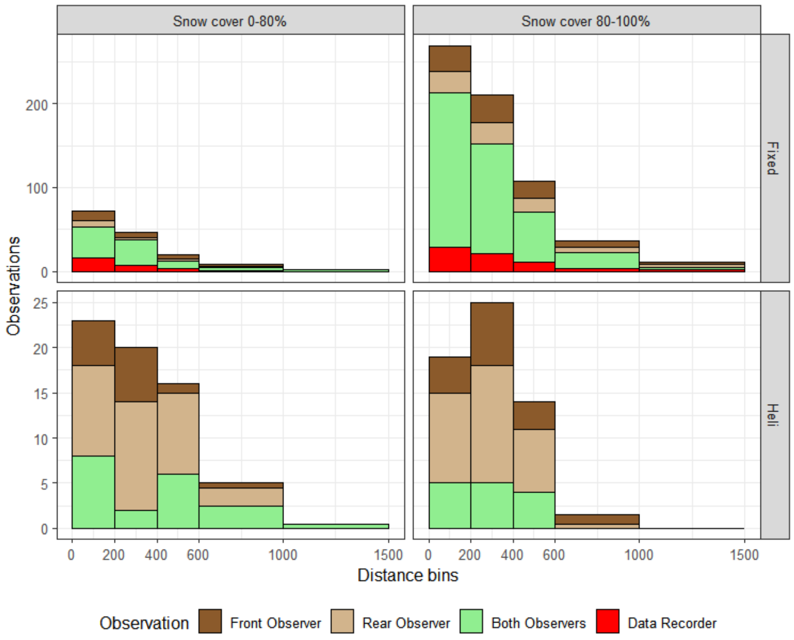

Figure 14. Detection histograms as a function of snow cover. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

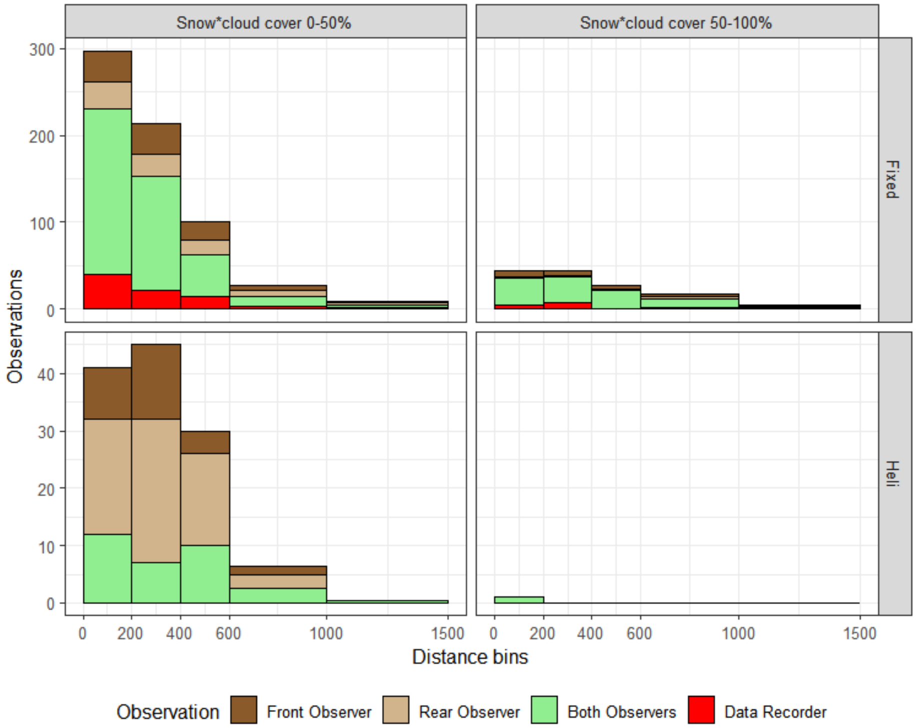

Figure 15. Detection histograms as a function of the product of cloud and snow cover. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

Model Selection Fixed Wing

Initial model selection tested whether hazard rate or half normal detection functions were more supported by the data. For this study hazard rate was more supported even when group size was considered (**Tables 5 and 6**, model 12). Of the covariates considered, univariate snow and cloud were supported with an additive snow and cloud covariate model (model 1) showing the most support. Interestingly, group size was not supported as a covariate suggesting good sightability conditions within all fixed-wing survey strata. Observer-specific detection histograms were also considered; however, model convergence was marginal as shown by large standard errors on beta terms and therefore these models were not considered especially representative since adequate model fit was achieved with the set of covariates that were used. For the double observer model selection, observers (with a focus on weaker observers that displayed lower detection probabilities than other observers), distance, and the log of group size were supported. The support of distance suggested that detection from observers showed some level of independence at further survey bins resulting in decreasing double observer probabilities.

A plot of the pooled detection function for model 1 (**Table 5 and 6**) suggests that the detection of caribou on the line (distance=0) was close to 1 with a shoulder of constant detection to approximately 200m after which it declined to 0.0 at the furthest bin (**Figure 16**). The actual estimate of detection on the line was 0.94 (SE=0.04). The fit of the distance detection function was adequate with a chi-square of 4.87. However, degrees of freedom were 0 due to covariates used to estimate the detection function. The base hazard rate model with no covariates did significantly fit the data with a chi-square value of 0.79, (df=1, p=0.49).

Visual inspection of the fit of the data to the mark-recapture component of the model (**Figure 17**) suggests adequate fit, however, chi-square values suggested marginal fit (chi-square=16.5, df=5, p=0.005). The main lack of fit was an underestimate of observations seen only by the secondary observer. The likely cause of this would be heterogeneity of sighting probabilities caused by the periodic inability to switch observers. Sensitivity analyses were conducted, including consideration of estimates with no mark-recapture component (using distance sampling only, therefore assuming detection is 1 at the closest survey bin) to better understand implications of lack of fit.

Table 5. Univariate model selection for distance sampling covariates for the 2024 fixed wing data set. The distance sampling detection function (DF: hr-hazard rate, hn-Half normal) is shown along with the distance and double observer model. A constant intercept double observer model was used for all analysis. Sample size adjusted Akaike Information Criterion (AICc), the difference in AICc between the most supported model for each model (∆AICc), AICc weight (wi), number of model parameters (K) and deviance is given. Constant models are shaded for reference.

No	DF	Distance model	AIC_c	ΔAIC_c	w_i	K	LL
1	hr	snow + cloud	3109.30	0.00	0.56	5	-1549.6
2	hr	snow + cloud + snowloud	3110.45	1.15	0.31	6	-1549.2
3	hr	snowloud	3114.26	4.96	0.05	4	-1553.1
4	hr	cloud	3114.77	5.47	0.04	4	-1553.4
5	hr	logsize + snowloud	3116.05	6.75	0.02	5	-1553.0
6	hr	logsize + cloud	3116.53	7.23	0.02	5	-1553.2
7	hr	logsize + cloud + snowloud	3118.08	8.78	0.01	6	-1553.0
8	hr	cloud_factor	3120.72	11.42	0.00	6	-1554.3
9	hr	weakobs	3127.13	17.83	0.00	4	-1559.5
10	hr	snow	3140.26	30.96	0.00	4	-1566.1
11	hr	snow_factor	3143.77	34.46	0.00	5	-1566.8
12	hr	constant	3146.88	37.58	0.00	3	-1570.4
13	hr	logsize	3147.22	37.92	0.00	4	-1569.6
14	hr	DataRecObs	3148.11	38.81	0.00	4	-1570.0
15	hr	size	3148.31	39.01	0.00	4	-1570.1
17	hr	SnowPatch	3148.38	39.08	0.00	6	-1568.1
18	hn	constant	3176.39	67.09	0.00	2	-1586.2
19	hn	size	3177.18	67.88	0.00	3	-1585.6

Table 6. Model selection for double observer and combined distance sampling/double observer covariates for the 2024 fixed wing data set. The distance sampling detection function (DF: HR-hazard rate, HN-Half normal) is shown along with distance and double observer model. Sample size adjusted Akaike Information Criterion (AICc), the difference in AICc between the most supported model for each model (∆AICc), AICc weight (w_i), number of model parameters (K) and deviance is given. Constant mark-recapture models are shaded for reference.

No	DF	Distance model	MR/2x model	AIC_c	ΔAIC_c	w_i	K	LL
1	hr	snow + cloud	ob6 + ob11 + distance + logsize	3070.31	0.00	0.62	9	-1526.0
2	hr	snow + cloud	ob6 + ob11 + distance + size	3071.64	1.32	0.32	9	-1526.7
3	hr	snow + cloud	ob6 + distance + logsize	3075.95	5.63	0.04	8	-1529.9
4	hr	snow + cloud	ob6 + ob11 + distance	3077.24	6.92	0.02	8	-1530.5
5	hr	snow + cloud	ob6 + ob11	3082.67	12.35	0.00	7	-1534.3
6	hr	snow + cloud	ob5 + ob6 + ob11	3082.90	12.59	0.00	8	-1533.4
7	hr	snow + cloud	weakobs	3091.95	21.63	0.00	6	-1539.9
8	hr	snow + cloud	distance + logsize	3093.30	22.99	0.00	7	-1539.6
9	hr	snow + cloud	logsize	3098.77	28.46	0.00	6	-1543.3
10	hr	snow + cloud	size	3100.48	30.17	0.00	6	-1544.2
11	hr	snow + cloud	SnowPatchF	3101.27	30.96	0.00	8	-1542.5
12	hr	snow + cloud	distance	3104.54	34.23	0.00	6	-1546.2
13	hr	snow + cloud	snowloud	3107.51	37.20	0.00	6	-1547.7
14	hr	snow + cloud	cloud	3107.87	37.56	0.00	6	-1547.9
15	hr	snow + cloud	snow	3108.67	38.35	0.00	6	-1548.3
16	hr	snow + cloud	constant	3109.30	38.99	0.00	5	-1549.6

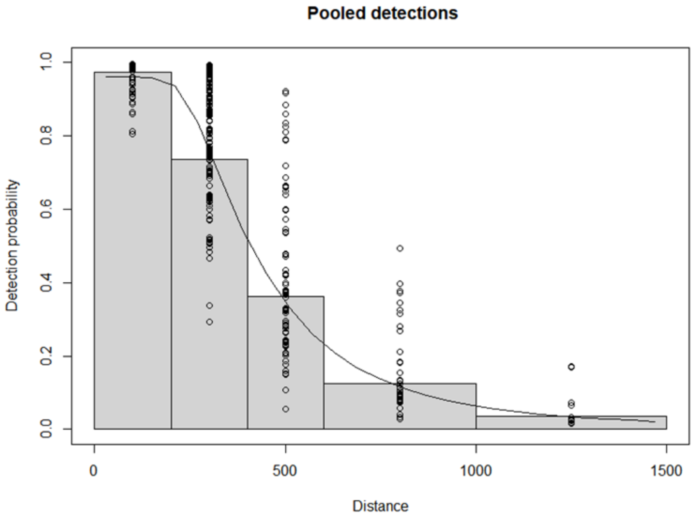

Figure 16. Fitted detection function for the most supported MRDS model for the fixed wing data set.

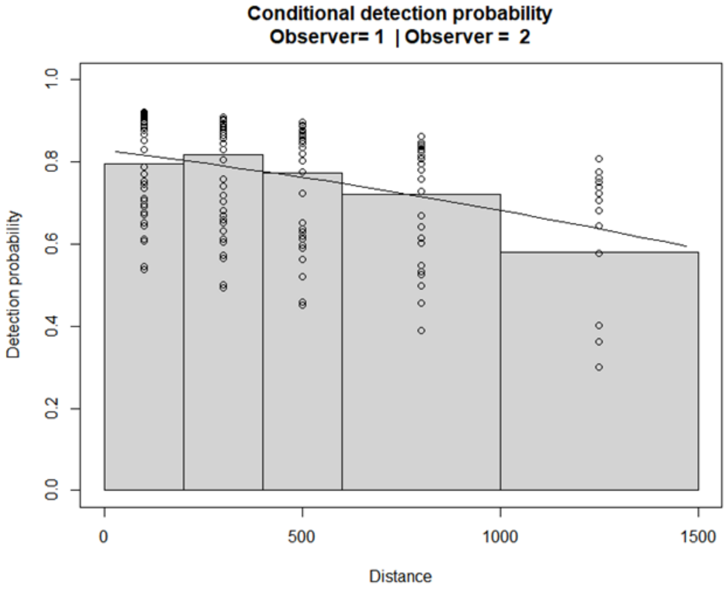

Figure 17. Fit of fixed wing mark-recapture double observer model for the fixed wing data set.

Model Selection Helicopter

Lower sample sizes of observations (131 observations) precluded consideration with more elaborate distance sampling models with the helicopter-only data set (**Table 7**). Models with more than 1 covariate did not converge and therefore univariate models were considered. Of detection functions, the hazard rate was most supported (model 6). A model with cloud cover as a covariate was most supported. A plot of the detection function shows a broader shoulder extending partially across the 200-400m survey sighting range. Model fit was adequate (chi-square=0.513, df=1, p=0.47) as indicated by chi-square tests (**Figure 18**).

Table 7. Model selection for distance sampling covariates for the 2024 helicopter data set. The distance sampling detection function (DF: hr-hazard rate, hn-Half normal) is shown along with the distance and double observer model. Sample size adjusted Akaike Information Criterion (AICc), the difference in AICc between the most supported model for each model (∆AICc), AICc weight (wi), number of model parameters (K) and deviance is given. Constant models are shaded for reference.

No	DF	Model	AIC_c	ΔAIC_c	w_i	K	LL
1	hr	cloud	344.70	0.00	0.60	3	-169.3
2	hr	snowloud	345.72	1.02	0.36	3	-169.8
3	hr	size	352.75	8.05	0.01	3	-173.3
4	hr	snow	353.07	8.37	0.01	3	-173.4
5	hr	logsize	354.18	9.48	0.01	3	-174.0
6	hr	constant	354.43	9.73	0.00	2	-175.2
7	hn	size	355.82	11.12	0.00	2	-175.9
8	hr	SnowPatch	356.01	11.31	0.00	5	-172.8
9	hn	constant	356.34	11.64	0.00	1	-177.2

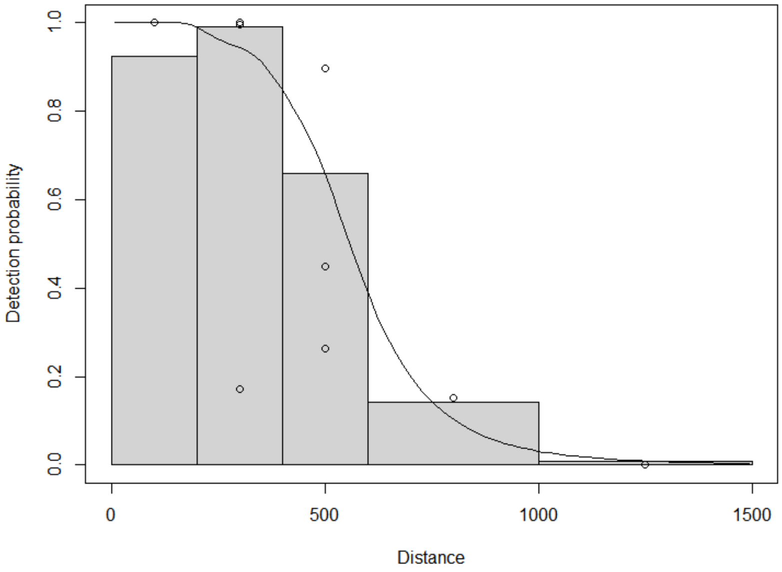

Figure 18. Fit of helicopter data set to distance sampling data.

4.2.2 Double Observer and Distance Analysis (2025)

Double Observer Summary

There were 45 combinations of observers during the 2025 survey (when accounting for primary/secondary ordering of observers). Summaries of the 2025 double observer data resulted in 12 pairs that switched with the remaining observer combinations not switching **(Table 8).** Of the 12 that switched, 2 pairings did not have sufficient sample sizes and were pooled into a single pair which resulted in 11 pairs. The remainder of the observers that did not switch were grouped into a single observer pair (12 in **Table 8**). The helicopter crew was considered as a single pairing (13 in **Table 8**), given that they were not able to switch and therefore did not have a pairing that could be modelled using double observer methods.

Plots of detection probabilities reveal weak pairings using either data recorder observation or observations without data recorder augmentation **(Figure 19).** More exactly, pairs 2 and 7 had lower detection probabilities (without data recorder observations added), and pairs 8 to 11 had lower detection when data recorder observations were added. To offset this issue, data recorder observations were used as the 2nd observer observations for pairs 8 to 11. A “weak observer pair” covariate was used to potentially account for weak probabilities for pairs 2 and 7.

Table 8. Summary of double observer pair data for 2025. P1x is the single observer sighting probability and p2x is the double observer probability. Data is summarized for double observer only data and double observer with data recorder observations as indicated by _nodr and _dr suffixes.

Pair	Switched?	Frequencies				Naïve detection probabilities			
		Front	Rear	Both	DataRec	P1x_nodr	P1x_dr	p2x	p2x_dr
1	yes	10	40	17	3	0.75	0.71	0.94	0.92
2	yes	1	10	12	1	0.48	0.46	***0.73***	***0.71***
3	yes	6	54	4	0	0.94	0.94	1.00	1.00
4	yes	1	33	2	1	0.94	0.92	1.00	0.99
6	yes	2	30	3	7	0.91	0.76	0.99	0.94
7	yes	6	13	27	0	0.41	0.41	***0.66***	***0.66***
8	yes	4	19	2	9	0.92	***0.68***	0.99	0.90
9	yes	3	16	4	8	0.83	***0.61***	0.97	0.85
10	yes	4	24	5	11	0.85	***0.64***	0.98	0.87
11	yes	3	30	3	19	0.92	***0.60***	0.99	0.84
12	no (pooled)	94	128	53	17	0.81	0.76	0.96	0.94
13	no (heli)	16	8	12	0	0.67	0.67	0.89	0.89

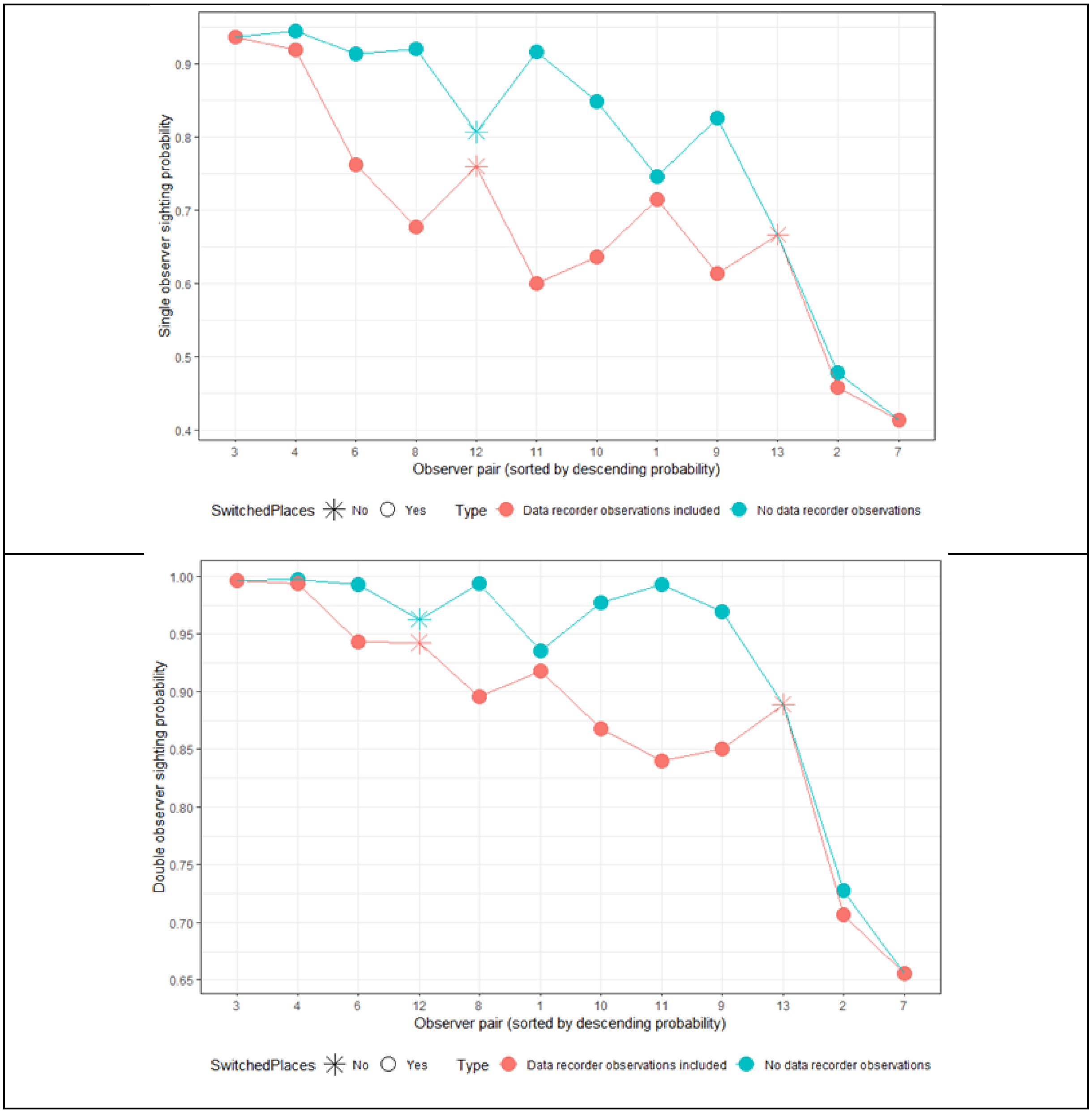

Figure 19. Graphical representation of double observer detection probabilities by observer pairs for 2025. The red dots indicate detection probabilities for applicable pairs where the 2 observers were primary, and the data recorder was considered the secondary observer.

Distance Sampling Summary

As for the 2024 analysis, the detection histogram of observations was highest in the closest bin, with a steady decline to the furthest bin, though sparse sample sizes precluded solid evaluation of a detection histogram for the Eurocopter B-2 helicopter (**Figure 20 and 21**). To confront this, we combined the 2024 and 2025 helicopter observation data for the analysis of the 2025 data set as detailed later in this report (Figure 29).

For the fixed-wing analysis, smaller group sizes appeared to have a more pronounced shoulder compared to larger group sizes for the fixed wing (**Figures 21 and 22**). Cloud cover had a potential effect of broadening the detection histogram for fixed wing aircraft at higher cloud cover levels (**Figure 23**). A broadening of the shoulder with higher snow cover was also suggested; however, the effect was minimal (**Figure 24**). The combined effect of snow and cloud is shown by the product of the two covariates. It can be seen that the detection histogram is flattened at higher levels of both cloud and snow cover (**Figure 25**).

In previous analyses of central Baffin strata, Prince Charles Island (sampled in 2014 and again in 2025) and characterized by its flat topography and almost continuous cover of snow, had higher sightability compared to other strata. Inspection of detection histograms for 2025 also suggests a broader shoulder with a higher proportion of observations in further survey bins (**Figure 26**).

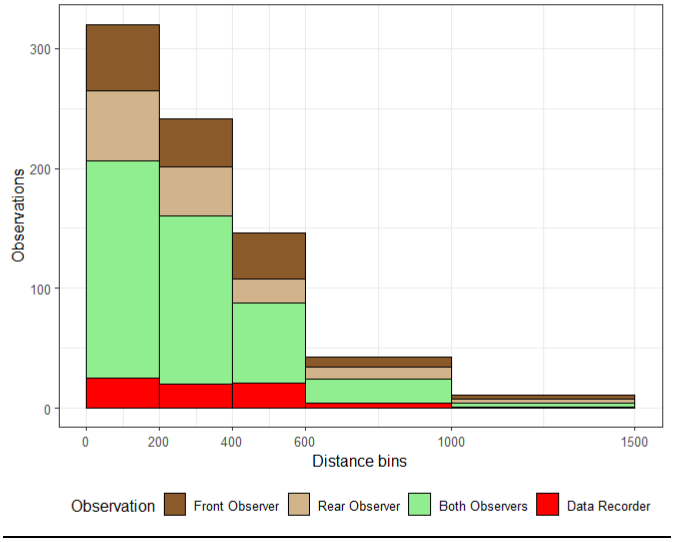

Figure 20. Histograms of detections as a function of distance from fixed wing for 2025. Observations are also color-coded by observation type. Observation frequencies are adjusted based on bin widths.

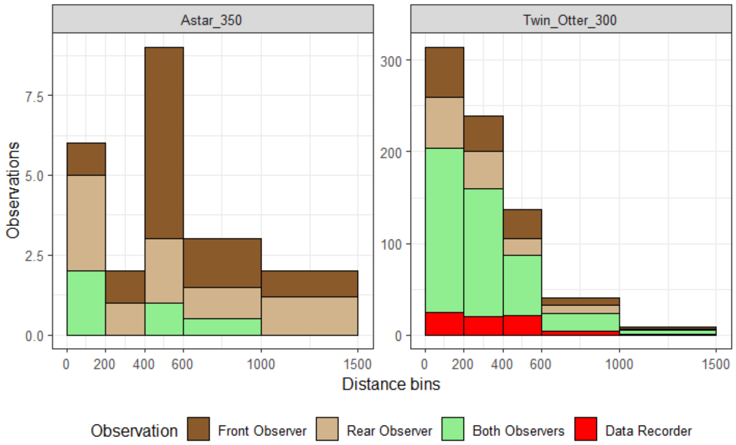

Figure 21. Histograms of detections as a function of distance from plane for 2025 aircraft type. Observations are also color-coded by observation type. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

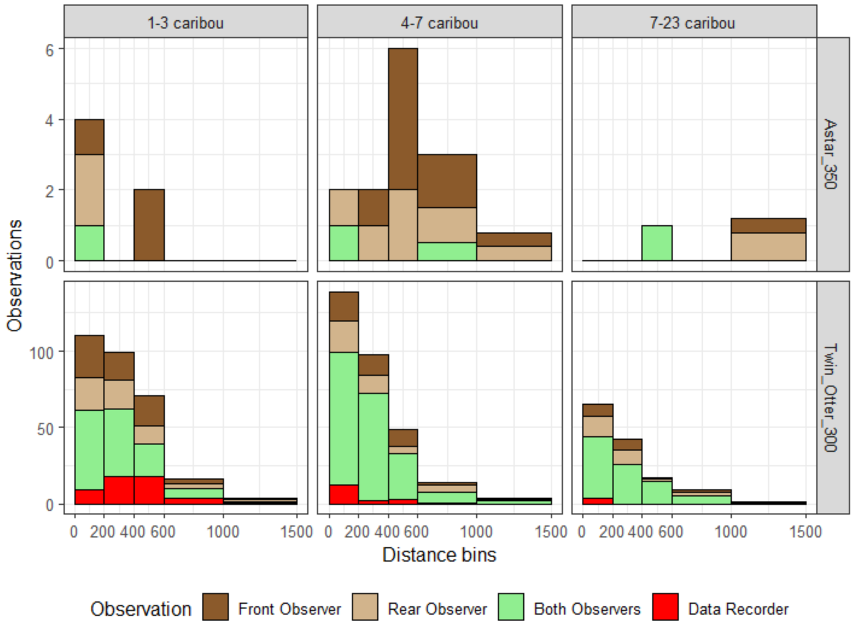

Figure 22. Histograms of detections as a function of group size and observation type for the 2025 survey. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

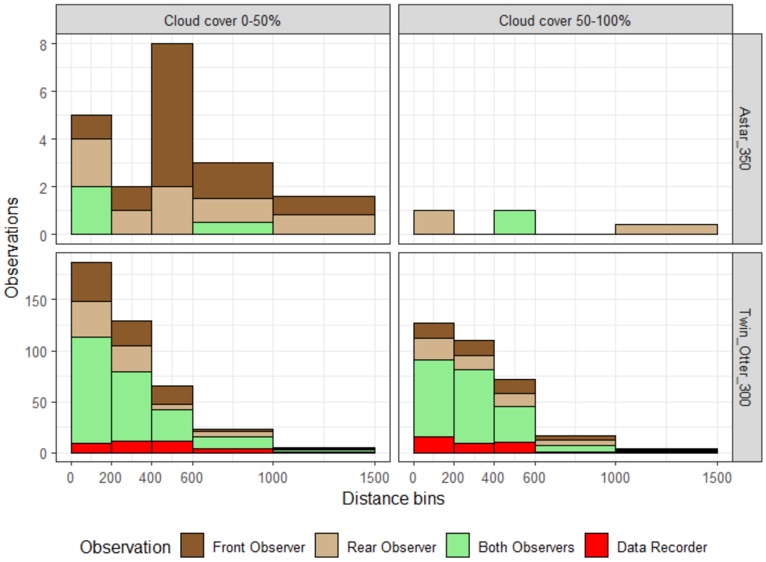

Figure 23. Detection histograms as a function of cloud cover for 2025. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

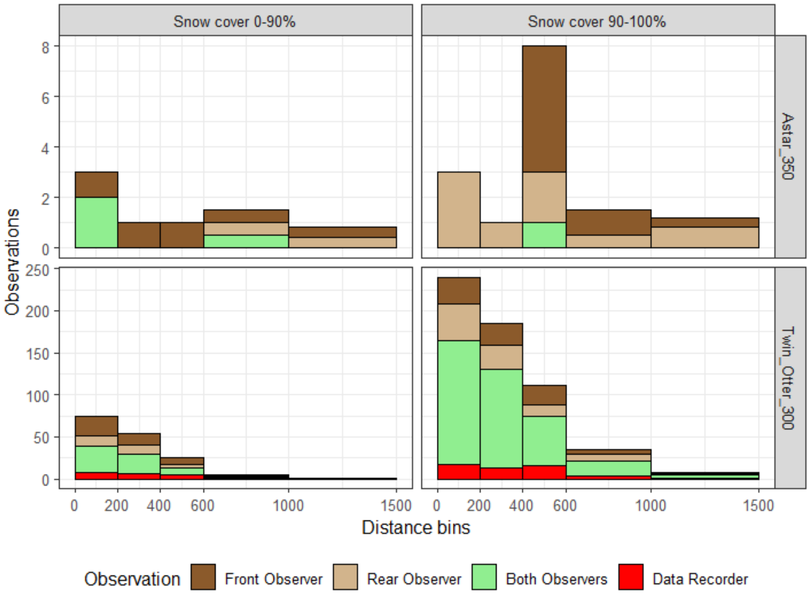

Figure 24. Detection histograms as a function of snow cover for 2025. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

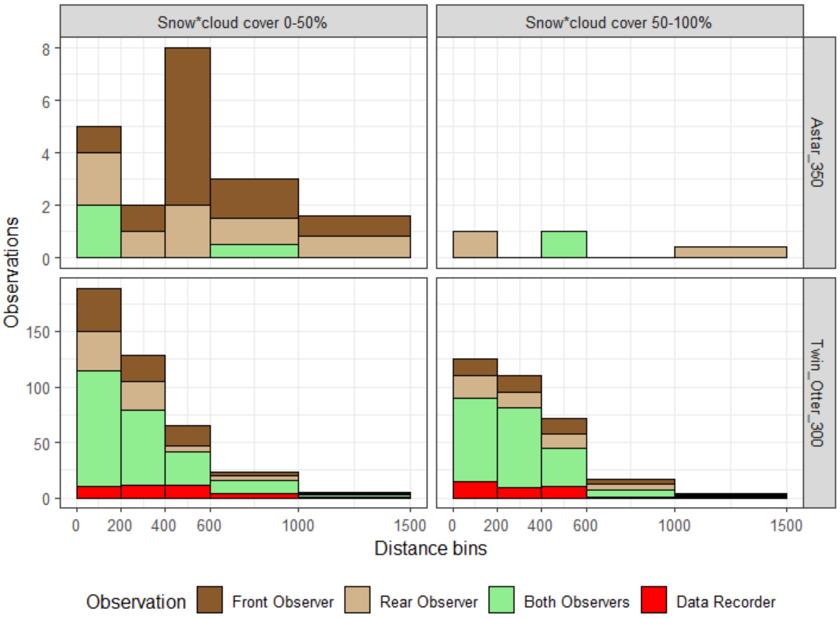

Figure 25. Detection histograms as a function of the product of cloud and snow cover for 2025. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

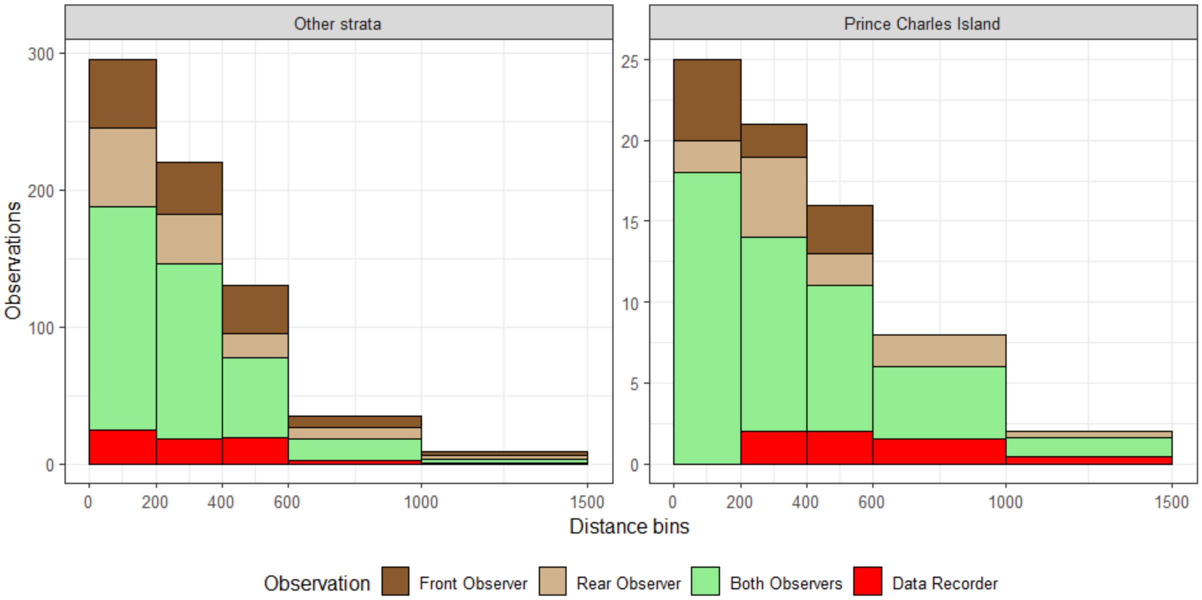

Figure 26. Detection histograms as a function of the product whether observations occurred on Prince Charles Island for 2025 survey. Observation frequencies are adjusted based on bin widths. Note the different y-axis scales.

Model Selection Fixed Wing

Model selection for the fixed wing aircraft initially focused on detection function choice, with a hazard rate model **(Table 9**: Models 6 and 15**)** being most supported in comparison to a half-normal detection function. The most supported model (Model 1) had group size, cloud cover, snow patchiness, and Prince Charles Island (PCI) as supported covariates. The most supported distance model was then used for mark-recapture model selection. Distance, the log of group size was more supported than a constant model **(Table 10).** A DRPair covariate, which was for lower detection probability observers, was not supported, suggesting that the amount of variation caused by these observers was minimal.

The fit of the MRDS model was good, as indicated by plots of the data relative to detection histograms **(Figure 27).** Chi-square tests for the distance portion had 0 degrees of freedom, precluding a p-value for the test; however, the overall chi-square was 3.6, suggesting a reasonable fit. Fit was also adequate to the mark-recapture portion of the MRDS model (chi-square=2.06, df=2, p=0.36) as suggested by plots of predictions compared to conditional double observer detection probabilities. Detection probabilities did decrease with distance; however, the amount was less than suggested by the distance plot **(Figure 28)** due to heterogeneity of double observer detection probabilities.

Table 9. Model selection for distance sampling covariates for the 2025 fixed wing data set. The distance sampling detection function (DF: hr-hazard rate, hn-Half normal) is shown along with the distance and double observer model. A constant intercept double observer model was used for all analysis. Sample size adjusted using Akaike Information Criterion (AICc), the difference in AICc between the most supported model for each model (∆AICc), AICc weight (wi), number of model parameters (K) and deviance is given. Constant models are shaded for reference.

No	DF	Distance model	AIC_c	ΔAIC_c	w_i	K	LL
1	hr	size + PCI + cloud + snowpatch	2632.84	0.00	0.66	7	-1309.34
2	hr	size + PCI + snow + cloud +snowpatch	2634.43	1.60	0.30	8	-1309.12
3	hr	size + snow + cloud + snowpatch	2641.34	8.50	0.01	7	-1313.59
4	hr	size + cloud + snow	2641.75	8.91	0.01	6	-1314.82
5	hr	size + snow	2642.15	9.31	0.01	5	-1316.03
6	hr	size + PCI	2643.09	10.26	0.00	5	-1316.51
7	hr	size + snow + snowpatch	2643.15	10.32	0.00	6	-1315.52
8	hr	size + snow + cloud + snowloud	2643.26	10.43	0.00	7	-1314.56
9	hr	PCI	2645.23	12.39	0.00	4	-1318.59
10	hr	snow + cloud + snowpatch	2645.95	13.12	0.00	6	-1316.92
11	hr	snow + cloud	2646.24	13.41	0.00	5	-1318.08
12	hr	snow	2646.93	14.09	0.00	4	-1319.44
13	hr	Strata	2647.37	14.53	0.00	7	-1316.61
14	hr	snow + cloud + snowcloud	2647.45	14.61	0.00	6	-1317.67
15	hr	snowpatch	2647.82	14.98	0.00	4	-1319.88
16	hr	size	2650.43	17.59	0.00	4	-1321.19
17	hr	snow_factor	2652.38	19.55	0.00	4	-1322.17
18	hr	logsize	2653.48	20.64	0.00	4	-1322.71
19	hr	weakobs	2654.40	21.56	0.00	4	-1323.17
20	hr	constant	2654.81	21.98	0.00	3	-1324.39
21	hr	snowcloud	2655.02	22.19	0.00	4	-1323.49
22	hr	cloud	2655.34	22.50	0.00	4	-1323.64
23	hr	cloud_factor	2658.02	25.18	0.00	6	-1322.95
24	hn	size	2663.31	30.48	0.00	3	-1328.64
25	hn	logsize	2663.49	30.65	0.00	3	-1328.73
26	hn	constant	2664.11	31.28	0.00	2	-1330.05

Table 10. Model selection for double observer and combined distance sampling/double observer covariates for the 2025 fixed wing data set. For this analysis the most supported DS model (Table: size + cloud + Snowpatch+PCI) was used. Sample size adjusted Akaike Information Criterion (AICc), the difference in AICc between the most supported model for each model (ΔAICc), AICc weight (w_i), number of model parameters (K) and deviance is given. Constant mark-recapture models are shaded for reference.

No	MRmodel	AIC_c	ΔAIC_c	w_i	K	LL
1	logsize + distance	2627.82	0.00	0.32	9	-1304.8
2	PCI + logsize + distance	2628.27	0.45	0.26	10	-1304.0
3	logsize	2629.84	2.02	0.12	8	-1306.8
4	size	2630.14	2.31	0.10	8	-1307.0
5	distance	2630.33	2.50	0.09	8	-1307.1
6	constant	2632.84	5.01	0.03	7	-1309.3
7	Snow_Patchyness	2633.45	5.63	0.02	8	-1308.6
8	DRPair	2633.59	5.76	0.02	8	-1308.7
9	snowc	2634.48	6.66	0.01	8	-1309.1
10	PCI	2634.66	6.84	0.01	8	-1309.2
11	snowcloud	2634.67	6.84	0.01	8	-1309.2
12	cloudc	2634.71	6.88	0.01	8	-1309.3
13	SnowPatchF	2635.32	7.50	0.01	9	-1308.5
14	logsize + distance	2627.82	0.00	0.32	9	-1304.8

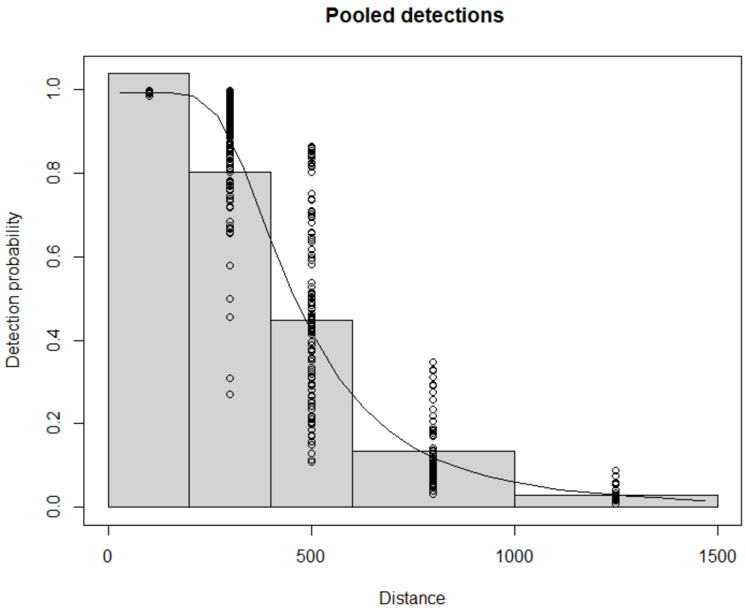

Figure 27. Fitted detection function for the most supported MRDS model for the 2025 fixed wing data set.

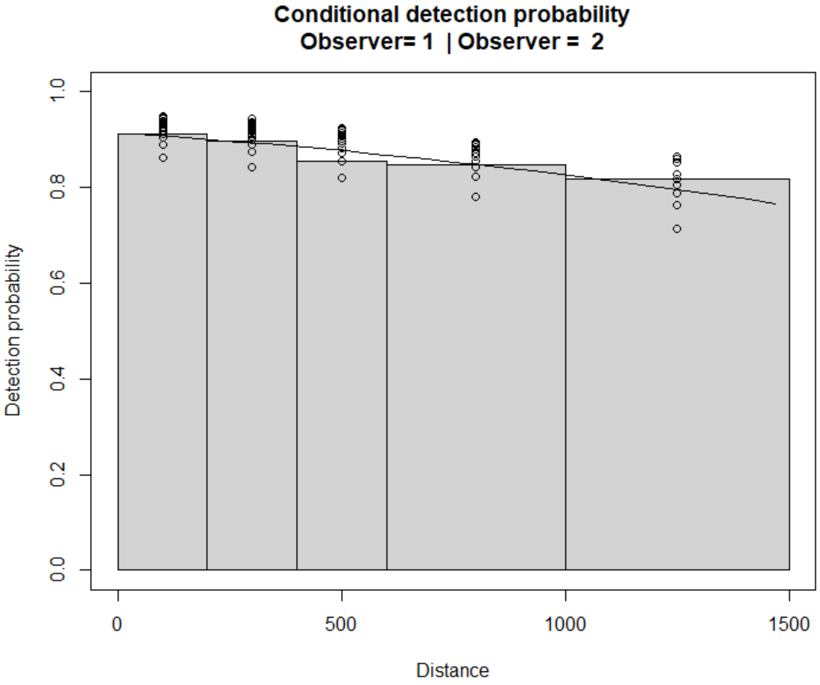

Figure 28. Fitted detection function for the most supported MRDS model for the 2025 fixed wing data set.

Helicopter Model Selection

The 2024 and 2025 helicopter data were combined for the 2025 analysis to offset low sample sizes in the 2025 data set. An additional year covariate was also added to the analysis to test potential differences in detection functions. A comparison of detection histograms **(Figure 29)** suggests proportionally more observations in the furthest survey bin in 2025; however, this may be due to low sample sizes in 2025. Model selection results suggested that the detection function scale varied by group size, year and cloud cover for helicopter observations, with the hazard rate detection function being most supported **(Table 11).** A plot of the overall detection function suggested a reasonable fit of the detection function to the data, with an overall chi-square value of 2.3 (0 degrees of freedom prevented a p-value from being developed) **(Figure 30).** The year-based covariate suggested that detection was higher for the helicopter used in 2025 compared to the same make and model of helicopter (Eurocopter B-2) used in 2024 **(Figure 31).** The effect of this covariate was a reduction in estimates for 2025 strata by approximately 20% (Model 3 vs Model 1: approximately 200 caribou). So, the net effect of using the year covariate is to make the 2025 estimate more conservative due to data deficiencies. Because of this, helicopter estimates were relatively imprecise (CV=20%) when compared with fixed wing estimates.

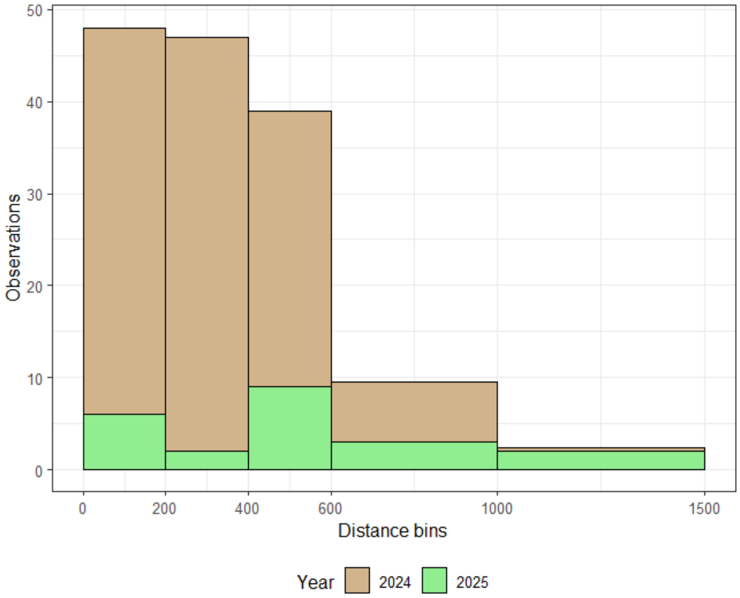

Figure 29. Detection histograms for 2024 and 2025 helicopter data sets.

Table 11. Model selection for distance sampling covariates for the 2024 and 2025 helicopter data sets. The distance sampling detection function (DF: hr-hazard rate, hn-Half normal) is shown along with distance and double observer model. Sample size adjusted Akaike Information Criterion (AICc), the difference in AICc between the most supported model for each model (ΔAICc), AICc weight (wi), number of model parameters (K) and deviance is given. Constant models are shaded for reference.

No	DF	Model	AIC_c	ΔAIC_c	w_i	K	LL
1	hr	size + Year + cloud	434.98	0.00	0.59	5	-212.3
2	hr	size + Year + cloud + snowloud	436.69	1.71	0.25	6	-212.1
3	hr	size + cloud	439.23	4.25	0.07	4	-215.5
4	hr	size + Year	439.67	4.69	0.06	4	-215.7
5	hr	size + cloudc + snow	441.34	6.37	0.02	5	-215.5
6	hr	size	445.04	10.07	0.00	3	-219.4
7	hn	size	446.11	11.13	0.00	2	-221.0
8	hr	Year	448.19	13.22	0.00	3	-221.0
9	hn	Year	449.54	14.57	0.00	2	-222.7
10	hr	logsize	450.71	15.73	0.00	3	-222.3
11	hn	logsize	452.01	17.04	0.00	2	-224.0
12	hr	cloudc	458.16	23.18	0.00	3	-226.0
13	hr	snowloud	460.89	25.91	0.00	3	-227.4
14	hr	Constant	464.13	29.16	0.00	2	-230.0
15	hr	snow	466.10	31.13	0.00	3	-230.0
16	hn	Constant	466.50	31.52	0.00	1	-232.2
17	hr	SnowpatchF	469.71	34.73	0.00	5	-229.7

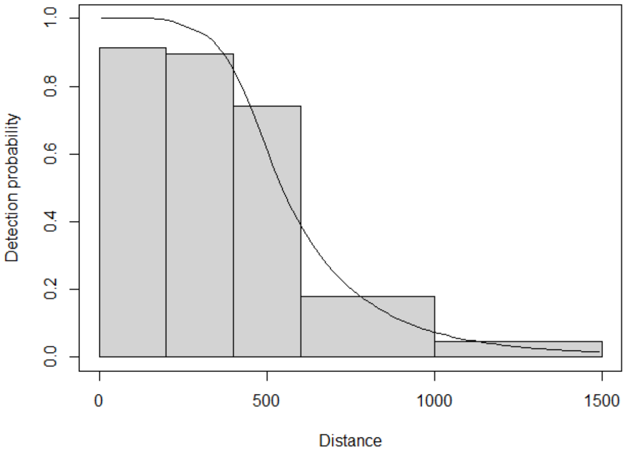

Figure 30. Fit of helicopter data set to distance sampling data for 2025.

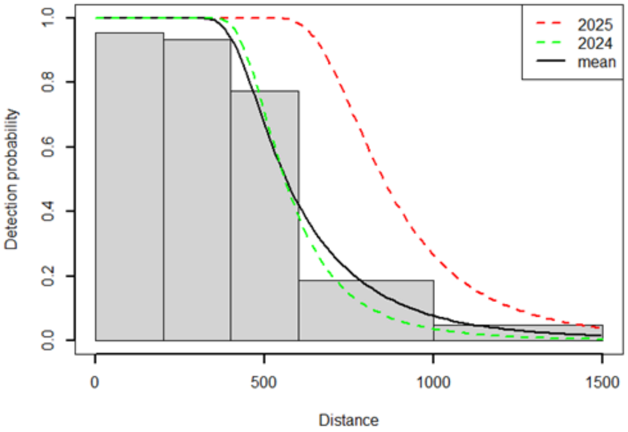

Figure 31. Comparison of detection functions for 2024 and 2025. The mean detection function and detection functions for 2024 and 2025 are shown.

4.3 Sensitivity Analysis of 2024 & 2025 Models & Data

4.3.1 Sensitivity Analysis (2024)

A sensitivity analysis was conducted for the 2024 fixed wing data set to assess sensitivity of estimates to model fit, inclusion of data recorder data, and distance sampling **(Table 6 and Figure 16).** The overall estimates from the most supported model were compared with various models and data formulations **(Table 12 and Figure 32).**

In the first analysis, we used a distance sampling only model that used estimates of the most supported distance models with no double observer model (assumed sightability=1 in the closest bin was considered). Estimates from this model were 584 caribou lower (2.4%) lower than the full MRDS model suggesting that sightability within the transect strip only reduced the estimate marginally compared to assuming it was 1. We note that this formulation also should be less sensitive to inclusion of data recorder data given that detection probabilities are not modelled; instead, it is assumed that relatively equal observer effort occurs during the survey so that the resulting detection functions apply across all observer pairs.

In the second analysis, we used a strip transect estimator that assumes sightability within the 0-400m strip. Estimates were 12% lower using this approach which was not surprising given that detection decayed after 200m based on calculated detection functions. Incorporation of double observer modelling did increase the estimate slightly (7% lower); however, it was still lower than the distance sampling only estimates.

In the third analysis, we used an estimate using the full MRDS model with all data recorder observations; with estimates being approximately 2,000 caribou (8.8%) lower than the MRDS model and 6.5% lower than the distance sampling model. This result suggests that inclusion of data recorder data for the extremely weak pairs likely offsets potential negative bias caused by larger numbers of caribou being missed by weak observer pairs.

In the fourth analysis, we used all data including data recorders, all of which was used with the most supported distance sampling model. This forth analysis was run with estimates being only 288 caribou lower (1%) than the MRDS model suggesting that just using data recorder data may be as efficient as double observer modelling.

Table 12. Sensitivity analysis of estimates of 2024 Baffin Island total estimates. The total number of caribou used in the estimate (n) is given along with each estimate (N). MRDS indicates a distance sampling/double observer model, DS indicates a distance sampling model, and DR indicates data recorder observations.

Model	n	N	SE	Conf. Limit		CV
Strip transect/Double observer	2609	22,438	1268.4	17,097	29,063	**0.057**
Strip transect	2644	21,289	1458.1	18,409	24,169	**0.068**
MRDS Fixed/DS heli-no DR observations	3614	22,056	1341.2	19,555	24,877	**0.061**
MRDS Fixed/DS helicopter	3843	24,162	1372.0	21,595	27,034	**0.057**
DS Fixed and Helicopter	3843	23,577	1362.4	21,031	26,432	**0.058**
DS Fixed and Helicopter-all DR observations	3908	23,874	1406.6	21,254	26,816	**0.059**

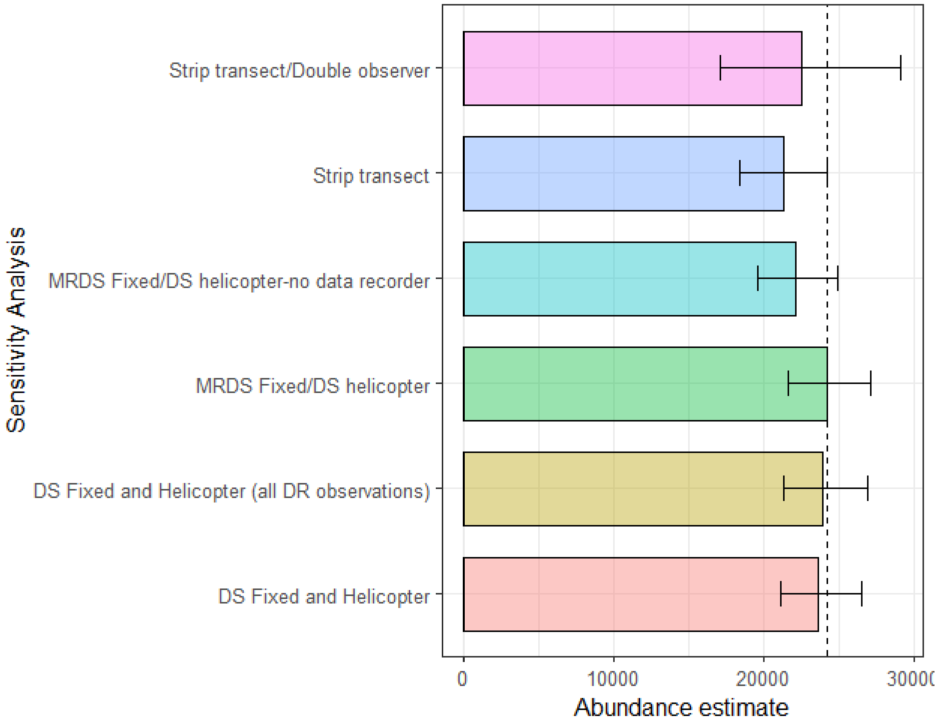

Figure 32. Graphical representation of 2024 sensitivity analysis. Dashed line indicates estimate used for analyses.

4.3.2 Sensitivity Analysis (2025)

A similar set of sensitivity analyses were conducted for the 2025 fixed wing Northern Baffin Island data set to assess the effect of inclusion of data recorder observations as well as use of distance sampling methods. Estimates were compared to the full MRDS estimate **(Table 10).** The helicopter portion of the data set, which was challenged by low sample sizes, was not used in sensitivity analyses.

As with the 2024 strip-transect/double observer results, 2025 estimates with or without data recorder observations were 10-16% lower than full data set estimates **(Table 13 and Figure 33)** demonstrating the utility of distance sampling to reduce estimate bias.

A second analysis considered the selective addition of data recorder observations used in the 2025 analysis (MRDS (selective DR obs in **Table 13**)) with no data recorder observations included (MRDS (no DR obs)). In this case estimates were 4% lower when data recorder observations were not included, suggesting that augmentation of weak observers with data recorder observations provides an effective way to offset issues with weak observers.

A final analysis compared estimates using just distance sampling with all data recorder observations (DS (all DR obs)) with the MRDS estimates with selective observations. In this case the distance sampling only estimates were slightly higher than the MRDS estimates, however, the difference was only 1.5%. As discussed later, this result suggests that just using distance sampling with combined data recorder and observer observations can be as effective as MRDS methods when survey conditions are favorable.

Table 13. Sensitivity analysis of estimates of 2025 Baffin Island total estimates. The total number of caribou used in the estimate (n) is given along with each estimate (N). MRDS indicates a distance sampling/double observer model, DS indicates a distance sampling model, and DR indicates data recorder observations.

Model	n	N	SE	Conf. Limit		CV
Strip transect (all DR obs)	2588	20,328	1589.9	17,177	23,480	0.078
Strip transect/Double observer	2532	21,774	1493.0	18,982	24,977	0.069
MRDS (selective DR obs)	3489	24,080	1812.2	20,739	27,958	0.075
MRDS (no DR obs)	3278	23,044	1841.3	19,668	27,001	0.080
DS (all DR obs)	3555	24,450	1942.0	20,898	28,606	0.079

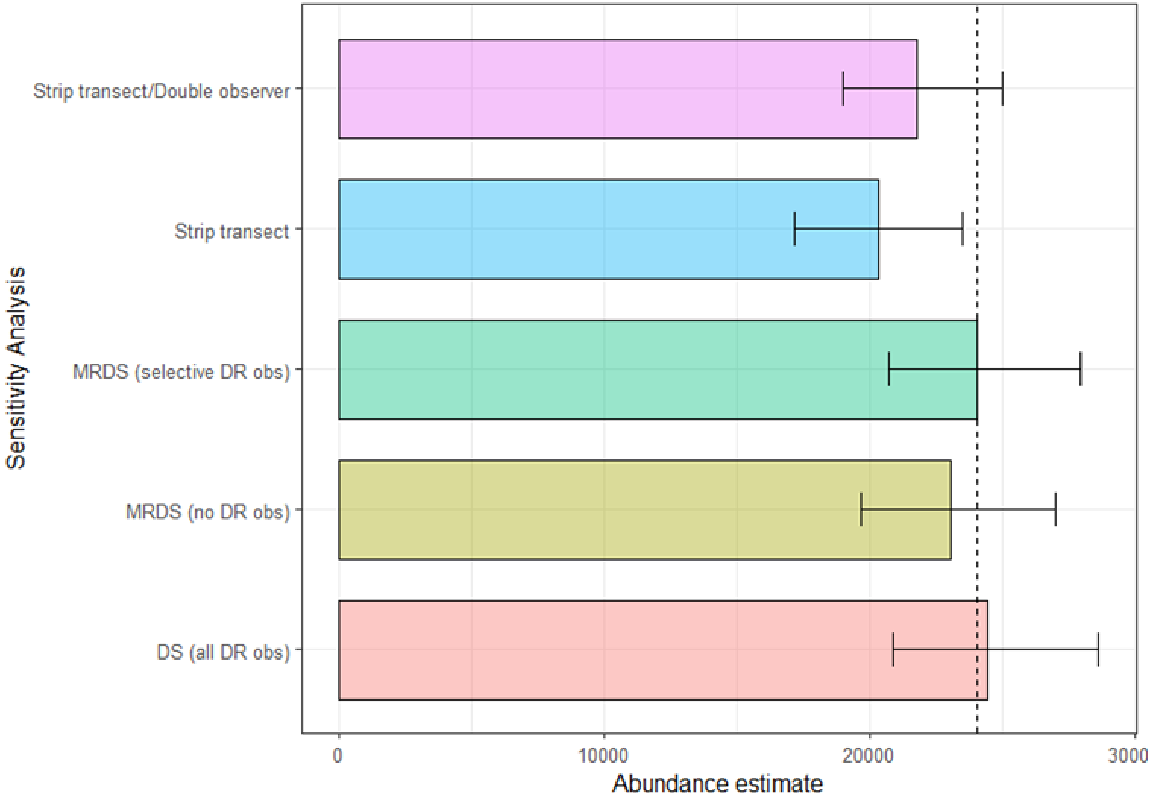

Figure 33. Graphical representation of 2025 sensitivity analysis. Dashed line indicates estimate used for analyses.

4.4 Estimates

Estimates derived from both March 2024, and 2025 surveys were analyzed separately before merging the two datasets together for a whole Baffin Island estimate. The results of these individual assessments are as follows below. However, to accurately assess the whole Island estimate, survey strata from both years would have to be merged in a way that would keep relative density assessments as mutually exclusive as possible. This process will be discussed later in this section.

4.4.1 March 2024 South Baffin Survey

March 2024 abundance estimates were derived from the most supported MRDS model for both the fixed-wing strata and the helicopter (Heli) strata (**Table 14**). Highest abundance and densities occurred on the MP-HD-FW (Meta-Incognita Peninsula High Density) where 11,694 adult, yearling, and calf caribou were estimated, followed by Hall Peninsula High Density strata (HP-HD-FW and HP-HD-H) where combined fixed wing and rotary wing methods estimated a total of 8,110 (Fixed 95% CI = 4,977-6,910; CV = 8.2%; Helicopter 95% CI = 1,572-3,207; CV = 18.0%) adults, yearlings, and calves, and finally FP-MD-FW (Fox Peninsula Medium Density), where 3,589 (95% CI = 2,558-5,035; CV = 16.1%) adults, yearlings, and calves were estimated. Overall estimates were relatively precise with the least precise estimates (highest CV's) occurring within the FP-LD-FW density stratum (with 11 on-transect caribou observations), the NLNE-LD-FW (Nettling Lake North East low density) stratum (with 66 on-transect caribou observations), and the NLN-LD-FW (Nettling Lake North low density) stratum (with 24 on-transect caribou observations) (**Table 14**). Combined these low-density strata had little influence on the overall abundance of south Baffin caribou, contributing a mean of 769 caribou to the south Baffin estimate. Higher density survey strata however were relatively precise yielding an estimate across all south Baffin survey strata of 24,162 (95% CI = 21,595-27,034; CV = 5.7%) adult, yearling, and calf caribou.

4.4.2 March 2025 Central and North Baffin Survey

Similar to March 2024, the March 2025 abundance estimates were derived from the most supported MRDS model for both the fixed-wing and the helicopter strata (**Table 14**). The NCB-HD-FW (North Central Baffin High Density Fixed-Wing) stratum recorded densities of 27.36 caribou per 100km^2 which were similar to densities to MP-HD-FW (Meta-Incognita Peninsula High Density Fixed-Wing) flown in 2024. These two strata contained the majority of caribou estimated across Baffin Island. In total 3,223 caribou were observed on transect within the NCB-HD-FW stratum which translated to an estimated total stratum abundance of 22,677 caribou (95%CI= 18,922-27,178; CV=9.2%). The estimate was precise with a CV of 8.5%. The next highest recorded densities of caribou occurred within the PCI-HD-FW (Prince Charles Island High Density Fixed-Wing) stratum where a relative density of 7.36 caribou/km^2 translated to an estimated 1,163 caribou adults, yearlings, and calves (95% CI=707-1,914; CV=24.2%), followed by the NL-LD-FW (Neergaard Lake Low Density Fixed-Wing) showing a relative density of 4.30 caribou/km2 and an estimated 164 adults, yearlings, and calves (95%CI=26 to 1,024;CV=98.5%). Both these strata produced imprecise estimates due to the relatively low sample population and as is evident by their high CVs. The remaining strata recorded 1.84 caribou/km2 within the NCB-MD-H (North Central Baffin Medium Density Helicopter), 1.61 caribou/km2 within the GF-MD-FW (Gifford Fiord Medium Density Fixed-Wing) and 0.85 caribou/km2 within the ISL-LD-FW (Western Islands Low Density Fixed-Wing)). In total these final strata accounted for 81 caribou seen on transect, yielding an estimate of 483 adults, calves, and yearlings between the three strata. Again, these estimates lacked precision, however, this lack of precision had little effect on the overall precision of the 2025 survey due to the relatively low numbers of caribou observed and estimated within these low and medium density transects when compared with the high density and high precision of the NCB-HD-FW strata and transects.

Table 14. Estimates for each stratum from the most supported MRDS model. The number of caribou counted on transect (n) is given for each stratum along with abundance estimates. Density is the abundance estimate divided by strata area X 100.

Strata	n	N	SE	Conf. Limit		CV	Density
2024							
FP-LD-FW	11	94	70.8	19	457	0.757	0.8
FP-MD-FW	650	3,589	578.8	2,558	5,035	0.161	16.6
MP-HD-FW	1,751	11,694	1041.7	9,787	13,972	0.089	28.0
NLNE-LD-FW	66	479	231.1	174	1,322	0.482	2.6
NLN-LD-FW	24	196	101.9	65	592	0.520	1.6
HP-HD-FW	909	5,864	479.8	4,977	6,910	0.082	11.7
HP-HD-H	432	2,246	403.9	1,572	3,207	0.180	11.4
Total	**3,843**	**24,162**	**1372.0**	**21,595**	**27,034**	**0.057**	
2025							
NCB-HD-FW	3,223	22,677	2081.0	18,922	27,178	0.092	27.4
GF-MD-FW	7	51	51.0	9	284	1.001	1.6
ISL-LD-FW	3	24	24.1	4	144	1.009	0.9
NL-LD-FW	18	164	162.0	26	1,024	0.985	4.3
PCI-HD-FW	238	1,163	281.5	707	1,914	0.242	7.4
NCB-HD-H	71	408	183.8	173	963	0.451	1.8
PI-LD-H	96	539	58.2	436	667	0.108	5.7
Total	**3,656**	**25,026**	**2115.8**	**21,182**	**29,568**	**0.085**	

4.4.3 Merging March 2024 and 2025 Overlapping Strata

We combined the March 2024, and 2025 caribou abundance estimates for a whole Baffin Island estimate. This analytical step was required for the development of a trend analysis utilizing the March/April 2012 South Baffin Island survey estimate, March 2014 Full Baffin Island survey estimate (Campbell et al. 2015), and the March 2024 and 2025 merged Baffin Island survey estimates (**Figure 34**). Further, and to analytically combine the 2024 Nettling Lake strata including the Nettling Lake East Low Density (NLNE-LD-FW) and the Nettling Lake Low Density (NLN-LD-FW), we analyzed their degree of overlap with the 2025 Central Baffin stratum (CB) (**Table 15**). To combine these overlapping strata estimates from the transects flown, a few modifications to the 2024 survey strata were required. We used all available past and recent telemetry and survey data to examine caribou movements and mixing within the localized area encompassing these three partially overlapping strata across the two survey years. We also used current 2024 and 2025 telemetry movement data to assess movement rates and spatial affiliations between the two survey years though this data was limited to only four (4) collars in March 2024 and four (4) collared caribou cows in March 2025.

An initial assessment of overlapping survey stratum showed the majority of the 2024 Nettling Lake North Low-density stratum (NLN-LD-FW) overlapping with the 2025 NCB-HD-FW stratum; however, no caribou were detected in the areas of the 2024 NLN-LD-FW stratum that did not overlap with the 2025 NCB-HD-FW stratum (**Figure 35**). Therefore, the NLN-LD-FW stratum was excluded from trend comparison (the estimate of caribou in the area that did not overlap 2025 was 0). We also examined the 2025 NCB-HD-FW stratum which also extended into the 2024 NLNE-LD-FW stratum. As with the NLN-LD-FW stratum, few caribou occurred in areas that did not overlap apart from a few groups to the southwest NLE-LD-FW stratum. To estimate these groups, the area of overlap between the 2025 NCB-HD-FW and 2024 NLNE-LD-FW strata was clipped to create a new 2024 NLE-LD-FW stratum that excluded the 2025 NCB-HD-FW stratum. Observations from 2024, that were in the 2025 NCB-HD-FW stratum, were then excluded to derive new estimates for the 2024 NLE-LD-FW stratum. This sampling configuration assumes that most caribou detected in 2025 were from the Central Baffin subpopulation and that an insignificant number of caribou moved from the South Baffin survey extents into the Central Baffin stratum survey extents (and vice-versa) in March 2024 and 2025. Past collar analysis (Campbell et al 2015) suggests that this subpopulation mainly occurs to the north of Nettling Lake with the South Baffin subpopulation or grouping predominantly occurring to the south of Nettling Lake during the time of year the survey was flown (**Figure 36**). Current collar data from 2024 and 2025, over the same days the surveys were conducted supports this hypothesis, showing minimal movement between central and south Baffin survey extents in March when the surveys occurred, and other months of the year as well (**Figure 37**). No collared caribou switched subpopulations during this period. Though this spatial assessment supports these stratification modifications, we must note that this comparison is limited by sample size and distribution of the collared caribou. Despite the small sample size, this assessment does suggest remarkable fidelity of caribou to regional areas within Baffin Island. Following the assessment of all available spatial caribou data and the final adjustment of overlapping strata and recorded caribou observations, the resulting 2024 and 2025 estimates were merged to derive a full island estimate of 48,681(CI=43,973-53,893) (**Table 15** and **Figure 38**).

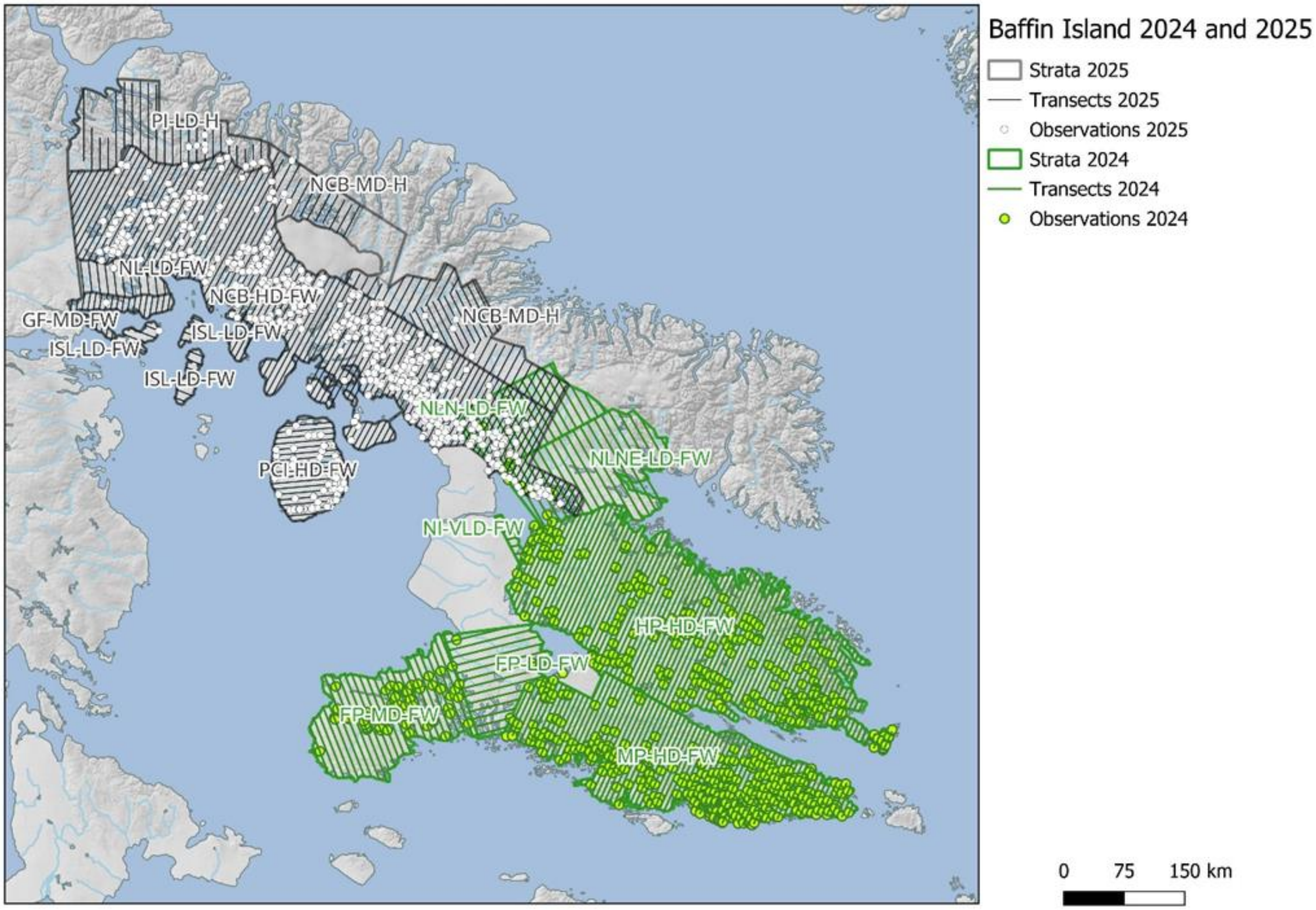

Figure 34. Areas sampled in 2024 (green) and 2025 (black with white observations).

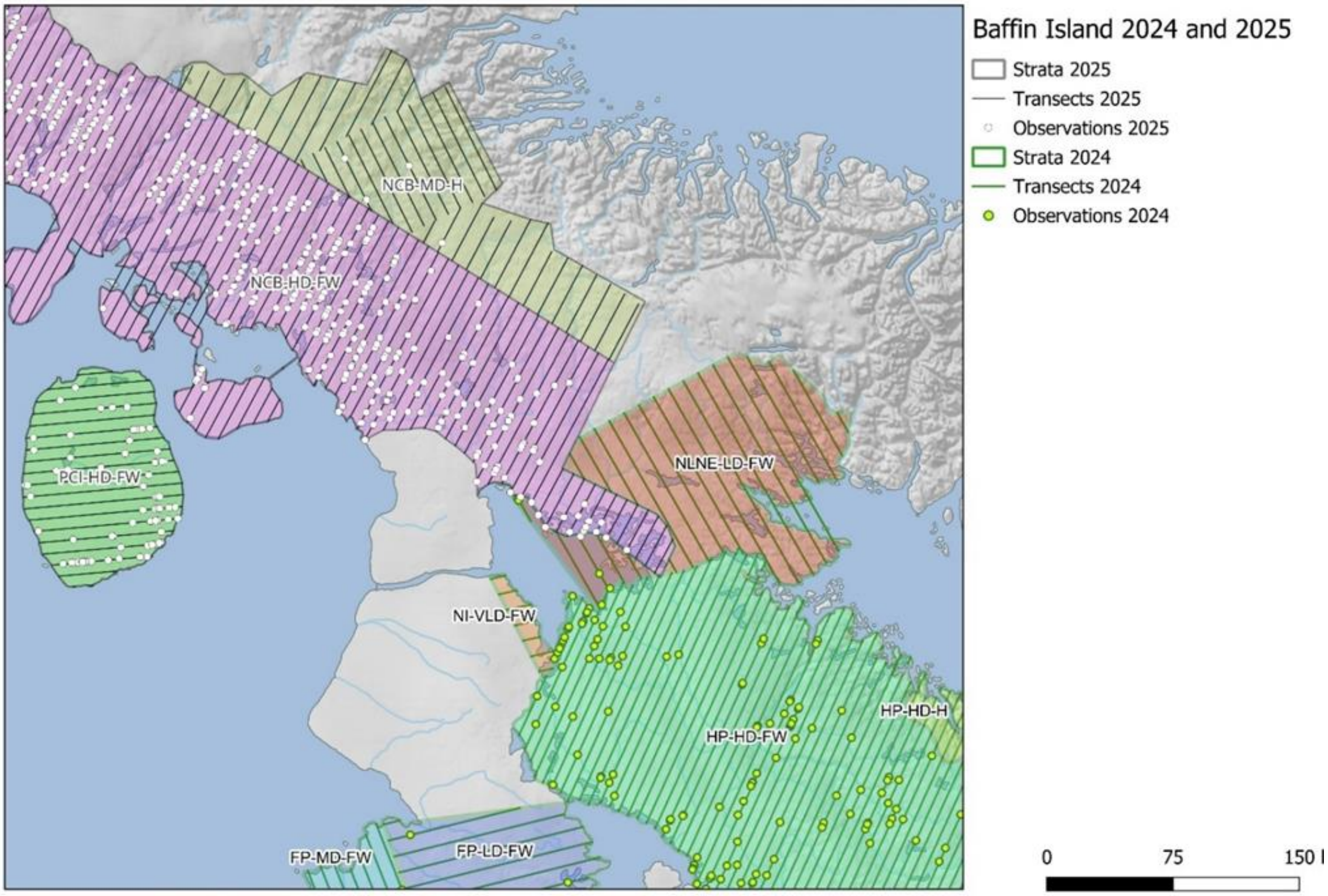

Figure 35. Close up of area of overlap of 2024 and 2025 sampling strata.

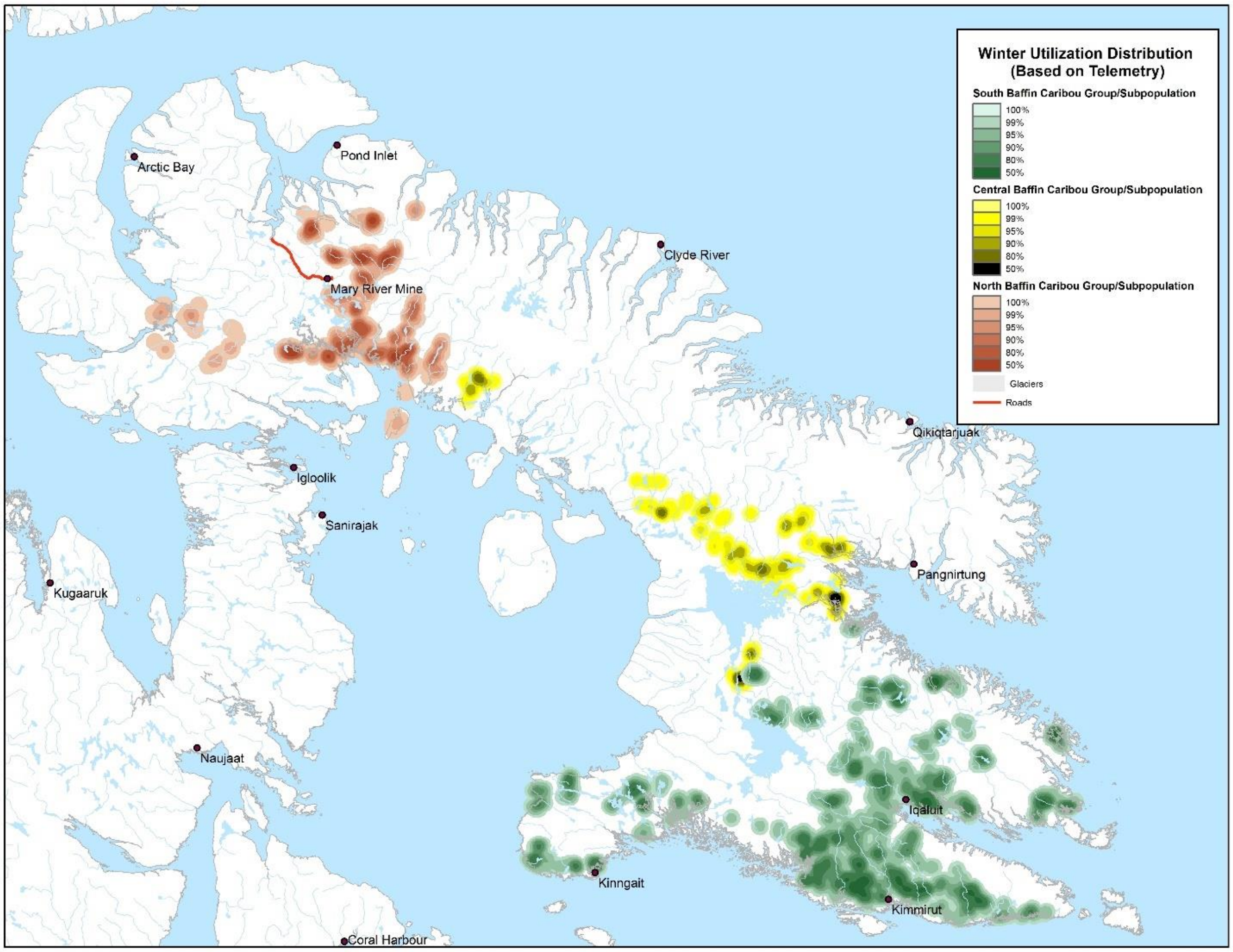

Figure 36. Winter range use based on utilization distributions utilizing a Kernel analysis with an 11 km search radius using historic (1987-1994) collar data. Darker colors indicate higher use. Figure from Campbell et al (2015).

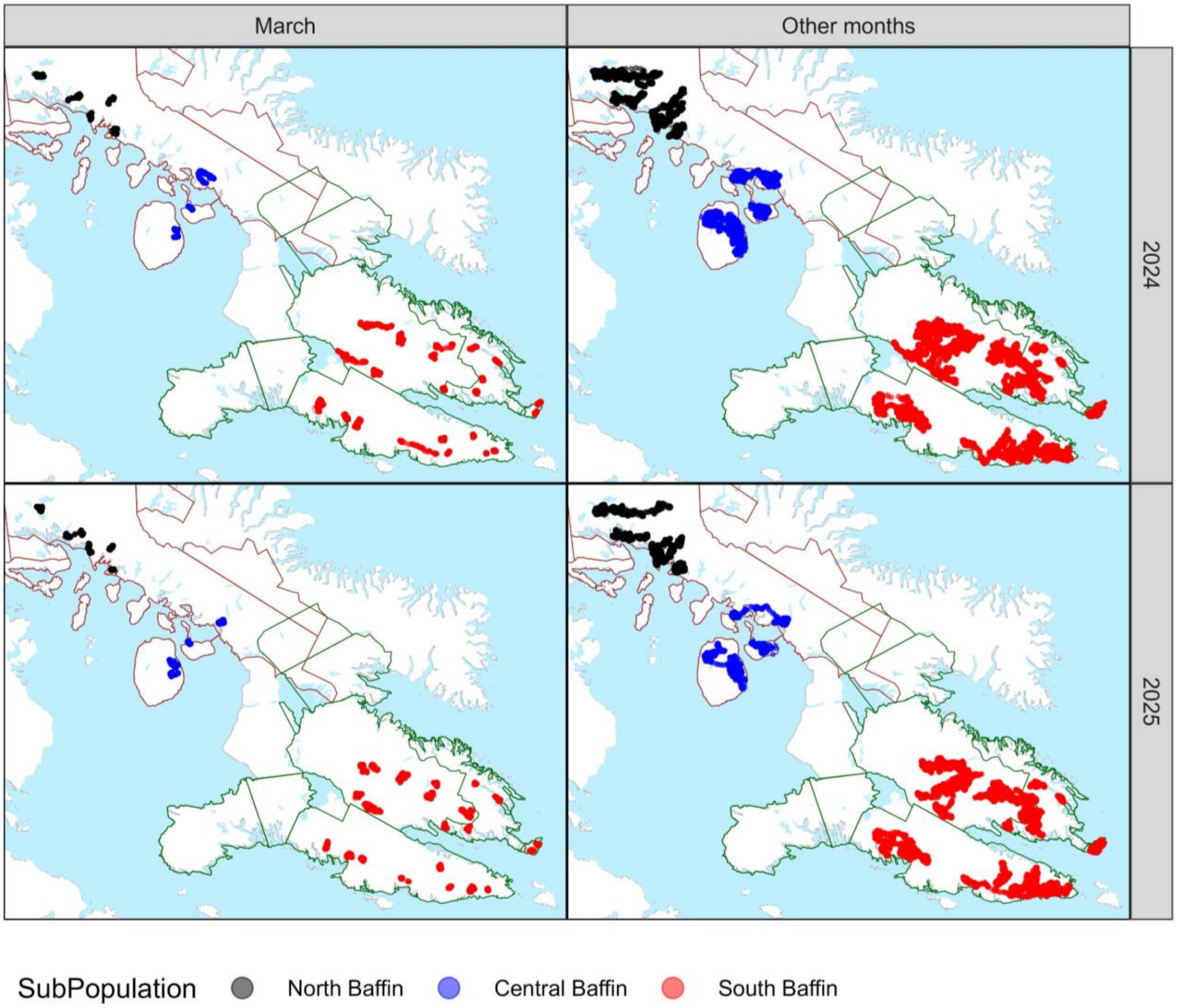

Figure 37. Locations of collared caribou (n=34 and 33 for 2024 and 2025) relative to survey strata (2024: green, 2025: brown) in March when surveys were conducted relative to other months of the year.

Table 15. Estimates from 2024 excluding area of overlap with 2025 strata (NLN-LD-FW strata eliminated and NLNE-LD-FW reduced) and the resulting combined estimates of 2024 and 2025 (FW=Fixed wing aircraft; H=Helicopter). The 2025 strata estimates are listed in Table 5.

Strata		**n**	**N**	**SE**	**Conf. Limit**		**CV**	**Density Caribou/km2**
2024								
Foxe Penn. Fixed wing Low Density	**FP-LD-FW**	11	94	70.8	19	457	0.757	0.8
Foxe Penn. Med Density Fixed Wing	**FP-MD-FW**	650	3,589	578.8	2,558	5,035	0.161	16.6
Meta-Incognita Penn. High Density Fixed Wing	**MP-HD-FW**	1751	11,694	1041.7	9,787	13,972	0.089	28
Nettling Lake East Low Density Fixed Wing	**NLNE-LD-FW** (reduced)	**23**	**168**	**181.3**	**24**	**1,189**	**1.081**	**1.09**
Hall Penn High Density Fixed Wing	**HP-HD-FW**	909	5,864	479.8	4,977	6,910	0.082	11.7
Hall Penn Heli High Density Helicopter	**HP-HD-H** (DS only)	432	2,246	403.9	1,572	3,207	0.180	11.4
2024 Total		**3,776**	**23,655**	**1360.7**	**21,111**	**26,506**	**0.058**	

2025 Total	3,656	25,026	2115.8	21,182	29,568	0.085
TOTAL 2024 and 2025	**7,432**	**48,681**	**2515.5**	**43,973**	**53,893**	**0.052**

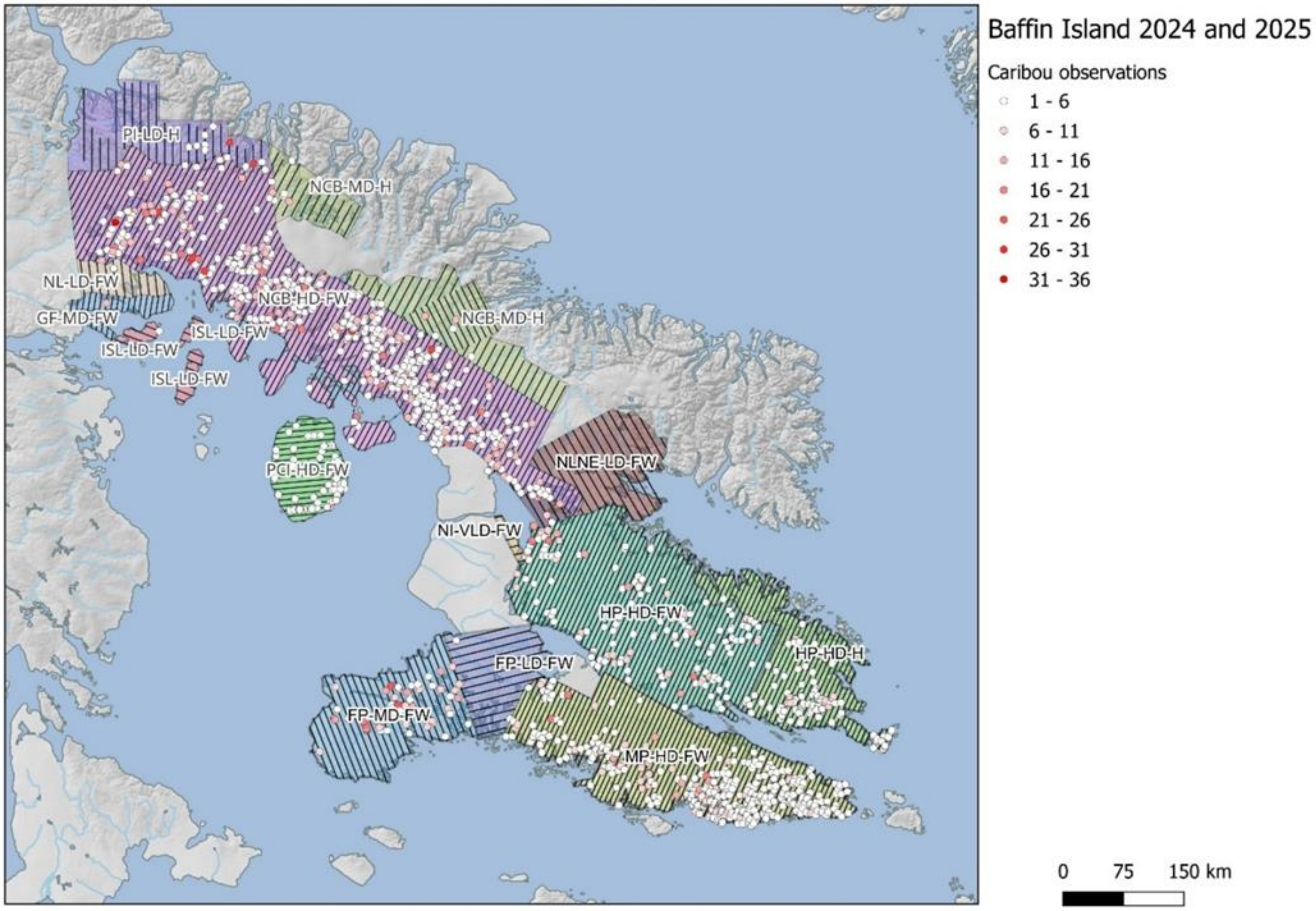

Figure 38. The combined 2024 and 2025 data sets with the 2024 NLNE-LD-FW stratum modified to avoid overlap with the 2025 NCB-HD-FW stratum.

4.5 Trend Analysis

4.5.1 Observed Abundance Trends

Comparisons between full Baffin Island abundance estimates as well as regional stratum estimates, were undertaken using data from the 2012, 2014, and merged 2024 and 2025 surveys (**Tables 15 and 16**). The 2014 full island estimate used to determine trend did not include Melville Peninsula or Borden Peninsula given that these 2 areas were not surveyed in 2024/2025. This reduced the estimate used for the analysis of trend from 4,872 (CI=3,661-6,484) to 4,645 (CI=3,667-5,885) (**Table 16**).

Regional trends from 2014 to 2024-5 were evaluated by pairing 2014 strata (**Figure 39 and Table 16)** with 2024-2025 strata based on overlap as summarized in Table 16.

Table 16. Estimates for 2014 Baffin Island survey (Campbell et al. 2015) strata that overlap the 2024 and 2025 surveys. Also listed are the corresponding 2024/2025 strata used in the trend analysis. Note that the Central Baffin region in 2014 was composed of the Central Baffin and Mary River strata (**Figure 39**).

Region/Strata Corresponding to 2014 Survey strata	**n**	**N**	**SE**	**Confidence Limit**		**CV**	**Corresponding 2024/25 strata used for trend analysis**
Central Baffin	197	1,091	278.4	662	1,798	0.255	NCB-HD-FW PI-LD-H
Mary River	49	224	97.1	96	521	0.433	
Foxe Peninsula	20	216	183.4	48	972	0.849	FP-MD-FW FP-LD-FW
Hall Peninsula	176	887	292.9	467	1,686	0.33	HP-HD-FW, HP-HD-H
Meta-Incognita Peninsula	91	539	207.5	256	1,138	0.385	MP-HD-FW
Prince Charles Island (PCI)	557	1,603	249.8	1,158	2,220	0.156	PCI-HD-FW
North Central Baffin	13	85	45	31	230	0.53	NCB-MD-H
Total	**1,103**	**4,645**	**560.2**	**3,667**	**5,884**	**0.121**	

Observations from the combined 2024 and 2025 data sets (**Figure 38**) indicated higher densities in most March 2024 and 2025 strata then were observed in March 2014 or March 2012. March 2014 observations and estimates illustrate relatively low numbers of caribou in comparison to March 2024 and 2025 strata observations and estimates (**Tables 15**, **16** and **Figure 39**).

Regionally, the greatest change was documented within the Central Baffin Region where the mean estimate increased from 1,315 caribou (adults and yearlings) in 2014, to 23,216 (p-value <0.0001) by 2025. The Meta-Incognita region recorded the next highest change from 539 to 11,694 (p-value < 0.0001), followed by the Hall Peninsula region where the estimated number of caribou increased from 887 to 7,878 (p-value < 0.0001), and finally the Foxe Peninsula region where the mean estimate increased from 216 adult, yearling, and calf caribou in 2014, to 3,682 by March 2024 (p-value < 0.0001) (**Table 17**). Significant increases in abundance were not detected within the Prince Charles Island region and North Central Baffin region, where p-values were recorded well above the 0.05 threshold. Mean estimates from these two regional strata did, however, suggest an increase in abundance within the North Central Baffin region, and a decrease in overall caribou abundance within the Prince Charles Island region (**Figure 40**).

Overall estimates across all Baffin Island strata between March 2014 and March 2024/25 saw a mean increase from 4,645 to 48,681 adult, yearling, and calf caribou respectively. This change was highly significant yielding a P-value of less than 0.0001 (P-values less than 0.05 are an indication of statistically significant change) (**Figure 41**).

The rates and magnitude of this change were estimated using the ratio of successive caribou survey estimates for the full Baffin Island survey area, as well as for individual strata making up the whole Baffin Island survey area (**Table 18**). For clarity, the year for the Baffin 2024/2025 merged surveys was set to 2024.5 to accommodate the splitting of the island wide survey effort into the 2024 (South Baffin) and 2025 (North and Central Baffin Island) surveys that covered the entire Island (except for a large portion of Borden Peninsula). Of most interest was a comparison of the 2012 and 2014 estimates with 2024/2025 estimates. The relatively high CV's reported for both the

2012 and 2014 surveys, coupled with extended (7 weeks) and partial coverage (parts of central Baffin and all of North Baffin Island not surveyed) of the 2012 survey, compared to the 2014 whole Baffin Island survey coverage across a 4 week period, precluded solid estimates of trend in most cases between these survey years.

The overall estimate for Baffin Island generated from the merged March 2024 (South Baffin), and 2025 (North and Central Baffin), indicate that caribou abundance increased approximately 11-fold since March 2014, which translates to a 25% rate of annual increase in abundance (CI=1.22-1.28). **Figure 42** shows yearly change estimates for the most relevant intervals. Increases occurred in all strata except for Prince Charles Island which decreased by 3% per year. Estimates of increase varied by each individual region, however, confidence intervals overlapped estimates for the entire region suggesting statistically similar trends.

Table 17. Estimates of abundance from previous and the present 2024/2025 surveys used for trend analysis based on comparisons listed in Table 16. The total number of caribou used in the estimate (n) is given along with each estimate and confidence limits as well as coefficient of variation (CV) and degrees of freedom. In addition, t-test for statistical significance between estimates are given.

Year	Caribou (n)	N	CV	Conf. Limit		df	T-test	dft	p-value
Baffin (all strata)									
2014	1,103	4,645	0.126	3,667	5,885	286.6			
2025	7,432	48,681	0.052	43,973	53,893	245.1	17.1	269.4	<0.0001
Central Baffin region									
2014	246	1,315	0.238	827	2,093	122.6			
2025	3,319	23,216	0.090	19,452	27,709	142.8	10.4	149.2	<0.0001
Foxe Peninsula region									
2012	6	69	0.995	12	389	19.6			
2014	20	216	0.849	48	972	30.4	0.8	38.3	0.4568
2024	661	3,682	0.158	2,577	5,492	23.0	5.7	27.6	<0.0001
Hall Peninsula region									
2012	41	480	0.337	250	925	65.5			
2014	176	887	0.330	467	1,686	96.0	1.2	143.9	0.2265
2024	1,342	7,878	0.075	6,793	9,137	86.7	10.6	127.9	<0.0001
Meta-Incognita Peninsula region									
2012	13	162	0.545	57	455	34.7			
2014	91	539	0.385	256	1,138	96.2	1.7	122.9	0.0966
2024	1,751	11,694	0.089	9,787	13,972	55.0	10.5	59.3	<0.0001
North Central Baffin region									
2014	13	85	0.533	31	232	55.2			
2025	71	408	0.451	173	963	154.0	1.7	171.5	0.0901
Prince Charles Island (PCI)									
2014	557	1,603	0.171	1,131	2,272	26.0			
2025	238	1,163	0.242	707	1,914	64.1	-1.1	75.7	0.2663

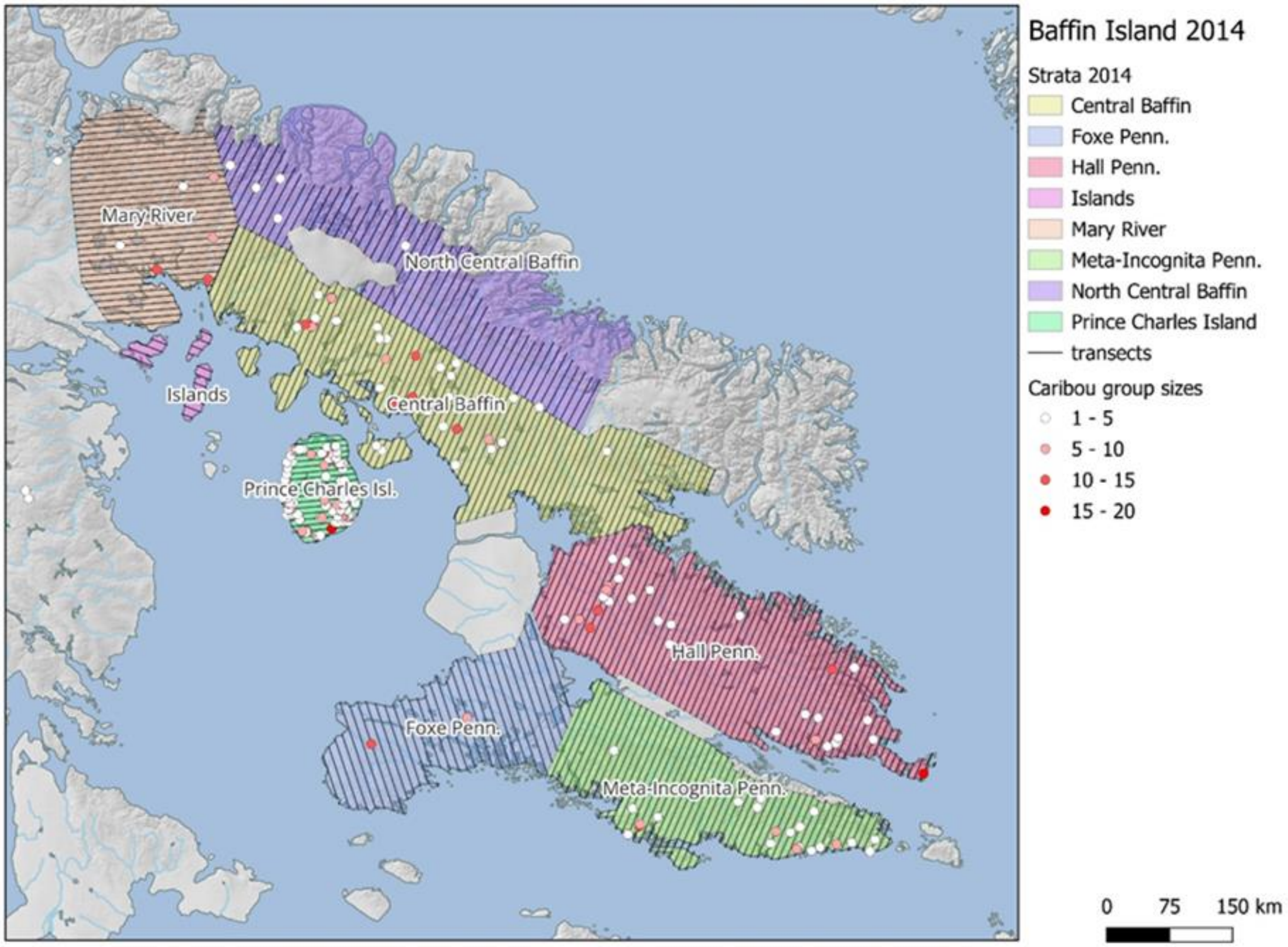

Figure 39 Observations from the 2014 Baffin Island survey (Campbell et al. 2015).

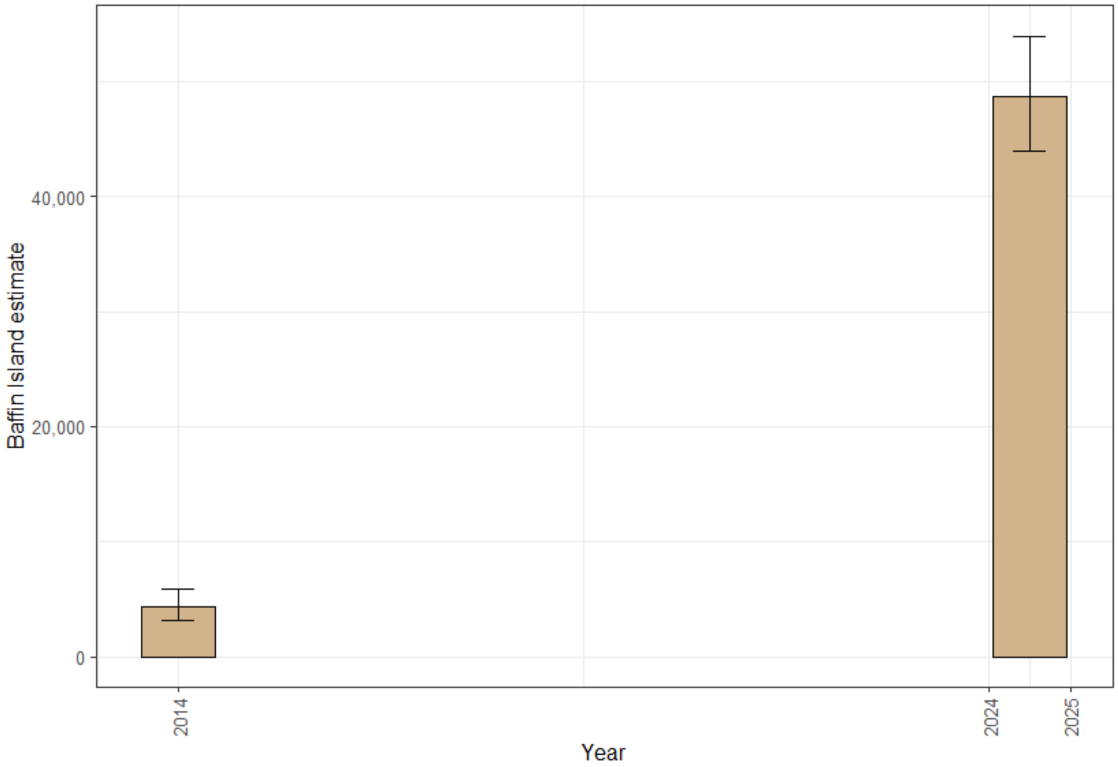

Figure 40 Estimates of abundance for the Baffin Island full island estimates in 2014 and 2024/25.

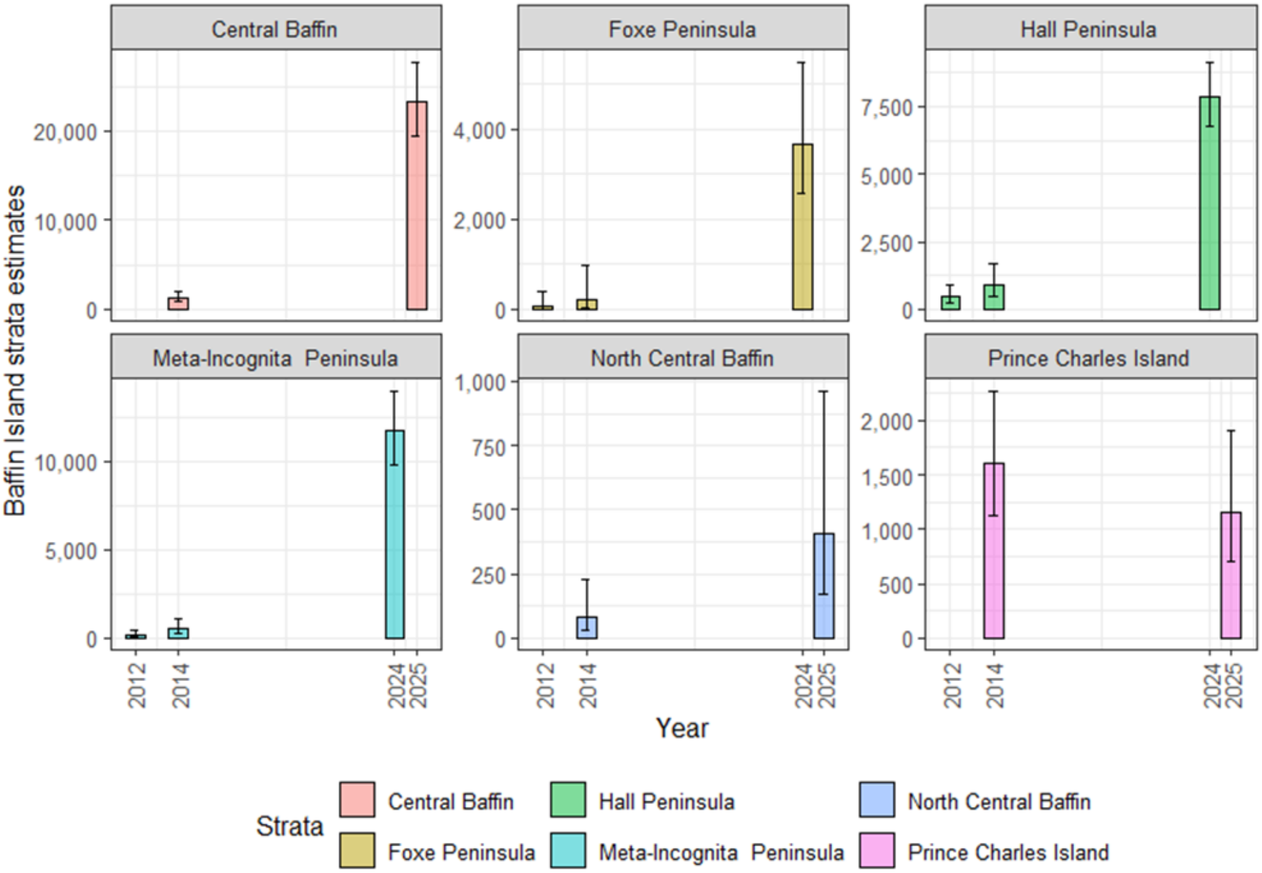

Figure 41. Estimates of abundance for 6 target regions in 2012, 2014, 2024, and 2025 as listed in **Table 16**. Note the different y-scales for each plot.

Table 18. Rates of change in abundance for regions as defined in **Table 16**. for 2012, 2014, 2024, and 2025. Abundance estimates are given for each year and estimates of gross change (N_{y2}/N_{y1}) and annual change (λ). N_{y1} is the abundance estimate for the first year of the comparison and N_{y2} is the estimate for the year of the second estimate.

Interval	N_{y1}	SE_{y1}	N_{y2}	SE_{y2}	GC	SE	Conf. Limit		λ	SE	Conf. Limit	
Baffin (all strata)												
2014-2024-2025	4,645	560.3	48,681	2515.5	10.48	1.40	8.16	13.62	1.25	0.02	1.22	1.28
Central Baffin region												
2014-2025	1,315	312.9	23,216	2081.8	17.65	4.77	11.06	4.49	1.30	0.03	1.24	1.36
Foxe Peninsula region												
2012-2014	69	68.5	216	183.4	3.14	9.73	0.38	4.10	1.77	1.28	0.62	5.44
2014-2024	216	183.4	3,682	583.1	17.05	25.6	5.05	14.73	1.33	0.10	1.18	1.58
Hall Peninsula region												
2012-2014	480	161.9	887	292.9	1.85	1.00	0.75	0.87	1.36	0.33	0.87	2.14
2014-2024	887	292.9	7,878	588.0	8.88	3.35	4.88	3.01	1.24	0.04	1.17	1.33
Meta Incognita Peninsula region												
2012-2014	162	88.1	539	207.5	3.34	3.03	1.03	2.23	1.83	0.64	1.01	3.50
2014-2024	539	207.5	11,694	1041.7	21.70	9.88	10.95	8.57	1.36	0.05	1.27	1.48
North Central Baffin region												
2014-2025	85	45.3	408	183.8	4.80	4.54	1.36	3.35	1.15	0.07	1.03	1.30
Prince Charles Island region												
2014-2025	1,603	274.1	1,163	281.5	0.73	0.22	0.40	0.22	0.97	0.03	0.92	1.02

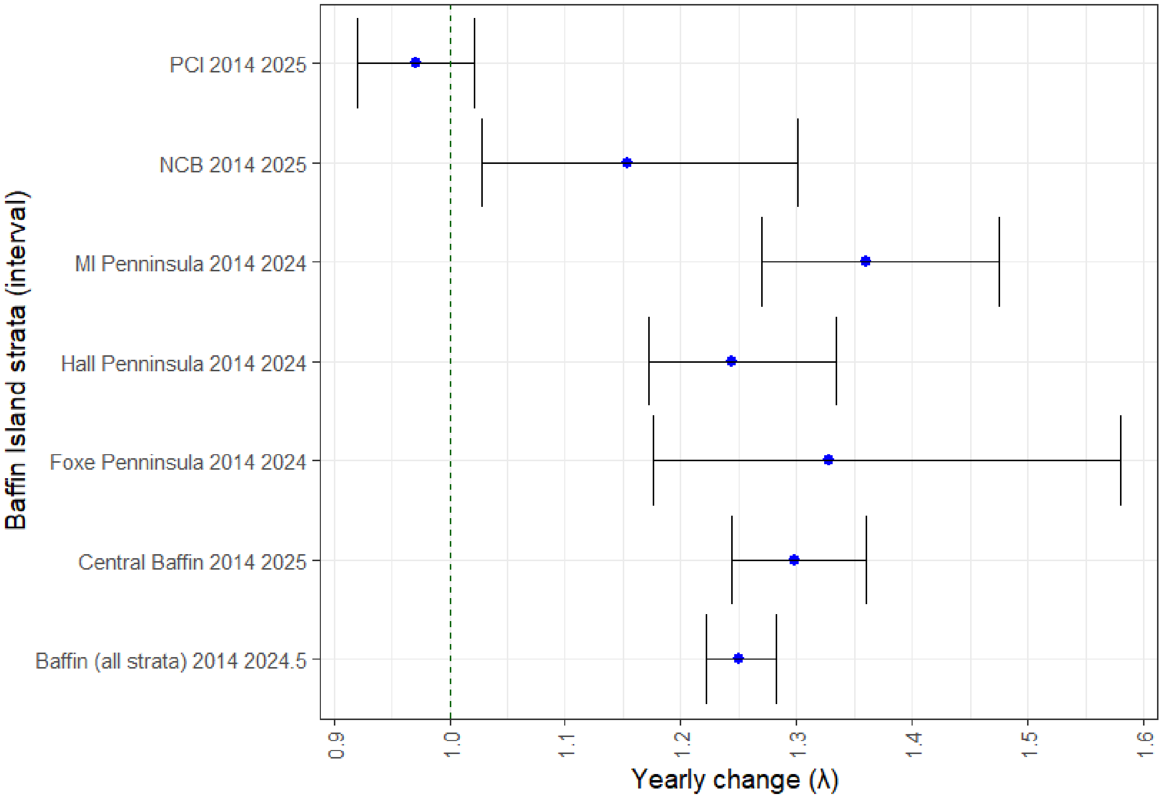

Figure 42. Comparison of yearly change (N_{t+1}/N_t) for Baffin (all strata) compared to region/strata specific change. A vertical line and λ =1 indicate population stability.

4.6 Spring Composition

Composition intensity, timing, and geographic location, varied between years and was highly dependant on funding, available qualified staff, and weather (Ringrose 2018, 2019, 2021). Emphasis was put onto spring composition studies as the best indicator of trend based on its ability to assess overwinter calf survival, the period with the highest expected calf mortality. This period is considered a more dependable indicator of herd productivity and trend. Generally, calves that survived into the spring were considered recruited into the population.

In the fall of 2015, classification crews flew a total of 96.4 hours (28.6 hours in North Baffin, 38.5 hours in Central Baffin, and 29.3 hours in South Baffin) classifying 208, 96, and 159 caribou respectively (**Table 19 and Table 20**) (Ringrose, 2018). In the spring of 2016, crews flew a combined total of 86.3 hours in both Central and South Baffin classifying 125 and 451 caribou, respectively, while in the fall of 2016 crews flew a total of 67.4 hours (19.6 hours in North Baffin and 47.8 hours in South Baffin) classifying 202 caribou in north Baffin, and 445 in south Baffin. Spring 2017 flight hours totaled 104.6 (26.2 hours in North Baffin, 41.6 hours in Central Baffin and 36.8 hours in South Baffin), classifying 254, 8, and 597 caribou respectively, while 2017 flights totaled 14.6 hours in North Baffin alone, observing 316 caribou. In the spring of 2018, crews flew a total of 102.5 hours (18.9 hours in North Baffin, 29.1 hours in Central Baffin, and 54.5 hours in South Baffin) classifying 100, 98, and 933 caribou, respectively. Unfortunately, there were not sufficient resources or cached fuel to conduct fall composition studies in 2018. By 2019 classifications were adjusted to spring only to focus available resources on what was believed to be the most useful index of demographic growth (Ringrose 2019). In spring 2019, classification crews flew 61 hours in south Baffin only observing 1,584 caribou. The most recent composition flights occurred in March/April 2021 within the north and south Baffin study areas (Ringrose 2021), at which time a total of 38.4 hours were flown in south Baffin, and 31.6 hours were flown within the north Baffin study area. South Baffin caribou observations totalled 1,734 the highest recorded to date while north Baffin observations totaled 192, largely due to poor weather and the inability to reach all targeted north Baffin pre-determined classification extents.

It is noteworthy that when compared to the 2014 caribou survey estimates for the north, central, and south Baffin Island regions, 2016, 2017, and 2018 spring classification counts assessed large proportions of the overall estimates. In 2016 11.5% of the survey estimate was assessed for central Baffin, and 16.5% for south. In spring 2017, 80.6% of the 2014 survey estimate was classified for north Baffin, and 21.8% for south Baffin suggesting good representation of the overall caribou population. Of the North, Central and South Baffin classification areas, the south Baffin had the most consistent sampling of caribou on their spring range. South Baffin classification counts increased from 451 in 2016, to 597 in 2017, to 933 in 2018, to 1,584 in 2019 and finally to 1,734 by 2021, suggesting substantial growth within these sampling areas.

High calf to cow ratios were observed for both north and south Baffin. Calf to cow ratios within the south Baffin steadily increased from 22 in 2016, 37 in 2017, to 39 in 2018, to a high of 57 in 2019, and most recently to 47 in 2021 (**Table 20**). Similarly north Baffin calf to cow ratios climbed from 39 in 2017, to 58 in 2018 ending with a high of 63 by 2021. Apart from spring 2016, all calf to cow ratios were for both north and south Baffin Island caribou were well above the known published thresholds for an increasing population (Heard et al. 1990, Boulanger et al. 2011). These findings suggest substantial growth since the establishment of harvest restrictions.

A logistic regression analysis (McCullough and Nelder 1989) was conducted to assess regional differences and overall trends in calf-cow ratios using surveys **(Table 21).** Additionally, an additive model was used (region+year) to assess differences in regions and explore if there was a regional increase in calf-cow ratios. The use of logistic regression accounted for differences in sample sizes in surveys with the response being the count of calves divided by the count of cows in each survey. A quassi-binomial response model was then used to account for likely overdispersion in the response data. Results suggested a weak positive trend (as indicated by the year term) as well as differences in mean calf-cow ratios in different regional areas.

Inspection of estimates relative to predictions suggests a relatively similar positive trend in all areas except Prince Charles Island, which also did not exhibit an increase in abundance between 2014 and 2025 (**Figure 43).** The most apparent trend occurred on South Baffin, which had the most survey data.

Table 19. Survey Flight hours by survey region 2015-2021.

YEAR	SEASON	FLIGHT HOURS		
		North Baffin	Central Baffin	South Baffin
2015	Fall	28.6	38.5	29.3
2016	Spring	***NC***	86.3	86.3
	Fall	19.6	***NC***	47.8
2017	Spring	26.2	41.6	36.8
	Fall	14.6	***NC***	***NC***
2018	Spring	18.9	29.1	54.5
2019	Spring	***NC***	***NC***	61.0
2021	Spring	31.6	***NC***	38.4

Table 20. Spring and fall composition results Oct 2015 to April 2021 (***NS***=Not sampled; ***NR***=Not recorded).

YEAR	LOCATION	SEASON	Cows	Bulls	Yearlings	Calves	Calves/100 cows (%)	Total Caribou Observed
2015	North Baffin Island	SPRING	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
		FALL	77	76	***NR***	55	**71**	208
	Central Baffin Island	SPRING	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
		FALL	39	29	***NR***	28	**72**	96
	Prince Charles Island	SPRING	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
		FALL	189	126	***NR***	133	**70**	448
	South Baffin Island	SPRING	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
		FALL	64	46	***NR***	49	**77**	159
2016	North Baffin Island	SPRING	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
		FALL	94	54	***NR***	54	**57**	202
	Central Baffin Island	SPRING	67	25	10	23	**34**	125
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	Prince Charles Island	SPRING	328	204	76	82	**25**	690
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	South Baffin Island	SPRING	222	151	29	49	**22**	451
		FALL	196	126	42	81	**41**	445
2017	North Baffin Island	SPRING	120	64	23	47	**39**	254
		FALL	139	74	17	86	**62**	316
	Central Baffin Island	SPRING	1	6	0	1	**100**	8
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	Prince Charles Island	SPRING	351	133	57	114	**32**	655
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	South Baffin Island	SPRING	249	181	75	92	**37**	597
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
2018	North Baffin Island	SPRING	36	36	5	21	**58**	100
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	Central Baffin Island	SPRING	33	40	7	18	**55**	**98**
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	Prince Charles Island	SPRING	161	73	37	31	**19**	302
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	South Baffin Island	SPRING	401	277	100	155	**39**	933
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
2019	North Baffin Island	SPRING	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	Central Baffin Island	SPRING	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	Prince Charles Island	SPRING	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	South Baffin Island	SPRING	664	465	108	347	**52**	1,584
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
2021	North Baffin Island	SPRING	87	44	6	55	**63**	192
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	Central Baffin Island	SPRING	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	Prince Charles Island	SPRING	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***
	South Baffin Island	SPRING	805	392	158	379	**47**	1,734
		FALL	***NS***	***NS***	***NS***	***NS***	***NS***	***NS***

Table 21. Logistic regression analysis parameters for analysis of regional trends in calf cow ratios. The parameters are on the logit scale with t-tests of parameter significance.

Term	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-401.796	291.885	-1.377	0.202
North Baffin Island	-0.739	0.648	-1.140	0.284
Prince Charles Island	-1.639	0.655	-2.504	0.034
South Baffin Island	-1.279	0.583	-2.194	0.056
Year	0.199	0.145	1.378	0.201

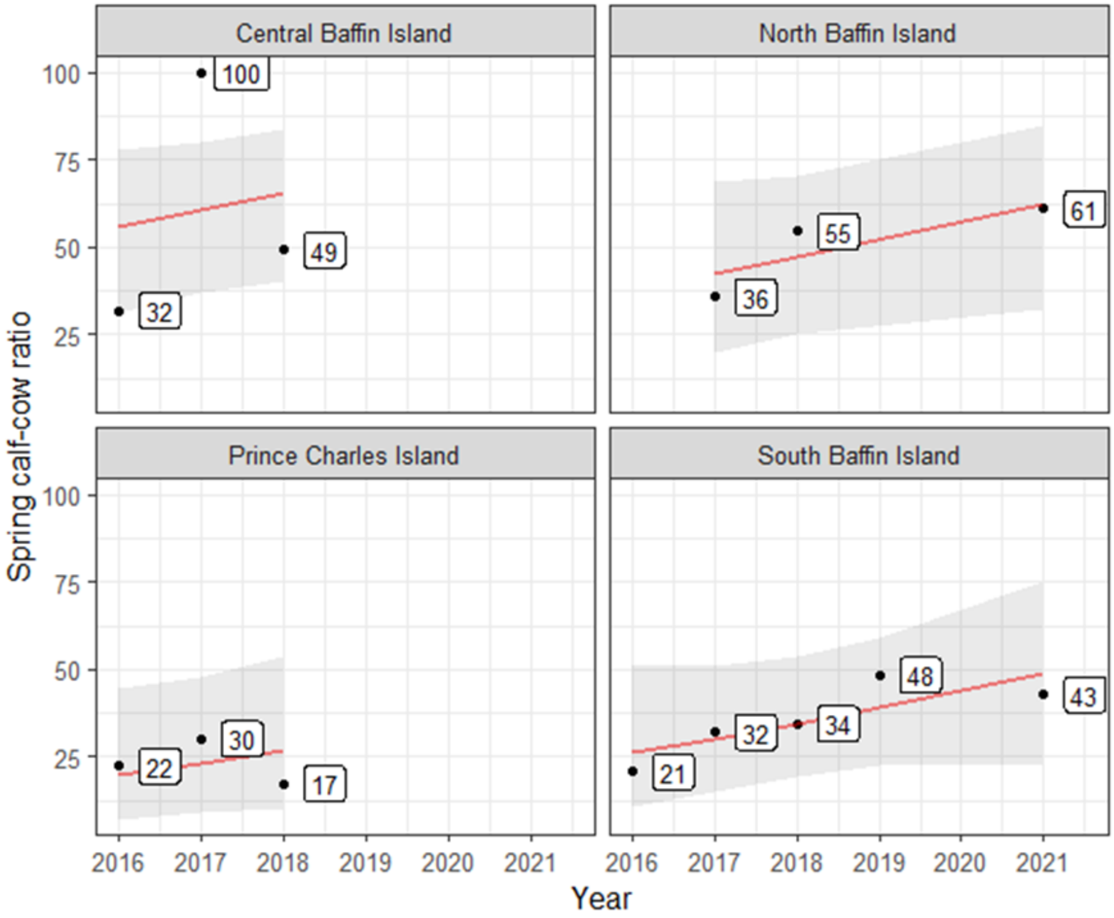

Figure 43 Spring calf/100 cow ratios expressed as a percentage for each of North Baffin, South Baffin, Central Baffin and Prince Charles Island groupings of caribou. Also shown are logistic regression predictions of trend in calf cow ratios with confidence limits given as shaded areas.

5.0 DISCUSSION

5.1 Baffin Island Populations/Subpopulations

No conclusive quantitative assessment of caribou population and/or subpopulation structure has been reported for Baffin Island. Ferguson was the first to report three populations across Baffin Island; the North Baffin population, the South Baffin population and the Northeast Baffin population (Ferguson, 1993; Ferguson and Gauthier, 1992; Ferguson et al., 1998). The delineation of these populations was based largely on Inuit knowledge with the first published boundaries released in 1992 (Ferguson and Gauthier, 1992; Ferguson, 1993) (**Figure 44**). Ferguson also described differing ecotypes and/or migratory types within the defined south Baffin population, suggesting that three subpopulations make up the south Baffin caribou population (Ferguson, 1993; Ferguson et al., 1998).

The most recent attempt to delineate distinct behavioral groupings of barren-ground caribou across Baffin Island was reported in Campbell et al. (2015). Campbell et al. (2015) examined the location data from 71 collared Baffin caribou cows collected between 1987 and 1994, as well as the location data of 31 collared north Baffin caribou cows collected between 2008 and 2011 (Campbell et al. 2015; Jenkins and Goorts, 2011, Ferguson 1988). The location database was not temporally consistent, covering a period of high abundance (1987-1994) and low abundance (2008-2011) creating temporal gaps and associated challenges in its interpretation. Additionally, the amount of data was small and as a result limited in statistical certainty and as such was limited in its reliability. Though the data was limited, and its collection period variable, the Kernal analysis between the two time periods agreed strongly with model results displaying very little mixing between groupings. In the case of the north Baffin grouping, this lack of mixing was present within both high and low abundance phases. North Baffin collared caribou cows displayed no tendency to switch with 100% of all collars captured within the defined north Baffin annual range, both between the 1987 to 1994 deployment and 2008 to 2011 deployment, remaining within that annual range (**Figure 6**). Unfortunately, no other annual or seasonal delineations for Baffin Island caribou have been reported. Therefore, the kernel analysis of the existing data provides important information to help better understand potential caribou subpopulation structure on Baffin Island. Though the data is limited, these preliminary analyses have provided insights into long-term Baffin Island caribou behavioral groupings that remain consistent with the March 2024 south Baffin abundance survey caribou distributions, and observations further adding support to the 2015 findings.

These surveys were successful in documenting a large increase in caribou in the survey area in all survey strata. Overall estimates were relatively precise compared to previous surveys which was partially due to the large increase in sample sizes (Campbell et al. 2015). The observed rate of increase of 25% per year (CI=22-28%) is similar to observed rates of increase on introduced island populations of caribou with minimal hunting and predation pressure (Heard 1990). These increases were largely driven by increases in the Central Baffin, Meta-Incognita, Hall, and Foxe Peninsula's stratums. We also note that there is no direct evidence of collar movement which would have caused an overestimation between the 2024 and 2025 strata due to double counting.

Modelling of the survey data was challenged by certain situations where detection rates were low, and observers were unable to switch. The helicopter data was especially problematic in that at face value it was suggested that detection probabilities were low. The removal model does not perform well when detection rates are low and as a result estimates using the removal model were extremely imprecise and not reliable. To offset this issue the helicopter strata was modelled separately using distance sampling only. This may result in a slightly conservative estimate for the helicopter strata, however, there is no straightforward way to model this data set in its current form. In future surveys an independent observer method should be considered for situations where there is no way for observers to switch places.

Inclusion of data recorder data for 2 weak observer pairs provided one approach to offset issues with observers that miss a substantial portion of caribou. With double observer methods it is difficult to model observer probabilities if both observers are weak since in the end, they both miss many caribou and therefore their estimate of sightability using the ratio of detections/non-detections will likely be biased high, leading to negatively biased abundance estimates (Laake and Collier 2024). Always having a strong observer on each side of the plane and having observers switch is essential to manage this issue. Inclusion of data recorder observations is essentially ad-hoc and less likely to provide as reliable an estimate when compared to using strong pairs of experienced observers.

Sensitivity analyses revealed that using distance sampling with all data recorder observations (without modelling double observer probabilities) provided estimates that were within 1-2% of the double observer/distance sampling approach. In this case, the data recorder observations help meet the assumption of sightability on the line being perfect while avoiding the complexities and assumptions of the double observer models. This approach may be viable if there are relatively strong observers and data recorders who actively search for caribou missed by the observers. We suggest this approach be used in unison with the double observer method in future surveys as a possible solution to offsetting these possible biases.

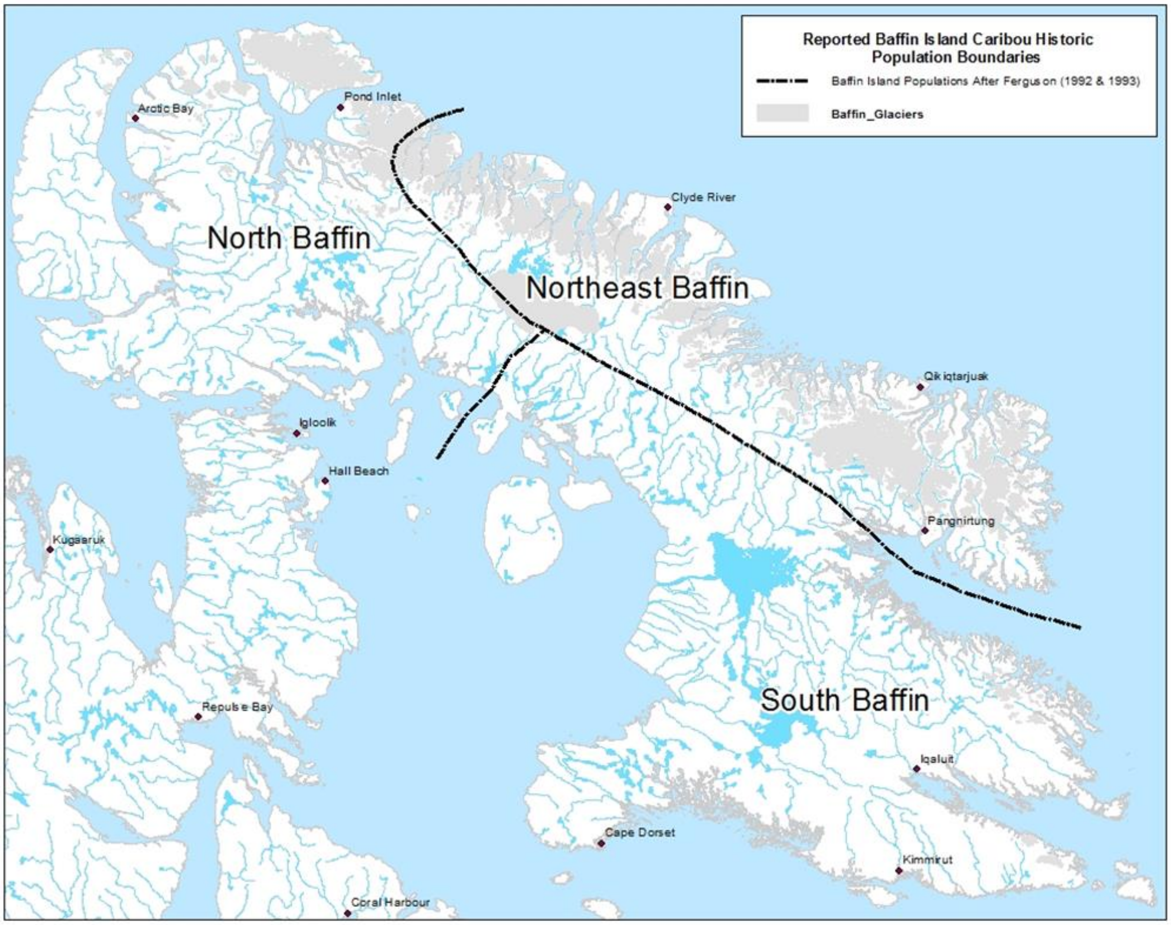

Figure 44. Caribou population divisions on Baffin Island after Ferguson (1993) and Ferguson and Gauthier (1992). Divisions based largely on IQ and not substantiated with genetic analysis and/or long-term spatial affiliations based on telemetry (Campbell et al. 2015).

5.2 Drivers of Observed Trend

The recovery of the Baffin Island caribou population within the 10-to-11-year span between the March 2014 and March 2024 and 2025 surveys was remarkable and obvious across most Baffin Island survey strata. The estimated annual rate of change of 1.25 (CI=1.22-1.28) translates (**Table 18**) to an annual rate of increase approaching some of the highest rates of increase recorded for caribou.

5.2.1 Comparison with other studies and underly demography

Annual rates of increase of 25% (CI=22-28%) observed on Baffin Island, parallels rates of increase for introduced caribou populations with minimal hunting and predation pressure. Heard (1990) estimated the intrinsic rate of increase (r_m) (which is the slope of a linear regression of the log of population size and year) for 8 introduced island populations. The annual rate of change (λ), as estimated in this study, can be calculated as the exponent of the year slope term (r_m) from the regression analysis of a heard (**Table 22**). Based on Heard's (1990) work, the mean annual rate of change of caribou (with no predations or hunting) was 1.29% (sd.=0.03, min=1.23%, max=1.34%, n=8) which is similar to the 1.25% observed on Baffin Island. The increase in populations for many of the islands considered in Heard (1990) were in the range of 10 years further suggesting that large increases can span across many years if habitat and other factors are supporting.

Table 22. Rates of increase of island populations of Caribou from Heard (1990). Annual rate of increase is equal to annual rate of change-1.

Population	years of increase	surveys	Intrinsic rate of increase (r_m)	Annual rate of change $\lambda = e^{r_m}$
Barff	10	4	0.29	1.34
Brunette Isl.	5	6	0.27	1.31
Belcher Isl.	4	2	0.28	1.32
St George Isl.	6	7	0.26	1.30
Adak Isl.	8	2	0.25	1.28
St Mathew Isl.	13	2	0.25	1.28
Southhampton Isl.	20	3	0.23	1.26
St Paul Island	7	8	0.21	1.23
Mean			**0.26**	**1.29**

The Southampton Island analysis of Heard (1990) applies to the period of 1967 when 48 caribou were introduced in 1967 when Heard (1990) estimated the population at 5,400 caribou by 1987, suggesting an estimated rate of increase of 26%. Campbell et al (2020), and Campbell and Boulanger (2024), analyzed the period from 1987 to 1997 where the population continued to increase at 18% per year until 1997 when it reached 29,425 after which time it declined sharply to 7,287 caribou by 2011. The rate of increase for Southampton Island likely decreased as it neared carrying capacity as well as due to increasing harvest pressure. During the period harvest pressure was exacerbated by the sale of caribou meat through the internet to Baffin Island communities that were having difficulties finding caribou on Baffin Island due to the caribou declines ongoing across the island.

The main assumption for the results of the Heard (1990) findings that we believe directly applied to Baffin Island caribou, was that post 2014, predation and hunting mortality was low on Baffin Island, while productivity was high. We speculate that caribou populations on Baffin Island were reduced to very low levels prior to the 2012 and 2014 survey allowing range conditions to improve which in turn lead to an increase in the abundance and quality of forage, ultimately translating into higher levels of productivity.

Heard (1990) also developed and used a population model to estimate maximum rate of increase of caribou populations. The results of this modelling exercise suggest that the rates of growth for barren-ground caribou could reach as high as 36% per year if female caribou pregnancy rates approached 100% starting at the yearling age class, and adult female survival approached 100% until age 20 when they would reach 100% mortality. This scenario is not biologically possible over long time periods but does put a ceiling on rates of increase in the unlikely event that the majority of female caribou are able to reach these milestones. We would also advise that strata-specific estimates of increase **(Figure 42)** were potentially influenced by movement between strata that occurred over the 10-year period in-between surveys and therefore the best estimate of trend is for the entire island is one that pools all surveys strata.

5.2.2 Using a Matrix Model to Determine Rate of Change

A stage-based matrix model based on caribou demographic analyses (Boulanger et al 2011, Boulanger et al 2024, Campbell et al 2025, Caswell 1989, Thomas et al. 2009) was used to further explore the levels of adult survival, calf survival, and pregnancy rate needed to achieve observed levels of increase on Baffin Island, and specific to caribou females (males not included). For this model adult female survival was varied from 0.8 to 0.96, calf survival from 0.35 to 0.98 with adult female pregnancy set at 0.95. Yearling survival was assumed to be equal to adult female survival. In addition, it was assumed 70% of yearlings (22 month old caribou during the fall rut) bred each year which is often the case with increasing populations (Parker 1981, Thomas and Kiliaan 1998). For example, Parker (1981) found that 43% of yearlings bred for the George River Herd during a population increase, while Heard (1990) assumed all yearlings bred. Finally, a sex-ratio of 0.57 favoring females was considered. Also, Thomas and Killiam found that younger females (ages 1.5-4 years old) produced more females (61-64 females/50 males). The assumption in this case was that the age structure of a recovering population would be dominated by younger females. The resulting rate of change (λ) values were then estimated as the dominant eigenvalue of the matrix model which constitutes the stable annual rate of population change for any combination of demographic parameters (Caswell 1989). The resulting estimates of annual rate of change indicate that calf-survival would need to be at least 0.75 and adult female survival approximately 0.91 or above to create levels of increase of 25% each year **(Figure 45).**

It is also possible to estimate calf-cow ratios based on adult female, calf and yearling survival from the matrix model (Boulanger et al 2011, White and Lubow, 2002). In this case the spring calf cow ratio is approximated as:

$$CC = \frac{F_a S_c^{t/365}}{S_f^{t/365} + 0.5 S_y^{t/365}}$$

where F_a is pregnancy rate, S_c is calf survival, S_f is adult female survival, S_y is yearling survival and t is the time interval from birth of calves on the calving ground to the March composition survey (assumed to be 270 days). The corresponding calf-cow ratios for the parameter range in **Figure 43** suggest that calf-cow ratios of at least 0.5 resulted when population increase was 1.2 (20% increase) or above. The calf-cow ratio varied with underlying levels of adult female and calf survival **(Figure 46).**

The main inference from this modelling exercise, similar to those developed by Heard (1990), is that very high levels of survival and productivity are required to produce rates of increase observed on Baffin Island. This finding highlights the importance of continued monitoring of productivity, harvest, and survival as an index of the rate of increase of caribou populations. Building on this discussion, we propose that the observed increase documented for Baffin Island caribou between March 2014 and March 2024/2025, can be attributed to several interacting mechanisms at work between these respective survey years. However, we suggest the main mechanisms of recovery were the result of co-management endorsed harvest restrictions, minimal predation pressure, high productivity, mild winters, limited anthropogenic activities in sensitive caribou seasonal range, and accessible abundant forage. A likely contributing factor was the large-scale decline in caribou numbers first evident around 2010. This reduction would have been consistent with the subsequent recovery of likely overgrazed seasonal range ultimately leading to the development of favorable range conditions, particularly in terms of forage abundance and quality.

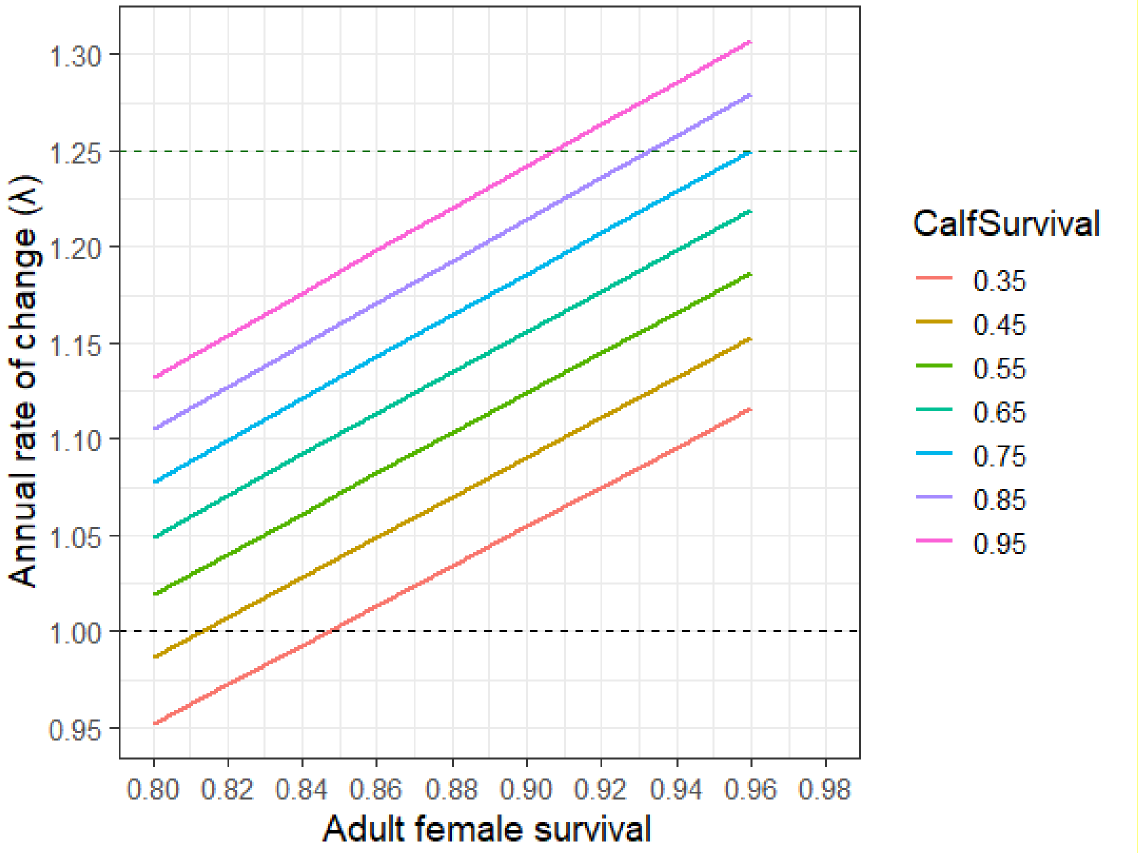

Figure 45. Results of stage-based model estimates of annual rate of change (λ) under varying levels of adult and calf survival. The dotted lines indicate levels of stability (λ=1) and the observed rate of increase on Baffin Island (λ=1.25).

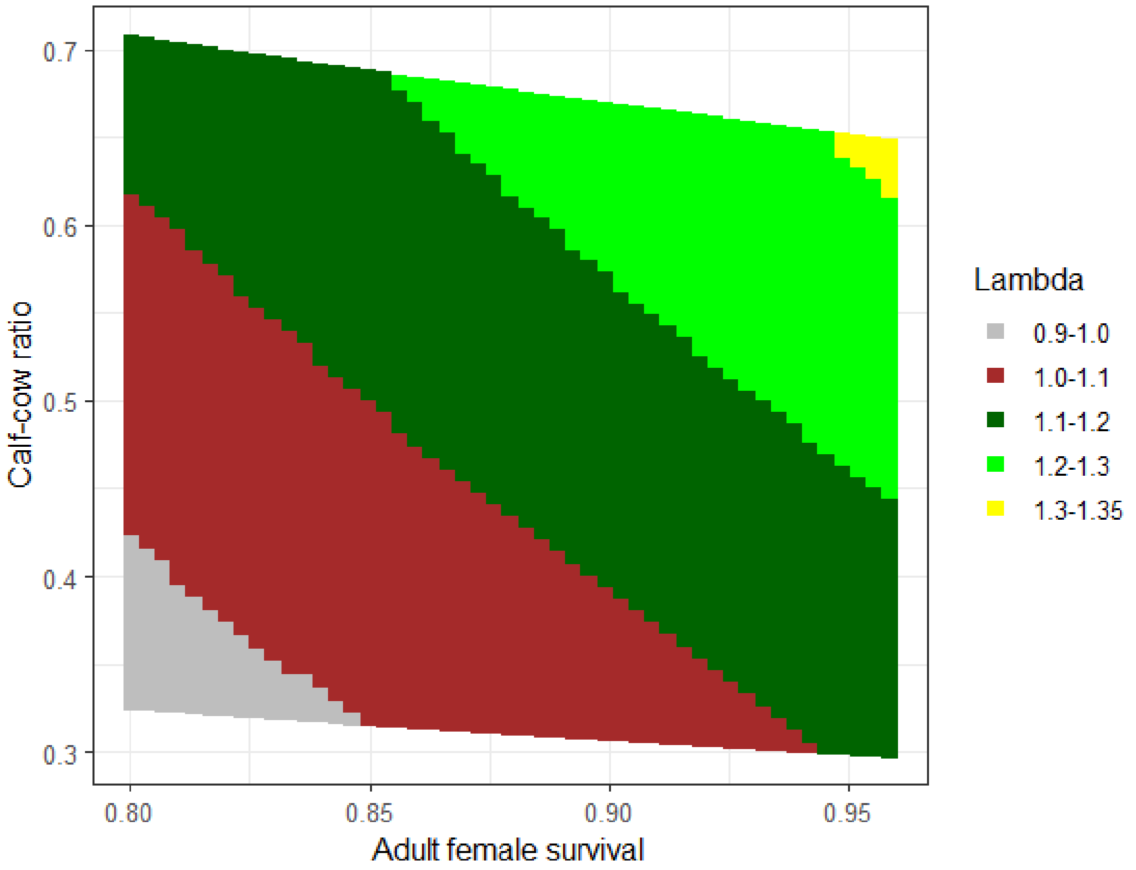

Figure 46. Calf-cow ratios from spring surveys resulting from ranges of adult female and calf survival simulated in Figure 50.

5.2.3 Baffin Island Caribou Herd Productivity

Understanding how to use the cow to calf ratio as an index for population trend is difficult without a Baffin Island specific baseline developed using paired quantitative composition and abundance survey results through time. Until a baseline is developed for Baffin Island caribou, we suggest the use of pre-existing baselines developed for mainland barren-ground caribou. At present, the only, and most similar baseline for barren-ground caribou has been developed by the Government of the Northwest Territories (GNWT). These developed calf to cow ratios suggests that a stable to increasing barren-ground caribou population would display 70-90 calves/100 cows at calving, 50-70 calves/100 cows during the fall rutting period, and 30-50 calves/100 cows during spring (Adamczewski et al. 2009; Tobey 2001; Gunn et al 2005). For Baffin Island, given the very low densities of wolves observed during aerial surveys and equally infrequent observations of wolves reported by Baffin Island hunters, we suggest that spring cow to calf ratio threshold values developed by the GNWT are likely much higher than what would apply to Baffin Island caribou. We advance this conclusion primarily because wolf predation levels on Baffin Island have been and likely, at least in the short term, continue to be far lower than those suggested for the Bathurst and Bluenose caribou herds of Nunavut and the NWT, which were used to develop these thresholds. Additionally, there are no grizzly bears on Baffin Island and only rare sightings of wolverine on the northwestern extents of Baffin Island just across from Melville Peninsula. Both these mammals are known predators of mainland barren-ground caribou.

Given the low relative densities of carnivores reported across Baffin Island over the past 20 years, we suggest that human harvest, up until 2015, was the main cause of predation related mortality for Baffin Island caribou. As such, it was likely the main mechanism suppressing caribou population growth (caribou harvest will be discussed in the following sections).

Productivity, measured in this report as spring calf to cow ratios, and based on how these ratios relate to overwinter calf survival, was well into the increasing range (above 30%) for most years across all of Baffin Island (**Figure 45**). Spring calf to cow ratios for north Baffin reached highs of 58% and 63% for spring 2018 and 2021 respectively, while highs of 57% and 47% were recorded for the south Baffin in spring 2019, and 2021 respectively. Central Baffin Spring calf/cow ratios, though data deficient, also showed signs of high productivity, reporting 55% in spring 2021 (the 100% listed value for spring 2017 was based on the observation of a single cow/calf pair). Additionally, considering a bull only harvest non quota limitation (NQL) put in effect from 2015 through 2018, bull ratios were recorded to have been within a normal range. Bull ratios exceeded Tobey's (2001) findings which concluded that the ratio of 40 bulls:100 cows represents a valid benchmark for the number of bulls required in a population to ensure all cows are bred successfully (Tobey 2001).

Productivity can be influenced by pregnancy rates as well as age of first breeding, and sex ratios at birth. Related to this is the underlying age structure of the population. Populations that have good nutrition may make it possible for proportions of yearling caribou (18 months at fall rut) to breed therefore increasing productivity. For example, Parker (1981) found that 43% of yearlings bred for the George River Herd during an increase. Thomas and Killiam (1998) and Thomas et al (1989) found that younger females (ages 1.5-4 years old) produced more females (61-64%) at birth. If productivity is high, it would be likely that age-structure may shift toward younger females therefore increasing overall productivity. The increasing trend in calf-cow ratios **(Table 21 and Figure 43)** does suggest that productivity was high and increasing which would support higher pregnancy rates, higher calf survival, and potentially female-skewed sex ratios at birth.

5.2.4 Harvest Management Pre-2015

Since the mid to late 1990s, local hunters across Baffin Island have reported decreasing caribou numbers, and as of 2013, many hunters reported that they had to travel further from their communities to locate caribou (Jenkins et al. 2012; Jenkins and Goorts 2013, Department of Environment 2013). These observations were also supported by scientific studies of the time. GN ENV flew a caribou abundance survey across southern Baffin Island in March/April/May 2012 (Jenkins et al. 2012). Poor weather extended the survey period well into the spring migratory period, and melting conditions encountered toward the end of the survey period created difficulties with caribou sightability; However, Jenkins did report an estimated 1,484 yearling, adult, and calf caribou across southern Baffin including Prince Charles Island. These results supported hunter reports of a substantial reduction in South and central Baffin Island caribou abundance. At the time Jenkins et al. (2012) suggested that the observed and reported declines may be due to a combination of factors including but not limited to climate change, resource exploration and development, and extensive and widespread harvest (Vors and Boyce 2009, Jenkins 2011, Fiesta-Bianchet 2011). At the same time there was concern that these hypothesized mechanisms of decline were limiting the chance of recovery for some, if not all, Baffin Island caribou populations/groupings.

The only published documentation of pre-2015 caribou harvest across Baffin Island is the 2004 Nunavut Wildlife Management Board (NWMB) Nunavut Wildlife Harvest Study (NWHS) (Priest and Usher 2004). The study utilized community-based door to door surveys during which community assigned field workers interviewed 67% of registered hunters within each community, each month. Registered hunters were randomly selected from each community based on a list generated using statistics Canada data, Inuit Beneficiary enrollment lists, and General Hunting licence (GHL) holders. It was the fieldworker’s role to assess the hunter’s harvesting intensity which categorised hunters into three classes: 1-Intensive, 2-Active, and 3-Occasional. Using the data collected through this process, wildlife harvest estimates were generated monthly for each of the June1996 through May 2001 harvesting years. As not all communities provided data for the June 1996 to May 1997 harvesting year, we assessed harvest based on the June 1997 through May 2001 harvesting years for all Baffin Island communities. Based on harvest study findings, 19,113 caribou were harvested from south Baffin communities, 9,616 caribou from North Baffin communities, and 3,099 from central Baffin communities between June 1997 and May 2001 (**Table 23**; *data from 1996 excluded due to incompleteness*). This suggests an annual harvest across all of Baffin Island of approximately 7,957 caribou of unknown age and sex between June 1997 and May 2001. Given a well accepted low risk estimate of sustainable harvest of 5% (Bathurst Caribou Advisory Committee 2021; *Bathurst caribou management plan*), a sustainable harvest based on the NWHS harvest estimates would require a population of approximately 39,785 caribou to be sustainable.

The earliest Island wide quantitative estimate of Baffin Island caribou abundance was developed in March 2014, at which time Campbell et al. (2015) estimated 4,645 adult, yearling, and calf caribou (95% CI=3,667-5,884, CV=12.1%). Within the south Baffin region, a partial survey of the Island in March/April/May of 2012 found similar low densities of caribou to those observed in 2014 (Jenkins et al., 2012; Campbell et al., 2015), while within the north Baffin region, reconnaissance data from a telemetry program run between 2008 and 2011 suggested similar low densities of caribou to those observed in 2012 and 2014 (Jenkins and Goorts, 2011). We suggest that based on this information, it is likely that the subsistence harvest had been above sustainable levels for several years prior to 2008, suggesting that low numbers of caribou could have persisted since the late 1990s to early 2000's as supported by consultation reports (Jenkins and Goorts 2013; Jenkins et. al. 2012).

If these assessments reflect the Baffin Island demography of the period, we expect that caribou seasonal range would have had a chance to recover over the approximate 20-year period between the first reports of declining caribou on or about 1995, and the initiation of harvest restrictions in 2015. We suggest that the Baffin Island caribou population would have started to increase in abundance far sooner, were it not for a subsistence harvest which was suspected to have been above sustainable harvest levels over that same period. This condition of a suspected harvest related suppression of caribou population growth, could have allowed caribou seasonal range and forage to have made a more complete recovery from previous population highs, a condition that could express itself in the form of high rates of productivity and growth within the remaining low densities of caribou across the Island. Additionally, hunter reports and survey findings all suggest low densities of wolves across the Island further benefiting calf survival and downstream productivity and growth.

5.2.5 Harvest Management Post-2015

Following the March 2014 whole Baffin Island abundance estimate, significant caribou declines across Baffin Island were confirmed quantitatively. Immediately following the release of the 2014 Baffin Island caribou survey report and results on November 1st, 2015, the Government of Nunavut Department of Environment (GN ENV) initiated a moratorium on caribou harvesting across Baffin Island through a ministerial management initiative. This prompted the fast tracking of the Nunavut Wildlife Management Boards (NWMB) assessment process including the establishment of harvest management actions through their GN ENV, Regional Wildlife Organization (RWO), and Hunters and Trappers Organization (HTO) inclusive co-management process. By August 2015, the NWMB, through multiple meetings and discussions with the GN ENV, Qikiqtaaluk Wildlife Board (QWB), Nunavut Tunngavik Incorporated (NTI), and the community HTOs of Arctic Bay, Pond Inlet, Igloolik, Sanirajak, Clyde River, Qikiqtarjuaq, Pangnirtung, Iqaluit, Kinngait, and Kimmirut, agreed to a whole Island Total Allowable Harvest (TAH) of 250 caribou, and the establishment of a Non-Quota Limitation (NQL) of a male only harvest (**Table 23**).

The TAH and associated NQL restricting female harvest remained in effect from August 27th, 2015, to September 18th, 2019, at which time they were re-assessed based on both scientific and IQ evidence of increased caribou abundance in some areas across Baffin Island. This new information primarily included evidence of high indices of productivity derived from semi-annual GN ENV fall and spring composition studies coupled with harvester reports and IQ, suggesting recovery of the Baffin Island caribou population in some areas.

The NWMB re-assessment first reviewed in June 2019, acknowledged the positive signs of recovery submitted by the GN ENV and the QWB, and by September 19th, 2019, rendered a decision to allow for the modification of the NQL to include up to 25 females within the 250 caribou TAH. As early signs of recovery continued to be reported by all Baffin Island stakeholders, NWMB and their co-management partners re-convened on June 16, 2022, to re-examine all Baffin Island Caribou TAH's and NQL's. Based on submissions by the GN ENV and QWB, the NWMB, on July 5th, 2022, rendered a decision to increase the TAH of Baffin Island caribou from 250 to 350 caribou for the 2022/2023 harvest season. This decision also allowed for an annual increase of the TAH by 50 caribou in the 2023/2024 harvest season, and each year following for the next 8 years or until additional information on the herd suggested otherwise. Additionally, the NWMB allowed for a modification to the NQL allowing for an increase of the female proportion of the TAH from 25 to 75 for the 2022/23 harvest season, with further allowance for an annual increase to the proportion of female caribou within the assigned TAH to 20% in the 2023/2024 harvest season and each year after that for the next 8 years or until new information on the herd suggests otherwise. As of November 1st, 2025, the current TAH stands at 500 caribou 100 of which could be female (**Table 24 and 25**).

The dramatic lowering of the caribou harvest across Baffin Island by the NWMB and approved by the GN Minister of Environment, we believe, set the stage for the dramatic recovery of the Baffin Island barren-ground caribou population. Total harvest dropped from an annual high of 7,957 caribou including females in the late 1990's and early 2000's, to 0 caribou by August 2015, then to a 250 per year male-only harvest for 7 years, for a total of 1,750 legally harvested caribou since 2015. This level of harvest shows a 97% reduction over the subsistence harvest estimated just 13 years prior. Of equal importance was the extremely low female harvest over the same period. During this same 7-year period only 25 females were legally harvested.

Though TAH's increased as did female proportions of the harvest beginning in 2022, it remained well below pre-TAH harvest estimates as did the female proportions of the annual harvest. In all, substantial reductions in the estimated harvest of caribou and the proportion of females harvested lasted just over 10 years, extending from October

2015 to present. We suggest that this dramatic reduction in overall harvest as well as the reduction in the female proportion of that harvest, was the main mechanism of the observed recovery documented within the 2024 and 2025 Baffin Island survey estimates. High productivity was key to the strong recovery as well and was likely the result of an extended period of harvest induced low caribou abundance, and the resultant recovery of preferred herbaceous vegetation used as forage by caribou throughout their annual cycle and across all seasonal range.

Table 23. Pre-2014 estimates of Baffin Island caribou harvest for all communities. Data summarized from the NWMB Nunavut Wildlife Harvest Study (2004).

Harvest Year (July 1-June 30)	TAH	Female Proportion of TAH	Estimated Harvest	Reported Harvest
1997/1998	Unlimited	?	8,669	Unreported
1998/1999	Unlimited	?	8,479	Unreported
1999/2000	Unlimited	?	6,578	Unreported
2000/2001	Unlimited	?	6,739	Unreported
Baffin Totals	**Unlimited**	**?**	**30,465**	**Unreported**

Table 24. Post-2014 Caribou harvest data for all Baffin Island by harvest year. Not all illegal harvest could be accurately quantified. Actual harvest may have exceeded indicated harvest rates due to illegal harvest.

Harvest Year	TAH	Actual Harvest (male & female)	Female Proportion of TAH	Difference (+/-)
2015-2016	250	183	0	67
2016-2017	250	229	0	21
2017-2018	250	233	0	17
2018-2019	250	236	0	14
2019-2020	250	247	25	3
2020-2021	250	247	25	3
2021-2022	250	245	25	5
2022-2023	350	352	75	-2
2023-2024	400	421	80	-21
2024-2025	450	422	90	0
Totals	**2,950**	**2,815**	**320**	**107**

Table 25. Post-2014 caribou harvest data by community and harvest year (not all illegal harvest could be accurately quantified. Actual harvest may have exceeded indicated harvest rates).

COMMUNITY	2015-2016		2016-2017		2017-2018		2018-2019		2019-2020		2020-2021		2021-2022		2022-2023		2023-2024		2024-2025	
	TAH	HVST	TAH	HVST	TAH	HVST	TAH	HVST	TAH	HVST	TAH	HVST	TAH	HVST	TAH	HVST	TAH	HVST	TAH	HVST
ARCTIC BAY	30	9	25	12	20	17	20	20	19	19	19	19	19	13	26	23	30	30	34	34
CLYDE RIVER	30	25	30	30	32	30	32	30	31	29	31	29	31	31	37	26	41	41	43	43
IGLOOLIK	10	0	10	7	12	11	12	10	10	13	10	13	10	12	25	41	31	23	40	34
IQALUIT	30	30	35	41	41	40	41	41	43	43	43	43	43	45	64	64	74	119	53	67
KIMMIRUT	30	30	31	31	33	33	33	33	35	35	35	35	35	35	42	42	45	45	50	48
KINNGAIT	30	13	25	18	20	19	20	19	20	21	20	21	20	21	38	37	43	38	52	52
PANGNIRTUNG	30	22	31	31	33	33	33	35	35	35	35	35	35	36	47	47	53	53	58	58
POND INLET	30	30	32	33	34	33	34	24	34	36	34	36	34	41	46	49	52	58	46	46
QIKIQTARJUAQ	30	24	31	26	25	17	25	24	23	16	23	16	19	9	17	15	20	10	30	24
SANIRAJAK	0	0	0	0	0	0	0	0	0	0	0	0	4	2	8	8	11	4	16	16
BAFFIN TAH	**250**	**183**	**250**	**229**	**250**	**233**	**250**	**236**	**250**	**247**	**250**	**247**	**250**	**245**	**350**	**352**	**400**	**421**	**450***	**450***

* = The full legal TAH allocation for Baffin Island was not distributed by the QWB during this harvesting season.

6.0 CONCLUSIONS

The Baffin Island 2024/2025 abundance survey documents a successful implementation of the Nunavut co-management caribou harvest management system. The data presented in this report suggests the north, central, and south Baffin caribou groups or herds, may have had a prolonged declining phase due to the proportionally high rates of harvest that continued following the onset of a declining phase. Based on anecdotal observations and numerous community consultations undertaken across Baffin Island over this period, this likely began in the early 2000's. Additionally, low densities of predators (particularly the wolf), and the absence of mainland predators (e.g. wolverine and grizzly bear), suggest that predation had little effect on the demographic trends of Baffin Island caribou over this same period. Similarly, prolonged periods of adverse weather or evidence of sustained reproductive disease were not apparent from the early 2000's to present and as a result could not directly account for the prolonged period of low caribou abundance in our opinion.

Following the 2015 activation of harvest management restrictions, ongoing monitoring studies showed a gradual movement of caribou back into previously well-known caribou habitat, with the concurrent effect of documented increases in relative densities documented using IQ and productivity-based classification studies. Beginning in 2015, the Baffin Island caribou harvest was dramatically reduced from an estimated 7,616 caribou annually to 250 caribou annually with an accompanying bull only NQL, clearly paving the way to the dramatic increases seen in the most recent population assessment.

We hypothesize that the prolonged low numbers of caribou across the Island allowed for previously overgrazed range to strongly recover, offering nutritious and abundant forage to Baffin Island caribou now provided substantial relief from extensive harvesting activity. Additionally, density dependant disease would have been substantially reduced as relative densities of caribou across the Island continued to decline and remained low well into the post-2015 recovery period.

We suggest the results presented in this report highlight a success story brought about by the working together of Baffin Island community HTO's, the QWB, and the Government of Nunavut, all under the umbrella of the NWMB and their primary role as the main instrument of wildlife management. We suggest that next steps should acknowledge and utilize the success of the Baffin Island caribou management structure as we move forward. Based on the March 2014 Baffin Island survey estimate (including Prince Charles Island) of 4,652, the NWMB, in discussions with the GN ENV, Baffin HTOs, and the QWB, assessed a TAH and NQL of a 250 caribou male only harvest as being consistent with the recovery of the Baffin Island caribou population. This assigned TAH represented a 5% harvest rate based on the 2014 estimate, proving successful in fostering the strong observed recovery over the 7 years it was in effect. The NQL applied would have also contributed to the strong recovery of the herds. During the first 4 years female harvest was restricted and for the next 3 years only increased to 25 out of the TAH of 250, thus strongly protecting the reproductive potential of the population through the protection of breeding females. Though management decisions made to address the Baffin Island caribou declines were reflective of multifaceted approaches and recommendations expressed by Nunavut stakeholders and management authorities, there is published literature supporting this management approach from studies conducted on mainland barren-ground caribou herds (Boulanger and Adamczewski 2016).

One of the major challenges of monitoring the Baffin Island populations is the high expense of population surveys to provide trends in the abundance of caribou. Because these surveys are expensive and logistically demanding, they are often carried out infrequently, which can result in data gaps. This hampers our ability to detect changes in population dynamics in a timely manner. One means of addressing this is the use of Integrated Population models (IPM) (Schaub and Kery 2022), which have been successfully applied to the Beverly (Campbell et al 2025), Bathurst, and Bluenose-East (Boulanger et al 2024) herds.

IPMs can combine estimates of abundance, productivity (calf-cow ratios), collar survival (through the establishment of telemetry programs), and harvest monitoring, to estimate demographic trends. IPMs use an underlying population model (similar to that described in **Figure 45**) to reconcile trends suggested from each data source. It can therefore be used to predict trends based on levels of productivity and harvest. While collar-based survival is not necessarily a requirement of IPMs, this information can add additional confidence in model results and reliability. In the absence of collared-based survival data, an IPM can still be used to help determine what level of survival is required to maintain the observed trend in survey results given observed levels of productivity (calf-cow ratios) and harvest. This approach would certainly become viable if calf-cow ratio surveys were conducted in a systematic way both temporally and spatially across Baffin Island. Ideally, collar data could be tracked consistently to assess survival rates, aid in locating and studying overwinter calf survival in a way representative of Island subpopulations or groupings, identify caribou groupings and movements to improve on methods and precision of demographic monitoring studies such as abundance surveys, and delineate seasonal range and migratory corridors and behaviour and any long-term changes to the same.

7.0 RECOMMENDATIONS

Disclaimer:

The recommendations section represents the opinions and recommendations of the Government of Nunavut, Department of Environment, Wildlife Research Division Staff, and do not necessarily reflect the opinions of the Government of Nunavut as a whole or all the authors contributing to this report.

Based on the findings of this report, we recommend a continuation of the harvest management regime set out by the NWMB. We suggest a harvest rate of 5% continue to be applied, which would suggest an island wide TAH of 2,334 caribou (based on the 2024/25 abundance estimate), with the maintenance of the NQL allowing 467 (20%) of the TAH to be females. We also recommend a NQL restricting the harvest of cow/calf pairs. We further recommend that this TAH and associated NQL, remain in place under the same harvesting regime most recently updated by the NWMB in 2022 (allowing for the TAH to increase by 50 caribou annually, of which 20% can be females without calves in tow), for a period of 5 to 7 years, or until new information suggests a re-assessment of these management actions. We further recommend that spring composition studies continue every 2 years to monitor herd productivity and indices of general abundance and trends. Finally, we recommend that a telemetry program be maintained within each of the north, central, and south Baffin caribou ranges to:

1- develop a better understanding of Baffin caribou critical seasonal range.

2- assess, predict, and mitigate (to the extent possible), any conflicts, disturbance effects, or herd-level impacts caused by industrial development and associated infrastructure on or impacting caribou seasonal range.

3- provide more detailed critical caribou range maps to better inform the Nunavut Land Use Planning process.

4- better understand north, central, and south Baffin caribou migratory corridors to help ensure these areas are not compromised by linear infrastructure of other land use related impacts.

5- further monitor caribou mortality for associated assessments of herd health and vulnerability primarily through the estimation of adult female survival rates through the tracking of collar data.

6- help locate caribou for more precise and cost-effective monitoring work including but not limited to systematic spring composition surveys to monitor herd productivity by region, regional abundance and reconnaissance surveys, and ecological land classification studies of caribou seasonal range.

At the end of this 5–7-year period, we further recommend that a re-assessment (either through abundance or reconnaissance aerial surveys) of the Baffin Island caribou population be considered, to provide more quantitative information with which to re-assess the existing TAH and associated NQLs. If implemented, these recommendations will help detect and address any negative impacts to Baffin Island caribou demographics arising from anthropogenic causes. We believe these measures will help safeguard Inuit subsistence harvesting rights, as guaranteed within the Nunavut Agreement.

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9.0 LITERATURE CITED

Adamczewski, J., J. Boulanger, B. Croft, H. D. Cluff, B. Elkin, J. Nishi, A. Kelly, A. D'Hont, and C. Nicolson. 2009. Decline in the Bathurst caribou herd 2006-9: A technical evaluation of field data and modeling, Environment and Renewable Resources, Government of Northwest Territories, Yellowknife NWT.

Bathurst Caribou Adviaory Committee. 2021. Bathurst Caribou Management Plan. 61 pp.

Boulanger, J., A. Gunn, J. Adamczewski, and B. Croft. 2011. A data-driven demographic model to explore the decline of the Bathurst caribou herd. Journal of Wildlife Management 75:883-896.

Boulanger, J., and J. Adamczewski. 2016. A General Approach to Harvest Modeling for Barren-Ground Caribou Herds in the NWT and Recommendations on Harvest, Environment and Natural Resources Manuscript Report No. 262. Government of Norwest Territories, Yellowknife NWT.

Boulanger, J., J. Adamczewski, J. Williams, S. Goodman, K. Clark, R. Abernathy, and L. LeClerc. 2024. June 2023 Calving Ground Surveys: Bluenose-East and Bathurst Barren-Ground Caribou Herds Environment and Climate Change, Govt of Northwest Territories, Yellowknife NWT.

Borchers, D. L., W. Zucchini, and R. M. Fewster. 1998. Mark-recapture models for line-transect surveys. Biometrics 54:1207-1220.

Buckland, S. T., D. R. Anderson, K. P. Burnham and J. L. Laake. 1993. Distance Sampling. Estimating Abundance of Biological Populations. Chapman & Hall, London.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers and L. Thomas. 2004. Advanced Distance Sampling - Estimating abundance of biological populations. Oxford Press.

Buckland, S. T., J. Laake and D. L. Borchers. 2010A. Double-observer line transect methods: levels of independence. Biometrics **66**:169-177.

Buckland, S. T., L. Thomas and N. B. Koesters. 2004B. State-space models for the dynamics of wild animal populations. Ecological Modelling **171**:157-175.

Burnham, K. P. and D. R. Anderson. 1998. Model selection and inference: A practical information theoretic approach. Springer, New York, New York, USA.

Campbell, M., J. Goorts, D.S. Lee, J. Boulanger, and T. Pretzlaw, T. 2015. Aerial Abundance Estimates, Seasonal Range Use, and Demographic affiliations of the Barren-Ground Caribou (Rangifer tarandus groenlandicus) on Baffin Island – March 2014. Government of Nunavut Department of Environment Technical Report Series – No: 01-2015. Government of Nunavut, Department of Environment, Iqaluit, NU. 196pp.

Campbell M.W., D.S. Lee, and J. Boulanger. 2019. Abundance Trends of the Beverly Mainland Migratory Subpopulation of Barren-Ground Caribou (*Rangifer tarandus groenlandicus*) June 2011-June 2018. Government of Nunavut, Technical Report Series-No: 01-2018. 141pp.

Campbell, M., and J. Boulanger. 2024. Long-term trends in abundance and spring distribution of the Southampton Island caribou herd: 1978 – 2023. Technical Report Series – No: KIV-01-2024. Government of Nunavut. Department of Environment.

Campbell, M.W., J. Boulanger, D. Lee, M. Dumond, and J. McPhearson. 2012. Calving Ground Abundance Estimates of the Beverly and Ahiak Subpopulations of Barren-Ground Caribou (Rangifer tarandus groenlandicus) – June 2011, Technical Summary. Department of Environment, Government of Nunavut.

Campbell M.W., J. Boulanger, J. Ringrose, A. Roberto-Charron, E. Greene, and C. Mutch. 2022. Abundance Estimates of the Northeastern Mainland Tundra Wintering

Subpopulations of Barren-Ground Caribou (*Rangifer tarandus groenlandicus*) on the Nunavut Eastern Mainland – June 2021. Executive Summary Report. Nunavut Department of Environment. 86 pp.

Campbell, M., J. Boulanger, J. Ringrose, J. Danahy, R. Kite, and A. Roberto-Charron. 2025. Abundance and Trends of the Beverly Mainland Migratory Subpopulation of Barren-Ground Caribou (Rangifer tarandus groenlandicus) June 2011 – June 2023. Department of Environment, Government of Nunavut, Arviat, Nunavut.

Campbell, M., J. Boulanger, and D. Lee. 2020. Long-term trends in abundance and distribution of the Southampton Island caribou herd: 1978 – 2019 Government of Nunavut, Department of Environment, Arviat, NU.

Caswell, H. 1989. Matrix population models. Sunderland, Massachussets, USA., Sinauer.

Department of Environment. 2013. Working Together for Baffin Island Caribou. Department of Environment, Government of Nunavut. Workshop Report. 17 pp.

Environment Canada. 2001. Narrative Descriptions of Terrestrial Ecozones and Ecoregions of Canada. http:/www.ec.gc.ca/soer-ree/English/Framework/Nardesc/efaullt.cfm. Accessed 13 August 2001. Last Updated 08-13-2001.

Ferguson, M. A. D. 1988. Satellite Telemetry Study of South Baffin Caribou. GNWT Department of Resources, Wildlife and Economic Development. Resource Notes. 28-29.

Ferguson, M. A. D. 1993. Working with Inuit to Study the Population Ecology of Baffin Island Caribou. Information North. 8 pp.

Ferguson, M. A. D. and L. Gauthier. 1992. Status and Trends of *Rangifer tarandus* and *Ovibos moschatus* Populations in Canada. Rangifer, ***12 (3)***. 127-141.

Ferguson, M. A. D., R. G. Williamson and F. Messier. 1998. Inuit Knowledge of Long-Term Changes in a Population of Arctic Tundra Caribou. Arctic. ***Vol. 51***, ***No. 3***. 201-219.

Fewster, R. M. 2011. Variance Estimation for Systematic Designs in Spatial Surveys. Biometrics 67:1518-1531.

Fiesta-Bianchet, M., J. C. Ray, S. Boutin, S. D. Cote, and A. Gunn. 2011. Conservation of caribou (Rangifer tarandus) in Canada: an uncertain future. Canadian Jounal of Zoology 89:419–434.

Gasaway, W. C., S. D. Dubois, D. J. Reed and S. J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Biological Papers of the University of Alaska No 22:1-108.

Grolemund, G., and H. Wickham. 2011. Dates and Times Made Easy with lubridate. Journal of Statistical Software 40:1 - 25.

Gunn, A., J. Boulanger, and J. Williams. 2005. Calf survival and adult sex ratio in the the Bathurst Herd of barren ground caribou 2001-2004, Department of Resources, Wildlife and Economic Development, Government of the Northwest Territories, Yellowknife, Northwest Territories, Manuscript report No. 163, , Yellowknife, NWT.

Heard, D. C. 1990. "The intrinsic rate of increase of reindeer and caribou populations in Arctic environments." Rangifer 3: 169-173.

Jenkins, D. 2011. Distribution and Abundance of Barren-Ground Caribou on Baffin Island, Nunavut. Nunavut Department of Environment Interim Report. Pond Inlet Nunavut. 10 pp.

Jenkins, D. and J. Goorts. 2011. Space Use and Movement Patterns of North Baffin Caribou. Field Summary and Progress Report. ***Version 2***. 12 pp.

Jenkins, D., and Goorts, J. 2013. Baffin Island Caribou Consultations, 2012. Draft. Department of Environment, Government of Nunavut.

Jenkins, D., Goorts, J., and Jeppessen, R. 2012. Baffin Island Caribou Consultations, 2012. Draft.Department of Environment, Government of Nunavut.

Jenkins, D. A., J. Goorts and N. Lecomte. 2012. Estimating the Abundance of South Baffin Caribou. Summary Report 2012. Nunavut Department of Environment. 33 pp.

Jolly, G.M. 1969. Sampling Methods for Aerial Census of Wildlife Populations. East Afr. Agric. For. J. **34**:46–49.

Krebs, C. J. 1998. Ecological Methodology (Second edition). Benjamin Cummins, Menlo Park, California.

Laake, J. L., and B. A. Collier. 2024. Understanding implications of detection heterogeneity in wildlife abundance estimation. The Journal of Wildlife Management 88: e22516.

Laake, J., M. J. Dawson and J. Hone. 2008a. Visibility bias in aerial survey: mark-recapture, line-transect or both? Wildlife Research **35**:299-309.

Laake, J., R. J. Guenzel, J. L. Bengtson, P. Boveng, M. Cameron and M. B. Hanson. 2008b. Coping with variation in aerial survey protocol for line-transect sampling. Wildlife Research **35**:289-298.

Laake, J., D. L. Borchers, L. Thomas, D. Miller and J. Bishop. 2012. Mark-recapture distance sampling (MRDS) 2.1.0. R statistical package program.

Manly, B. F. J. 1997. Randomization and Monte Carlo Methods in Biology. 2nd edition. Chapman and Hall, New York.

Mazerolle, M. J. 2016. AICcmodavg: Model selection and multimodel inference based on (Q)AIC(c). . R package version 2.1-0.: https://cran.r-project.org/package=AICcmodavg

McCullough, P. and J. A. Nelder. 1989. Generalized Linear Models. New York, New York, USA, Chapman and Hall.

Nagy, J.A., D.L. Johnson, N.C. Larter, M.W. Campbell, A.E. Derocher, A. Kelly, M. Dumond, D. Allaire and B. Croft. 2011. Subpopulation Structure of Caribou

(*Rangifer tarandus L.*) in Arctic and Subarctic Canada. Ecological Applications. **21(6)**: 2334-2348**.**

Norton-Griffiths, M. 1978. Counting Animals. Serengetti Ecological Monitoring Programme Handbook No. 1. Afropress Ltd., Nairobi Kenya. 139 pp.

Parker, G. L. 1981. Physical and reproductive characteristics of an expanding woodland caribou population in northern Labrador. Can J Zool 59:1929-1940.

Pebesma, E. 2018. Simple Features for R: Standardized Support for Spatial Vector Data. The R Journal 10:439-446.

Priest H., and P.J. Usher. 2004. The Nunavut Wildlife Harvest Study. Nunavut Wildlife Management Board Final Report. 814 pp.

QGIS Foundation. 2020. QGIS Geographic Information System. QGIS Association. http://www.qgis.org.

R Development Core Team. 2009. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Ringrose J. 2018. Baffin Island Caribou Composition Summary Report 2015-2018. Government of Nunavut Final Report. 18 pp.

Ringrose J. 2019. Baffin Island Caribou Spring Composition Survey Report 2019. Government of Nunavut Final Report. 15 pp.

Ringrose J. 2021. Baffin Island Caribou Composition Survey – Spring 2021. Government of Nunavut Final Report. 13 pp.

Schaub, M. and M. Kery. 2022. Integrated Population Models. London, UK, Academic Press.

Thomas, D. C., S. T. Buckland, E. A. Rexstad, J. Laake, S. Strindberg, S. L. Hedley, J. R. B. Bishop, T. A. Marques and K. P. Burnham. 2009. Distance software: Design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology In Press.

Thomas, D. C., S. J. Barry, and H. P. Kiliaan. 1989. Fetal sex ratios in caribou: Maternal age and condition effects. Journal of Wildlife Management 53:885-890.

Thomas, D. C., and H. P. Kiliaan. 1998. Fire-caribou relationships: (II) Fecundity and physical condition of the Beverly herd. Canadian Wildlife Service Technical Report No 310, Edmonton Alberta.

Tobey B. 2001. Caribou Management Report Game Management Unit 13 and 14B. in C. Healy, editor. Alaska Department of Fish and Game, Project 3.0. Juneau, Alaska. Pp 90-95.

Vors, L. S., and M. S. Boyce. 2009. Global declines of caribou and reindeer. Global Change Biology 15:2626–2633.

White, G. C., and B. Lubow. 2002. Fitting population models to multiple sources of observed data. Journal of Wildlife Management 66:300-309.

Wickham, H. 2009. ggplot2: Elegant graphics for data analysis. Springer, New York.

Wickham, H. 2011. The Split-Apply-Combine Strategy for Data Analysis. Journal of Statistical Software 40:1 - 29.

Williams T.M., and D.C. Heard. 1986. World Status of Wild Rangifer tarandus Populations. Rangifer Special Issue. No. 1pp-19-28.