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An assessment of juvenile gyrfalcon harvest in the Coast Mountains population of the Yukon and northern British Columbia

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Government of Yukon
Fish and Wildlife Branch
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Abstract

Gyrfalcons in the Coast Mountains of the southwest Yukon and northern British Columbia occur at the southern limits of their circumpolar distribution. This is the only known monitored population with declines in both occupancy and productivity (Franke et al. 2020). Reasons for the decline have not been established and may be related to climate change or other factors.

This population's range extends into British Columbia, where there has been a managed harvest of juvenile birds, based on nest productivity, for use in falconry (Mossop and Munroe 1990). The Government of Yukon's Department of Environment surveyed gyrfalcon nest sites in the Coast Mountains from 1982 to 2016 to monitor productivity. These survey results were provided to the Government of British Columbia to inform annual harvest opportunities for British Columbia falconers.

We evaluated the sustainability of harvest of juvenile gyrfalcons based on 35 years of productivity data from the Coast Mountains population. We assessed whether harvest rates were within thresholds recommended by the United States Fish and Wildlife Service (Millsap and Allen 2006): a maximum juvenile harvest rate for gyrfalcons of 1% of annual production. Given that this is a conservative threshold based on insufficient demographic data for the species, we also evaluated a maximum sustainable harvest rate of 5% of annual production, a threshold recommended for several other raptor species.

From 1982 to 2016, productivity for the surveyed nest sites varied between 5% and 67%. Our assessment revealed that no amount of juvenile harvest in this population was within the conservative threshold recommended for gyrfalcons (harvest rates within 1% of annual production). The more liberal threshold recommended for other raptor species (harvest rates within 5% of annual production) would allow a sustainable harvest of one juvenile when annual productivity is above 40%.

Over the term of this assessment, a harvest of one juvenile gyrfalcon per year exceeded the liberal harvest threshold for 23 of the 35 survey years (66%). In no years did annual productivity rates support a sustainable harvest of two juveniles per year with either threshold. This demonstrates that current allocation policies of one to two harvest opportunities per year is not sustainable and could lead to over-harvest. In the absence of annual population monitoring, we urge the need for a more conservative approach to harvest management.

Recommendations:

- Update harvest guidelines between the governments of the Yukon and British Columbia to ensure that harvest of juveniles for falconry is sustainable.
- Limit juvenile harvest to one fledged gyrfalcon per year, but only in those years when a survey has been conducted and the productivity rate has been determined to be above 40%.

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Introduction

Gyrfalcons (*Falco rusticolus*) are the largest falcon species and have a circumpolar distribution favouring subarctic and arctic ecosystems (Booms et al. 2011). The gyrfalcon population in the Coast Mountains of the southwest Yukon and northwest British Columbia occurs at the southern limit of its distributional range in North America. Gyrfalcons are apex predators that produce few offspring. As a result, their populations may be vulnerable to the influences of climate change, to fluctuations in their primary prey numbers, and the additive effects of harvest.

The Government of Yukon's Department of Environment staff monitored the reproductive success for a sample of known gyrfalcon nest sites in the Coast Mountains from 1982 to 2016. These surveys informed the allocation of harvest opportunities for the live-capture of juvenile gyrfalcons in northern British Columbia for use in falconry. In this report, we summarize productivity trends for this population and the history of harvest management to assess harvest sustainability.

Reproductive biology

Gyrfalcon breeding pairs are territorial and nest sites are often used for decades (Booms et al. 2011), which makes it feasible for wildlife managers to conduct nest surveys to monitor populations. Gyrfalcons are year-round residents in the southern Yukon. They nest on cliffs and use bare ledges or nests of other birds, such as golden eagles (*Aquila chrysaetos*) and common ravens (*Corvus corax*). Females generally lay two to four eggs in April and incubate the eggs for 35 days. Nestlings fledge within 50 days of hatching (Anderson et al. 2017). Juveniles, which we define as individuals less than one year of age (Millsap and Allen 2006), typically stay in their natal area with their parents for several months post fledging (McIntyre et al. 2009; Burnham and Newton 2011). Juvenile dispersal is not well documented. Although long-distance movements have been observed once juveniles leave their natal area (McIntyre et al. 2009), genetic studies revealed high fidelity of juveniles to the same breeding territory or study area (Booms et al. 2011). Breeding adults also show very high fidelity to their breeding territories (Booms et al. 2011).

Across their circumpolar distribution, gyrfalcons are ptarmigan (*Lagopus* spp.) specialists, although they also prey on a variety of other avian and mammalian species. Ptarmigan are especially important prey during pair bonding and egg production (Booms et al. 2008). During courtship and the incubation period, males offer prey to the females (Barichello 2011). Female reproductive condition is associated with the abundance of ptarmigan. Several studies have found linkages between cyclical patterns of ptarmigan abundance and reproductive success of gyrfalcons (Barichello and Mossop 2011; Nielsen 2011).

Conservation and legal status

The global population of gyrfalcons is estimated to be stable with 70,000 individuals, which includes 46,700 adults (BirdLife International 2017; Franke et al. 2020). The International Union for the Conservation of Nature Red List assessed gyrfalcons as Least Concern in 2016 (BirdLife International 2017). The reasons for the designation as Least Concern were their stable population trend, large range, and population size. Global threats to the species include collection of their eggs and young for falconry, birds killed by trappers and illegal shooting, intensive hunting of ptarmigan, and climate change (BirdLife International 2017).

The Canadian population of gyrfalcons is estimated to be 33,000 (Partners in Flight 2020). Based on Christmas bird counts, populations in the southern portion of the species wintering range have shown a moderate increase (Government of Canada 2015). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed gyrfalcons as Not at Risk in 1987. Gyrfalcons are federally protected though provisions of the Convention on International Trade in Endangered Species (CITES) and provincial and territorial legislation. Several Canadian jurisdictions allow individuals with a permit to obtain wild gyrfalcons for their personal use, but these birds cannot be exported for commercial purposes. Since 1984, all gyrfalcons legally exported from Canada for international trade are captive-bred birds (Convention on International Trade in Endangered Species of Wild Fauna and Flora 2000).

In the Yukon, the gyrfalcon is a species of conservation concern and tracked by the Yukon Conservation Data Centre (Yukon Conservation Data Centre 2019). Although more information is required, there are 354 known nest sites from inventory surveys and incidental observations. Most of these nest sites are not monitored; therefore, some portion of the known sites may represent alternate nest sites in the same nesting territory or sites abandoned and no longer occupied by gyrfalcons. Occupancy and productivity of the southwest Yukon population appears to be in decline relative to other circumpolar populations found at higher latitudes (Franke et al. 2020).

Gyrfalcons are a Specially Protected Species under the Yukon's *Wildlife* Act and cannot be hunted, trapped, or possessed (Wildlife Act R.S.Y. 2002, c. 229). Falconry and the keeping of wildlife in captivity for recreational or commercial purposes is not permitted in the Yukon (Wildlife Regulation O.I.C. 2012/84). Nevertheless, a person may transport a captive gyrfalcon and falconry equipment while in transit through the Yukon if issued a Yukon *Wildlife* Act permit. These are issued to falconers permitted to capture gyrfalcons in areas of northern British Columbia where they are issued a British Columbia *Wildlife* Act permit. This allows licensed falconers to travel through the Yukon to access areas in northern British Columbia along the Haines and Atlin Roads and South Klondike Highway. If a falconer successfully captures a gyrfalcon, a Yukon conservation officer must inspect the banded bird prior to export as a condition of the Yukon *Wildlife* Act permit.

In British Columbia, gyrfalcons are designated as a species of Special Concern and Blue-listed due to their small breeding population estimated to be fewer than 19 breeding pairs (BC Conservation Data Centre 2015; Chutter 2015). Eight known nest sites are located in northwestern British Columbia and were periodically monitored as part of this study. During

years when we monitored all eight sites, a yearly average of three nest sites (37%) were occupied.

In Alaska, gyrfalcon populations are relatively stable (Alaska Natural Heritage Program 2007). The estimated population is 6,100 (Alaska Natural Heritage Program 2007) including an estimated 350 to 370 breeding pairs (T. L. Booms, Regional Wildlife Biologist, Alaska Department of Fish and Game, personal communication). Franke et al. (2020) reviewed monitoring survey results from Seward Peninsula, Denali National Park and northeastern Alaska (Colville River). The authors found a declining trend in gyrfalcon nest occupancy in the Seward Peninsula and a cyclic pattern with an overall downward trend in productivity in Colville River. The remaining areas had stable occupancy and productivity rates. In Alaska, the capture of live birds for falconry is allowed, but with limits. Approximately three to five gyrfalcons are captured for falconry each year. Based on available productivity data, this harvest represents less than 1% of annual juvenile production (T. L. Booms, Regional Wildlife Biologist, Alaska Department of Fish and Game, personal communication).

Harvest management

The Department of Environment monitored the reproductive success of gyrfalcons in the Coast Mountains for 35 years from 1982 to 2016. Department staff and others surveyed gyrfalcons by visiting all potential cliff-nesting habitat in the Coast Mountains. Cliff faces were searched for gyrfalcons and their signs (excrement and lichen deposits indicative of raptor use). Following initial surveys in the first few years, crews chose a subset of nest sites to monitor in subsequent years. Surveys occurred in the southwest Yukon, occasionally extending into British Columbia, and were conducted in June by helicopter or by ground. During surveys, staff recorded the number of adults and young to determine occupancy and productivity rates.

At the onset of this program, the productivity surveys informed the annual allocation of harvest opportunities for the Yukon and British Columbia. While the Yukon conducted these annual surveys, they also shared the results with the Government of British Columbia to inform capture quotas for juvenile that have fledged from the nest for falconry in their portion of the population's range. A formula developed in 1990 was used to allocate a harvest between one and nine gyrfalcons when productivity rates were above 40% (Appendix 1). In 1999, Deputy Ministers responsible for wildlife management from the Yukon and British Columbia governments signed a memorandum of understanding to undertake an assessment of the sustainability of gyrfalcon harvest along the Haines Road and revisit the harvest allocation formula.

In 2002, amendments to the Yukon's *Wildlife* Act no longer allowed the capture and possession of wildlife for recreational or commercial purposes and the harvest of gyrfalcons in the Yukon ended. In 2010, the Yukon implemented a regulation under the *Wildlife* Act to permit the transportation of birds of prey and associated capture equipment through the Yukon while in transit to another jurisdiction. This regulation supported the harvest of gyrfalcons by permitted British Columbia residents in the areas in northern British Columbia that are road-accessible from the Yukon.

The Yukon discontinued annual surveys of gyrfalcon nest sites in 2016, after which the Government of British Columbia continued to provide one to two harvest opportunities per year in areas of northern British Columbia that are road-accessible from the Yukon. British Columbia gyrfalcon harvest for falconry ranges from zero to three juveniles that have fledged from the nest per year (Chutter 2015). The province has a maximum annual quota of 12 harvest opportunities for gyrfalcon, of which zero to six opportunities are allocated in northern British Columbia (Chutter 2009). In recent years, capture permits were valid from September 1 to January 15. Historically, most gyrfalcons were captured from the mountain pass along the Haines Road in northern British Columbia.

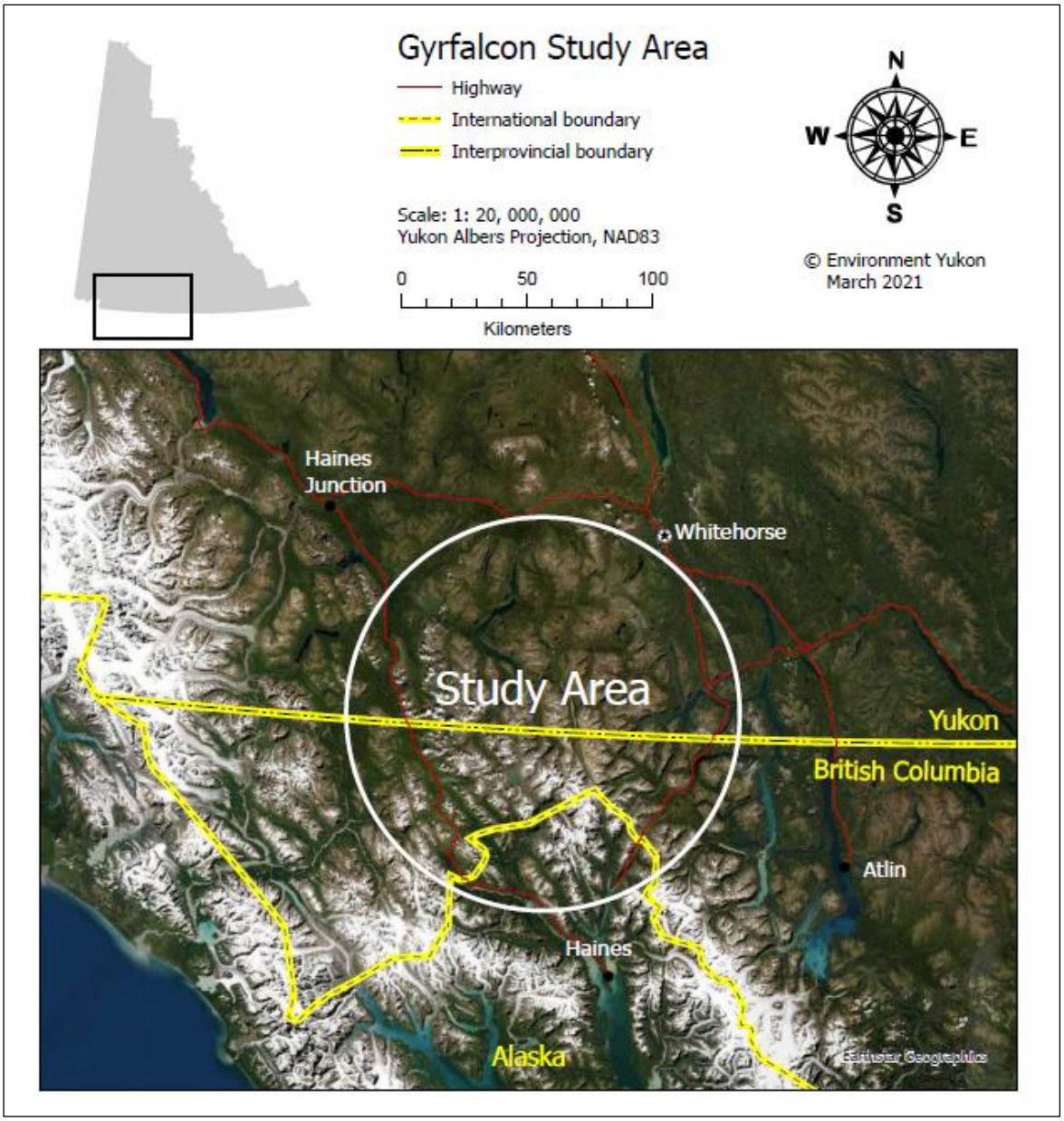

Fig. 1. General location of Coast Mountains gyrfalcon study area.

Assessment of harvest rates

To evaluate the sustainability of gyrfalcon harvest for falconry in the Coast Mountains, we reviewed productivity trends from annual surveys and estimated harvest rates from the theoretical capture of either one or two juveniles per year from the population. To account for variability in annual production, we report low and high estimates of annual production (methods described in Appendix 2) and base our assessment on the low estimate. We assumed harvested juveniles were from the resident population (Appendix 2).

We assessed whether harvest rates were within thresholds recommended by the United States Fish and Wildlife Service (Millsap and Allen 2006). For gyrfalcons, Millsap and Allen (2006) recommended a maximum juvenile harvest rate of 1% of annual production. They recommended this conservative threshold because insufficient demographic data was available to estimate maximum sustainable yield. For most raptors where this information was sufficient, including peregrine falcons (*Falco peregrinus*), they recommended a maximum sustainable harvest rate of 5% of annual production. We assessed harvest rates using both thresholds and defined juveniles as individuals less than one year of age (Millsap and Allen 2006).

Millsap and Allen (2006) cautioned that falconry harvest rates should be conservative because it is very difficult to collect the information necessary to assess the impacts of juvenile harvest. Signs of over-harvest are difficult to observe because cliff-nesting raptor populations are constrained by suitable nesting habitat and prey availability. Indicators of over-harvest may include a decrease in the number of young adults without territories, the number of young breeding pairs, or nest site occupancy (Millsap and Allen 2006).

Productivity trends

Overall, an average of 35% of surveyed nests sites in the Coast Mountains were productive (successfully produced young) from 1982 to 2016, although annual rates varied between 5% and 67%. Productivity rates during this 35-year period were cyclic (Fig. 2) and declined over the study period ($F_{1, 33}$=6.550, p=0.015, r^2=0.166). Years with low productivity coincided with fewer offspring per breeding pair (Fig. 2). Overall the average number of young per successful breeding pair was 2.48 (SE = 0.06) when 213 observations were pooled. The annual average number of young per breeding pair also appeared to decline over time (Fig. 2; $F_{1, 33}$=3.832, p=0.059, r^2=0.104).

The Coast Mountains gyrfalcons are the only known monitored population that has shown a decrease in both occupancy and productivity at nest sites (Franke et al. 2020). Most other populations in the circumpolar north show stable trends with none appearing to increase. The Coast Mountains is the most southerly of monitored populations and at the southern limit of the species' wintering and breeding range. As an arctic and subarctic species, the southern distribution of the Coast Mountains population may be more vulnerable to climate change effects, including fluctuations in prey availability.

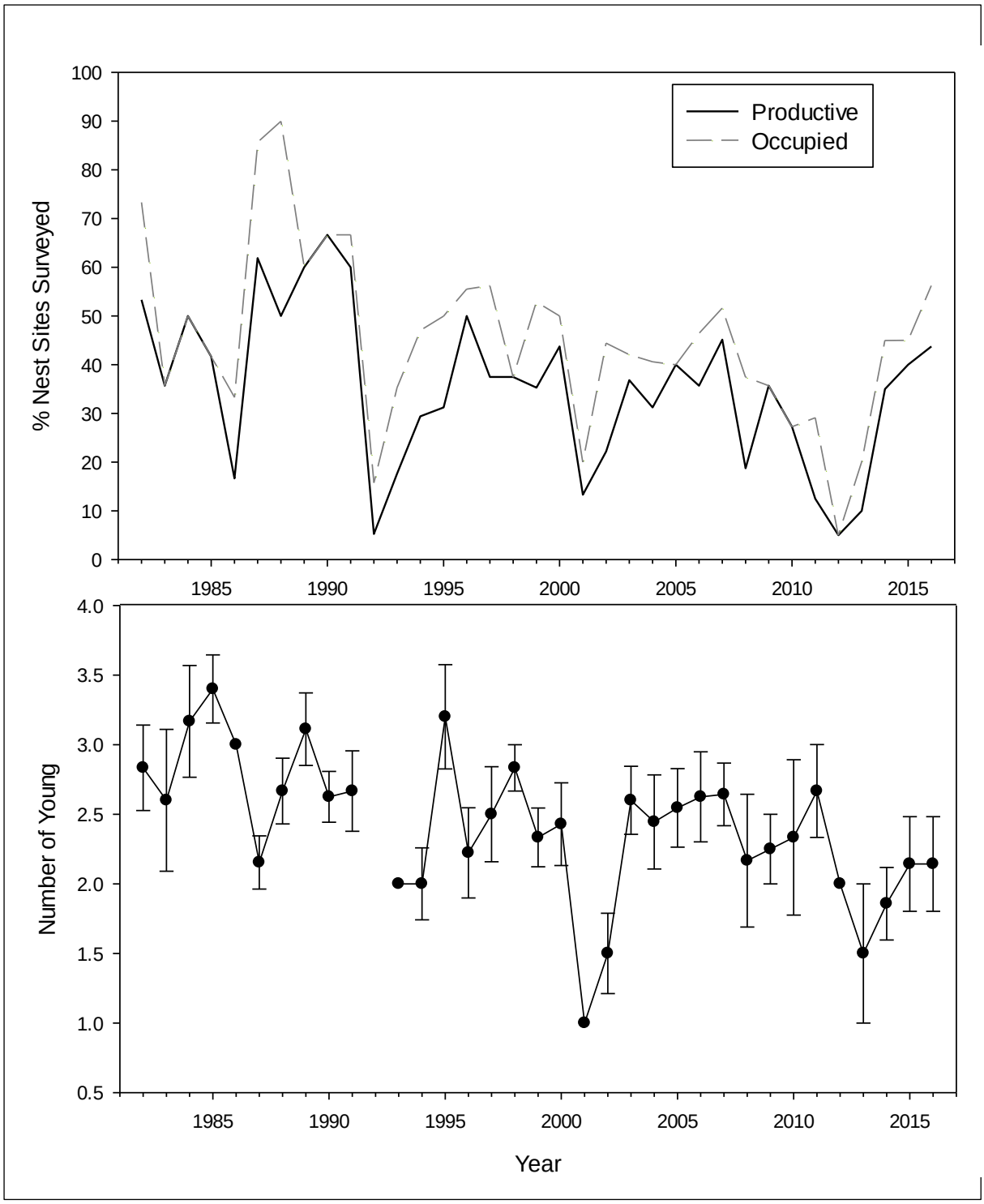

Fig. 2. Occupancy and productivity of gyrfalcon nest sites in Coast Mountains from 1982 to 2016, including the per cent of occupied and productive nests (top) and mean (SE) number of young per successful breeding pair (bottom). In 1992, only one breeding pair was productive and the number of young could not be determined because the female was incubating eggs.

Productivity and harvest rates

Annual productivity estimates from the Coast Mountains population did not support a harvest within the limits recommended by Millsap and Allen (2006) for gyrfalcons. No amount of juvenile harvest was sustainable within 1% of annual production (Fig. 3). Based on this conservative threshold, a theoretical annual harvest of one juvenile gyrfalcon was unsustainable for all 35 years this population was surveyed (Fig. 5).

Annual productivity estimates from the Coast Mountains population did support a limited harvest within the more liberal limits recommended by Millsap and Allen (2006) for several other raptors species. Productivity rates above 40% are needed to support a sustainable harvest of one juvenile gyrfalcon within the threshold of 5% of annual production (Fig. 3 and 4). Since productivity rates were greater than 40% in the Coast Mountains population in only 12 of the 35 years the population was surveyed, the theoretical harvest of one juvenile gyrfalcon was often unsustainable (Fig 5 and Appendix 1). Due to declines in productivity over time between 2001 and 2016, the harvest of one gyrfalcon was unsustainable for 14 of 16 years. The practice of providing harvest opportunities only when annual productivity rates were above 40% (Appendix 1) was an effective strategy at ensuring that no harvest took place when the capture of one juvenile was unsustainable.

The theoretical harvest of two juvenile gyrfalcons was unsustainable for all 35 years the Coast Mountains population was surveyed based on both 1% and 5% thresholds (Fig. 5). Therefore, the previous practice of providing three to six harvest opportunities (Appendix 1) when the annual productivity rate is above 40% is also not sustainable.

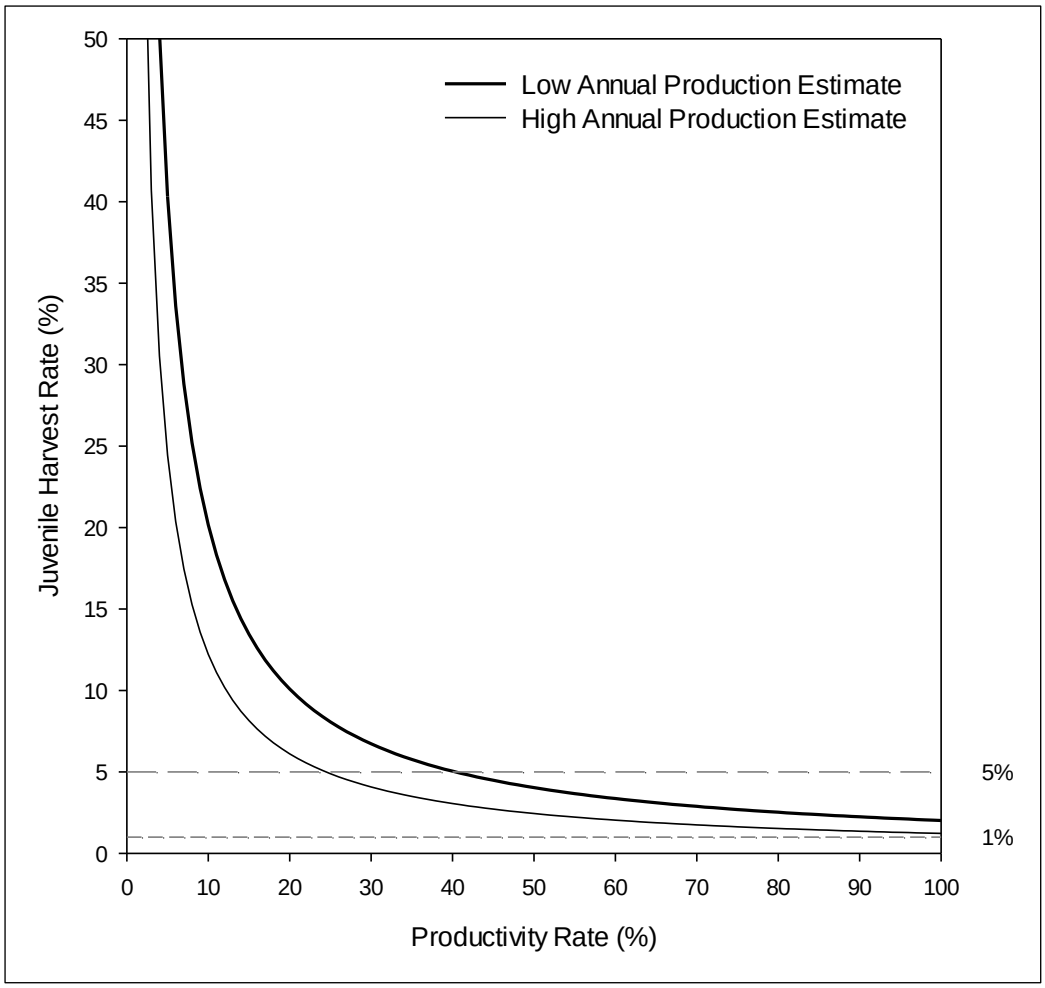

Fig. 3. Relationship of productivity and harvest rates from the theoretical capture of one juvenile gyrfalcon from the Coast Mountains population. Reference lines represent sustainable harvest rate thresholds of 1% and 5%. For a description of methods, see Appendix 2.

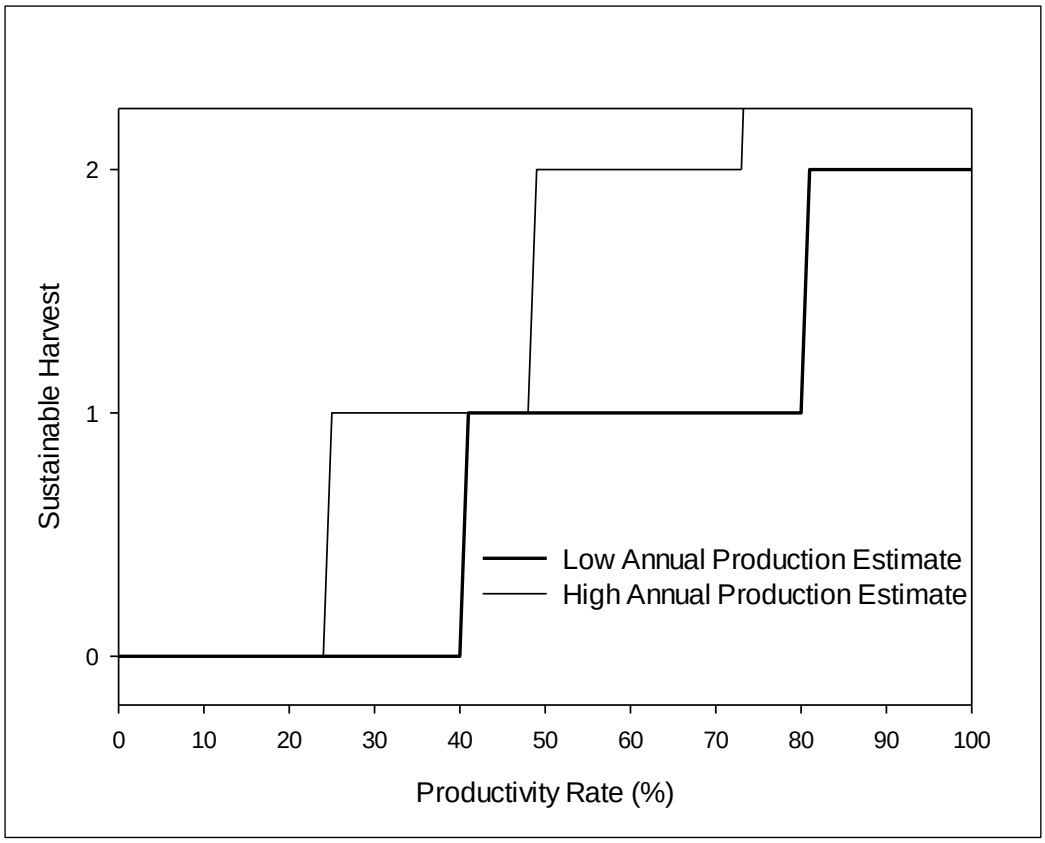

Fig. 4. The number of juveniles that can be harvested within a 5% sustainable harvest threshold. No amount of harvest is within a 1% sustainable harvest threshold. For a description of methods, see Appendix 2.

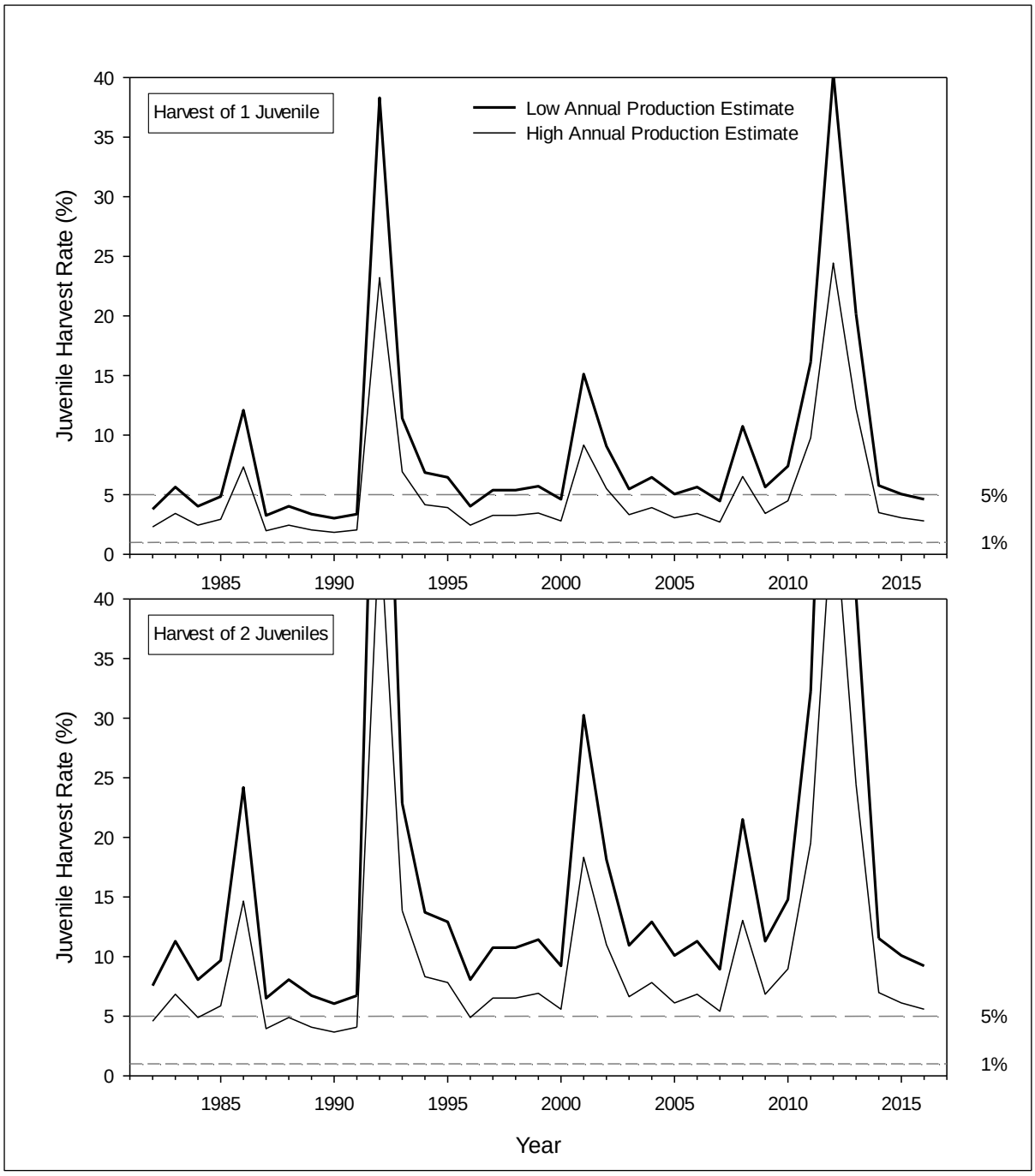

Fig. 5. Harvest rates from the theoretical capture of one and two juvenile gyrfalcons per year based on estimates of annual production from productivity surveys in the Coast Mountains. Reference lines represent sustainable harvest rate thresholds of 1% and 5%. For a description of methods, see Appendix 2.

Harvest history

Harvest records are incomplete prior to 2000, therefore we cannot assess the sustainability of harvest levels from 1982 to 2000 or whether observed declines in productivity could be associated with harvest. Harvest in British Columbia was approximately 15 to 25 birds in the 1980s and 10 birds in the 1990s (Government of BC, unpublished data). Fewer permits for the capture of gyrfalcons were issued in the Yukon during those periods.

From 2000 to 2020, available records show five juvenile gyrfalcons from the Coast Mountains population were harvested under permit from British Columbia (Table 1). This harvest was restricted to juveniles that had fledged from the nest. Although these harvest numbers are low, harvest rates ranged from 4.6% to 9.2% based on low estimates of annual production. No population survey was conducted after 2016 and therefore we could not assess the harvest rate for the juvenile gyrfalcon captured under permit in 2017.

Harvest by British Columbia falconers was low since 2000 because of a lack of opportunities for the capture of juvenile falcons. Low productivity rates did not support a harvest in some years and from 2002 to 2010, captive wildlife regulations did not allow the possession and transport of gyrfalcons in the Yukon. A regulatory amendment came into effect in 2010 that facilitated transport of falcons and falconry equipment through the Yukon.

Table 1. Legal harvest of gyrfalcons from Coast Mountains region of British Columbia and the number of permits issued under the Yukon's *Wildlife Act* to transit captive gyrfalcons through the Yukon.

Year	Productivity rate (%)	Actual allocation in BC	Actual harvest in BC**	Permits issued for transit in the Yukon***
2000	43.8	3	1	1
2001	13.3	0	0	0
2002	22.2	0	0	0
2003	36.8	3*	0	0
2004	31.3	3*	1	0
2005	40.0	3	0	0
2006	35.7	3*	0	0
2007	45.2	3	0	0
2008	18.8	0	0	0
2009	35.7	3*	0	0
2010	27.3	2*	0	1
2011	12.5	0	0	0
2012	5.0	0	0	0
2013	10.0	0	0	0
2014	35.0	1*	0	1
2015	40.0	1	0	0
2016	43.8	2	2	2
2017	No Survey	1	1	1
2018	No Survey	1	0	1
2019	No Survey	0	0	0
2020	No Survey	2	0	2

* *Harvest allocation was based on a predetermined subsample of surveyed nest sites where productivity rates were above 40%. In this report, we calculate productivity rates from all surveyed nest sites (Appendices 1 and 2).*

** *Available harvest records may be incomplete from 2005 to 2009.*

*** *Transport of captive gyrfalcons and falconry equipment were not permitted under the Yukon's* Wildlife Act *from 2002 to 2010.*

Conclusion

Our assessment revealed that the current practice of allocating one to two harvest opportunities per year for juvenile gyrfalcons in the Coast Mountains is unsustainable and a more conservative harvest management approach is needed. This population is at the southern limit of the species range and is the only known monitored population that has shown declines in both occupancy and productivity (Franke et al. 2020). As an arctic and subarctic apex predator, this population's southern distribution may make it more susceptible to climate change and the additive effects of harvest.

No amount of harvest of juvenile gyrfalcons is within the 1% sustainable harvest threshold recommended for gyrfalcons (Millsap and Allen 2006). Given that this threshold is conservative due to a lack of demographic data to model sustainable harvest thresholds, we also evaluated harvest based on a more liberal threshold of 5% used with several other raptors species.

Within a 5% sustainable harvest threshold, a theoretical harvest of one juvenile gyrfalcon was unsustainable 23 of the 35 years (66%) surveyed in the Coast Mountains. The past practice of not allowing a harvest when annual productivity rates were equal to or below 40% ensures that no harvest occurred when annual production does not support the sustainable harvest of one juvenile bird. During years with few young, it is especially important to be conservative regarding harvest in order to maximize the possibility that young of the year survive.

The harvest of two juvenile gyrfalcons a year from the Coast Mountains population is unsustainable and will impact this population, as it does not meet either sustainable harvest threshold (Millsap and Allen 2006). Potential impacts include a decrease in the number of breeding adults, nest occupancy, and population growth rates, and as a result, population decline.

The need for a conservative harvest management approach is also required because the Yukon discontinued annual productivity surveys in 2016. Without annual surveys, it is not possible to ensure that any harvest is sustainable within a particular year. Although actual harvest in the past two decades was very low, harvest opportunities were constrained by low productivity rates not supporting a harvest or a lack of regulations to allow the transit of gyrfalcons through the Yukon. The absence of these constraints and regular monitoring highlights the need for a conservative harvest management approach for this population in the future.

Recommendations:

- Update harvest guidelines between the Yukon and Government of British Columbia to ensure that harvest of juveniles for falconry is sustainable.

- Limit juvenile harvest to one fledged gyrfalcon per year, but only in those years when a survey has been conducted and the productivity rate has been determined to be above 40%.

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Appendices

Appendix 1. 1990 harvest allocation formula

In 1990, biologists from the Yukon and British Columbia governments developed a draft plan for managing the harvest of gyrfalcons for falconry in the Coast Mountains (Mossop and Munro 1990). At the time, British Columbia received 10 to 15 requests for permits to capture gyrfalcons from the region, whereas the Yukon received two to three. The draft plan allowed for the capture of juveniles by qualified falconers for recreational falconry based on a quota system (Tables 2 and 3).

Table 2. Formula used to allocate juvenile gyrfalcon harvest opportunities in the Yukon and British Columbia (from Mossop and Munroe 1990).

Criteria	Yukon Allocation	British Columbia Allocation
Annual productivity rate > 70%	3	6
Annual productivity rate 41% to 70%	2	3
Annual productivity rate ≤ 40%	0	0

This harvest allocation formula was meant to maintain a harvest rate below 10% of the annual production of young for the population (Mossop and Munro 1990). In 1999, the Deputy Ministers for the Yukon's Department of Renewable Resources and British Columbia's Department of Environment, Land and Parks signed a memorandum of understanding to encourage collaboration and joint management of wildlife. In that agreement, both agencies agreed to undertake an assessment of the sustainability of gyrfalcon harvest along the Haines Road.

In 2002, the Yukon's *Wildlife Act* was amended to prohibit individuals and organizations to keep wildlife in captivity, with some exceptions under permit, such as wildlife rehabilitation. The rationale for this change was that the majority of Yukon residents did not support the use of captive wildlife and the number of people interested in recreational falconry was very small. The expense and time required to develop regulations for capturing wild falcons was not justified. In 2010, the Yukon developed regulations under the *Wildlife Act* to permit the transportation of birds of prey into and out of the Yukon while in transit to another jurisdiction. This regulation supports the harvest of gyrfalcons by permitted British Columbia residents in the areas of northern British Columbia that are accessible by road from the Yukon.

From 2004 to 2008, the Yukon and British Columbia governments collaborated to census all known nest sites with financial support from the British Columbia Habitat Conservation Trust Fund (Chutter 2009). Following each survey in June, the results were reported to the Government of British Columbia with the recommended harvest allocation based on a regular sub-sample of nest sites. We found no differences in productivity trends between

regular and additional nest sites surveyed from 2004 to 2008 (paired t-test of arcsine transformed productivity rate: T=0.924; p=0.41; paired t-test of number of young: T=1.167; p=0.28; paired t-test of arcsine transformed occupancy rate: T=0.224; p=0.83). Therefore, we calculated productivity rates from all surveyed nests in this report (Appendix 2).

Table 3. Summary of annual productivity rates based on all surveyed nest sites and associated total harvest allocation of gyrfalcons from Coast Mountains based on the 1990 formula.

Year	Productivity	Allocation
1982	53.3	5
1983	35.7	0
1984	50.0	5
1985	41.7	5
1986	16.7	0
1987	61.9	5
1988	50.0	5
1989	60.0	5
1990	66.7	5
1991	60.0	5
1992	5.3	0
1993	17.6	0
1994	29.4	0
1995	31.3	0
1996	50.0	5
1997	37.5	0
1998	37.5	0
1999	35.3	0
2000	43.8	5
2001	13.3	0
2002	22.2	0
2003	36.8	0
2004	31.3	0
2005	40.0	0
2006	35.7	0
2007	45.2	5
2008	18.8	0
2009	35.7	0
2010	27.3	0
2011	12.5	0
2012	5.0	0
2013	10.0	0
2014	35.0	0
2015	40.0	0
2016	43.8	5
Mean	35.3	1.7
Total		60

Appendix 2. Harvest rate estimate methods

We estimated annual juvenile harvest rates associated with the theoretical capture of one and two juveniles from the Coast Mountains population based on two estimates of annual production using the methodology described by Millsap and Allen (2006). We estimated annual production from survey monitoring data from 1982 to 2016 with the following formula:

$$Juvenile\ Harvest\ Rate\ = \frac{\#\ Harvested\ Juveniles}{Annual\ Production}$$

$$Low\ Annual\ Production\ =\ Annual\ Productivity\ Rate * 20\ Breeding\ Pairs * 2.48\ Young$$

$$High\ Annual\ Production\ =\ Annual\ Productivity\ Rate * 33\ Breeding\ Pairs * 2.48\ Young$$

We based low estimates of annual production on the maximum number of surveyed nests (20) that showed signs of activity by the presence of gyrfalcons or excrement indicative of recent use. This was calculated from 2008 when a full census of known nest sites occurred. This value is also the average number of active nest sites from the full census surveys that occurred from 2004 to 2008. We based high estimates of annual production on the total number of known nest sites (33).

We calculated annual productivity rates from all nest sites that were surveyed (Appendix 1). For all annual production estimates, we used the 2.48 as the mean number of young per successful breeding pair. We chose this pooled average from 213 observations rather than annual averages because brood sizes were unknown in some years of low productivity or in cases when females were incubating young.

We assumed that juveniles harvested along the Haines and Atlin roads and South Klondike Highway in northern British Columbia are from the resident population of the Coast Mountains and not migrants. Preliminary genetics data suggests that several birds captured from the Haines Road are closely related to gyrfalcons from local nest sites (S. L. Talbot, Research Wildlife Geneticist, United States Geological Survey, unpublished data). Juvenile gyrfalcons are usually harvested in late August or September. The movements of juvenile gyrfalcons post fledging are not well understood. Juveniles remained in their natal area until late August to early September in some cases and well into September and October in other cases in the Seward Peninsula and Denali National Park, Alaska and Greenland (McIntyre et al. 2009; Burnham and Newton 2011).