

Changes in the Composition of the Harvest in Three Polar Bear Subpopulations in the Western Canadian Arctic after the US Listing of the Polar Bear as a Threatened Species

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ABSTRACT. The 2008 United States (US) listing of the polar bear as a threatened species prohibits the importation of polar bear trophies into the US, significantly decreasing the number of Americans paying for guided polar bear hunts in Canada. We examined the numbers and composition of the harvest in three polar bear subpopulations—Northern Beaufort Sea, Southern Beaufort Sea, and Viscount Melville Sound—located in the Inuvialuit Settlement Region in the western Canadian Arctic in order to identify what happens when support for guided hunting is withdrawn. We find that there was no significant change in the number of polar bears harvested or in the sex composition of the harvest in the three subpopulations after the US listing. Over the 12-year study period, harvests in each subpopulation were always within the quota. The number of guided hunts decreased after the US listing, and the number of subsistence hunts increased in each subpopulation during this time. The number of bears harvested as a percentage of tags (hunting licenses to harvest one polar bear, the sum of which equals the annual quota) used was significantly higher in the Northern Beaufort Sea after the listing. This is because a tag issued for a guided hunt is considered used even if the hunt is unsuccessful, which is often the case, as hunters seek large male bears, whereas a tag issued for subsistence is re-issued until a successful harvest. We conclude that while the US listing and rapid decline in guided hunts did not affect the number of polar bears harvested, it did disrupt the Inuit cultural economy.

Keywords: conservation hunting; guided hunting; Inuit; Inuvialuit; sport hunting; wildlife co-management

RÉSUMÉ. En 2008, les États-Unis ont placé l'ours polaire sur la liste des espèces menacées, ce qui s'est traduit par l'interdiction d'importer des « trophées » d'ours polaires aux États-Unis et a eu pour effet de diminuer considérablement le nombre d'Américains retenant des services de chasse guidée d'ours polaires au Canada. Nous avons examiné le nombre et la composition des récoltes parmi les trois sous-populations d'ours polaires (nord de la mer de Beaufort, sud de la mer de Beaufort et détroit du Vicomte de Melville) situées dans la région désignée des Inuvialuit dans l'ouest de l'Arctique canadien afin de déterminer ce qui se passe quand le soutien aux services de chasse guidée est retiré. Après l'entrée de l'ours polaire sur la liste américaine, nous constatons que le nombre d'ours polaires récoltés ou que la composition des récoltes des trois sous-populations en fonction du sexe a peu changé. Au cours de l'étude échelonnée sur 12 ans, les récoltes de chaque sous-population se trouvaient toujours dans les limites des contingents. Le nombre de chasses guidées a diminué après l'entrée de l'ours polaire sur la liste américaine et pendant ce temps, le nombre de chasses de subsistance a augmenté pour chacune des sous-populations. Après l'entrée sur la liste, le nombre d'ours polaires récoltés en fonction du pourcentage de permis (permis de chasse pour récolter un seul ours polaire, dont la somme correspond au contingent annuel) était considérablement plus élevé dans le nord de la mer de Beaufort. Cela s'explique du fait qu'un permis délivré pour une chasse guidée est considéré comme « utilisé » même si la chasse ne porte pas fruit, ce qui est souvent le cas parce que les chasseurs sont souvent à la recherche de gros ours mâles, tandis que lorsqu'un permis est délivré pour la chasse de subsistance, il est délivré de nouveau tant que la récolte n'a pas été fructueuse. Nous en concluons que même si l'entrée de l'ours polaire sur la liste des espèces menacées aux États-Unis et la chute rapide du nombre de chasses guidées n'ont pas eu d'effet sur le nombre d'ours polaires récoltés, elle a tout de même nui à l'économie culturelle inuite.

Mots-clés : chasse de conservation; chasse guidée; Inuit; Inuvialuit; chasse sportive; cogestion de la faune

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INTRODUCTION

Polar bears (*Ursus maritimus*) are important to Inuit in Canada for culture, spirituality, subsistence, and economics (Boas, 1888; Van de Velde, 1957; Wenzel, 1983; Schmidt and Dowsley, 2010). To Inuit, wildlife conservation and cultural conservation are one and the same, and Inuit have effectively managed polar bears and other populations of wildlife for generations (Brody, 1976). Indeed, polar bears are one of the most culturally regulated species for Inuit (Riewe and Gamble, 1988; Schmidt and Dowsley, 2010). Inuit have always harvested polar bears for food, clothing, and tools, and after contact with non-Inuit, also for income from the sale of pelts (Wenzel, 2005). Today, Inuit are full partners in the management of polar bears in Canada through their involvement on wildlife co-management boards, drawing upon the best available scientific data and Inuit traditional knowledge.

Beginning in the early 1970s, “sport hunting,” also referred to as “conservation hunting” and sometimes referred to herein as “guided hunting,” was developed in the Canadian Arctic and took on an important economic role in the lives of Inuit (Freeman and Wenzel, 2006). Inuit in the Canadian Arctic have the right, under their land claims settlements, to harvest polar bears at sustainable levels and to use these harvesting rights to offer guided hunts to non-Inuit. Sports hunters travel to the Canadian Arctic from around the world, but most have come from the United States (US) (Wenzel, 2008). Guided hunts provide important social and economic benefits to Inuit communities, many of which have limited economies, while strengthening the conservation hunting regulatory framework (Wall, 2005; Wenzel, 2008). The conservation benefits of guided hunting include the selective harvesting of large male bears, which is consistent with most polar bear management harvest quotas that are set at a minimum 2:1 male/female sex ratio. As well, guided hunting aligns with additional justification and incentives to protect polar bear habitat from potentially damaging activities such as offshore resource extraction or development (Freeman and Foote, 2009). The economic benefits of guided hunting include cash payments to the community, guides, and helpers, in addition to the meat, which is widely distributed throughout the community (Freeman and Wenzel, 2006; Wenzel, 2008; Dowsley, 2010). Guided hunting also provides important social benefits. Participating in a guided hunt as a guide or helper connects Inuit to an activity that is highly valued within Inuit society and generates significant social capital (Wenzel, 2008). Guiding non-resident hunters likewise promotes the transfer of traditional knowledge and land skills across generations (Pearce et al., 2011).

In the last two decades, polar bear conservation has been at the forefront of many international climate change campaigns because of the threat that declining summer sea ice poses to polar bear survival (Tyrrell and Clark, 2014). Due to their reliance on sea ice for hunting and travel, polar bears are highly sensitive to changes (Laidre et al., 2008;

Hamilton et al., 2014; Lunn et al., 2016). Studies conducted in the Southern Beaufort Sea of the US and Canada have linked declines in summer sea ice to reduced physical condition, growth, and survival of polar bears (Regehr et al., 2010; Bromaghin et al., 2015; Ware et al., 2017; Bromaghin et al., 2021). Projected future climate change and reduced spatial and temporal availability of sea ice are expected to be increasingly important forces in polar bear population dynamics in the future (Schliebe et al., 2008; Hunter et al., 2010; Castro de la Guardia et al., 2013; Bromaghin et al., 2021). Scientists and Inuit generally agree that observed declines in summer sea ice extent have already negatively affected some polar bear subpopulations, but some Inuit groups in Nunavut question the impact of anticipated future loss of sea-ice habitats on other polar bear subpopulations (Tyrrell, 2006; Dowsley and Wenzel, 2008).

Polar bear conservation is governed by a strict set of cultural and formalized rules, many of which are self-imposed by Inuit hunters and reflect the pride that Inuit take in making decisions to ensure that populations will be sustained (Joint Secretariat, 2015). Co-management bodies, including Inuit and scientists, carefully monitor the status of polar bears and have developed formal management plans for their conservation that consider expected future climate change impacts (Joint Secretariat, 2017). These plans include annual harvest quotas that are divided between communities and outline aspirations for the collection of traditional and scientific knowledge and monitoring to inform management decisions.

Findings showing that a decline in summer sea ice has had a negative impact on polar bear body condition and survival rates in the Southern Beaufort Sea subpopulation, combined with projections of population declines due to continued warming and the ensuing loss of sea ice habitat contributed to the 2008 decision to list polar bears as threatened under the US Endangered Species Act (United States Fish and Wildlife Service, 2008). The threatened designation means the animal is at risk of becoming an endangered species, in danger of extinction, in the foreseeable future if its habitat continues to be destroyed or adversely changed. The listing means that Americans are no longer allowed to import polar bears as hunting trophies into the US. In this paper, we study what happens when US support for guided hunting is withdrawn. We examine the numbers and composition of the polar bear harvest between 2004 and 2016 for three polar bear subpopulations located in the Inuvialuit Settlement Region (ISR) in the western Canadian Arctic: Northern Beaufort Sea (NB), Southern Beaufort Sea (SB), and Viscount Melville Sound (VM). To do this, we aggregated harvest data for each subpopulation and checked for normality and homogeneity of variances for each location between “least concern” (2004–08) and “threatened” group designations (2008–16). Assumptions were not met, and we used the nonparametric Wilcoxon rank sum test was used to compare values between groups. We tested significance at $p < 0.05$, $\alpha = 0.05$. We hypothesized that for each subpopulation there would be

no significant change in the number of bears harvested, but that we would observe a change in the composition of the harvest. In particular, we hypothesized that, after the US listing, the percentage of the overall harvest made up of guided hunts would decline; the percentage made up of subsistence hunts would increase; and the number of bears harvested as a percentage of tags issued (meaning, the percentage of the tags issued that are fulfilled by the harvest of a bear, either in a guided or subsistence hunt) would increase.

POLAR BEAR CONSERVATION IN CANADA

Through the 1950s, and particularly during the 1960s, there was a rapid increase in the recorded number of polar bears harvested, likely driven by an increase in the price paid for polar bear hides and the use of snow machines, aircrafts, and boats for hunting. In just a few decades, illegal, unregulated polar bear trophy hunting across the Arctic had led to severe pressure on the species in some regions, and there was a recognized need for improved management of the species (Prestrud and Stirling, 1994; Freeman, 2001). In response, and after extensive negotiation, the five nations with jurisdiction over areas where polar bears are distributed (Canada, Denmark [Greenland], Norway, US, and the former United Soviet Socialist Republics [Russia]) signed the Agreement on the Conservation of Polar Bears (referred to herein as ‘the agreement’) in Oslo, Norway, in 1973 (Larsen and Stirling, 2009). The agreement came into effect on 26 May 1976 and was unanimously reaffirmed in 1981 (Fikkan et al., 1993). This agreement was significant because it was one of the first treaties in international wildlife law to specify that decisions should be based on sound conservation practices based on the best available scientific data. It also represented the first time the five Arctic rim nations collaborated in a signed commitment to solve a common regional problem (Prestrud and Stirling, 1994). Among other areas, the articles of this document express agreement among the signatories on the following: prohibition against all taking of polar bears, with some specific exemptions (Articles I and III); protection of ecosystems that include polar bears (Article II); and undertaking of national programs of research on polar bears (Article VII) (Prestrud and Stirling, 1994). All signatory countries (the range states of polar bear habitat distribution) except Canada used the agreement to impose restrictions on or stop all polar bear sport hunting. Canada successfully argued for the inclusion of a provision (Article III) that allowed local people using traditional methods to harvest polar bears in the exercise of their traditional rights in accordance with the laws of the given range state, including guided hunts (Larsen and Stirling, 2009). Article III was particularly important for the US and Canada, with their large Inuit population, and for Greenland’s Indigenous people, whose access to traditional hunting and fishing was important for their

livelihoods, and whose rights were already recognized in national legislation (Prestrud and Stirling, 1994). Freeman and Wenzel (2006) discuss trophy hunting as a basis for developing polar bear conservation hunting programs.

In Canada, the principles of the agreement are implemented through a collaborative approach that is shared with wildlife management boards established through land claim agreements and provincial, territorial, and federal governments. The boards establish quotas based on the best available scientific data and local traditional knowledge. They also strictly regulate and monitor the harvest using hunting tags and quotas to determine the number of polar bears harvested per year in each jurisdiction (Prestrud and Stirling, 1994). This study focuses on three polar bear subpopulations located within the jurisdiction of the ISR created under the Inuvialuit Final Agreement (IFA, 1984). All management of polar bear subpopulations in the ISR is shared based on user-to-user agreements (agreements between two groups) with the following jurisdictions: Alaska (for SB) and Nunavut (for NB and VM) (Brower et al., 2002). In the ISR, wildlife is managed by the wildlife management advisory councils (WMACs) for the North Slope (NS) and Northwest Territories (NWT) in accordance with sections 12(46-57) and 14(45-60) of the IFA. The WMAC (NS) and the WMAC (NWT) “provide advice to the appropriate ministers on all matters relating to wildlife policy and the management, regulation, and administration of wildlife, habitat, and harvesting” for the ISR (IFA, 1984:37). The Inuvialuit Game Council (IGC) plays a vital role in co-managing the system. Under the IFA, the IGC represents the collective Inuvialuit interest in all matters pertaining to the management of wildlife and wildlife habitat in the ISR (IFA, 1984). The duties of the IGC are set out in section 14(74) of the IFA and include appointing “Inuvialuit members for all joint government/Inuvialuit bodies having an interest in wildlife, including the Wildlife Management Advisory Councils (NWT and North Slope)” (IFA, 1984:50). The IGC allocates wildlife harvest quotas to the six ISR communities (IFA, 1984). In regard to polar bears, Inuvialuit are permitted to transfer their exclusive hunting tags to guided hunts. When this occurs, the tag allocated to the guided hunter cannot be reallocated if the hunt is unsuccessful. When a tag is issued for subsistence, the hunter has a specified length of time during which they can harvest a polar bear. At the end of this time, if a bear is not harvested, the tag is returned to the Hunters and Trappers Committee (HTC) and reissued. The hunter is eligible to be considered for another subsistence tag in the same season after others have had a chance to use the tag.

METHODS

The US listing was largely based on scientific findings showing relationships between sea ice changes and polar bear survival in the SB subpopulation. For this reason, we

focused on the three polar bear subpopulations within the ISR in order to compare SB to the other two subpopulations. This choice also related to the lead author's experience working with communities in that region. The analysis required using harvest data collected in the ISR; therefore, the authors first presented the paper concept to the IGC and requested use of the harvest data (September 2019). The IGC did not have any issue with the paper concept and instructed the authors to work with the Department of Environment and Natural Resources (ENR), Government of Northwest Territories (GNWT), to obtain harvest data, then report back to the IGC with the results of the analysis. The authors reported the results and interpretations to the IGC in March 2021. The IGC did not have any issue with the report and advised the authors to contact Environment and Climate Change Canada to ensure there was no conflict or duplication of work, which we did, finding nothing.

We obtained data from ENR. This included harvest data for the SB, NB, and MV subpopulations for the period of July 2004 to June 2016, as reported by communities in the ISR (Aklavik, Inuvik, Paulatuk, Sachs Harbour, Tuktoyaktuk, Ulukhaktok) and Nunavut (Kugluktuk and Cambridge Bay) (GNWT, 2009, 2011, 2016). Reporting for each harvest period (beginning July 1 of one year and ending on June 30 of the next) included: the total number of tags issued (quota); the number of polar bears harvested and sex composition of the harvest; and how many tags were used for successful and unsuccessful guided hunts, subsistence hunts, and kills related to problem animals, human defence, or humane acts. It would have been desirable to include data for more harvest periods before and after the US listing, but these are the data that ENR made available to us.

Under the harvest management system in the ISR and Nunavut, the use of a tag, harvest reporting, and sample collection (including proof of sex and tooth) are mandatory under the Hunter and Trapper Committee (Hunters and Trappers Organization in Nunavut) (HTC/HTO) bylaws. ENR officers collect these data and samples from harvesters in each community and share them with regional ENR offices. The harvest report sometimes classifies the sex of a harvested bear as "unverified male/unknown." This means the harvested bear was reported as male, but no baculum was submitted for verification, a tag was unreturned and assumed used, or the sex is unknown because no samples were submitted. We listed these data as "un-sexed" in the analysis table; we included them in calculations of the number of bears harvested and tags used, but not in the calculation of sex-ratio.

We grouped the data as "least concern" (2004–08) and "threatened" (2008–16). We aggregated data for each subpopulation and calculated percentages for responses as a portion of the total harvest or tags used. It is noteworthy that wildlife management boards delineated subpopulation boundaries using information on polar bear movement patterns and genetics, as well as wildlife management consideration. There is frequent movement

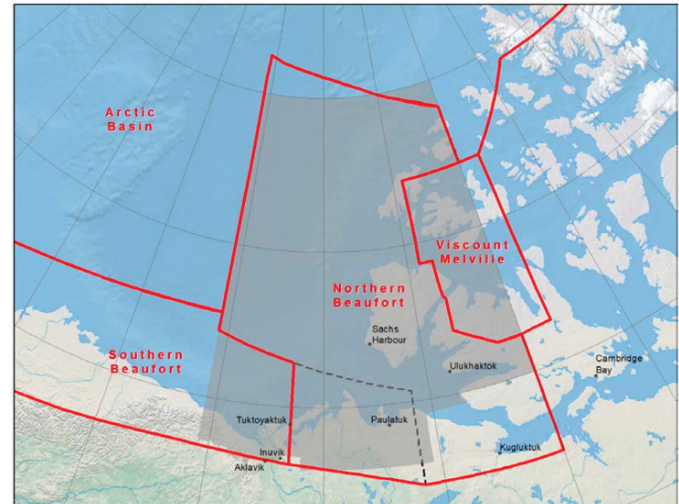


FIG. 1. Subpopulation boundaries for polar bears in the ISR. New subpopulations boundaries as of 2013–14 are shown as red lines and previous boundaries as dashed lines. The ISR is shown in light grey (Joint Secretariat, 2017).

of bears between these areas, and both scientists and Inuvialuit consider SB and NB to be a single group of bears that moves according to conditions needed for the bears to successfully hunt their prey. However, the wildlife management agencies in the ISR agree to use subpopulation categories as units to facilitate harvest management (Joint Secretariat, 2017). In 2013–14, and based on movement analyses, wildlife management agencies in the ISR revised the boundary between NB and SB subpopulations to better reflect separation between these bears; the change took effect during that harvest period (Griswold et al., 2017) (Fig. 1). After the boundary change, harvest quotas changed in the SB (from 40 to 21) and in the NB (from 65 to 77, and then to 70 in 2015–16).

Our analysis focused on identifying what correlation, if any, exists between the listing and the numbers and composition of the harvest. We tested the following response variables for each subpopulation: total bears harvested; female bears as a percentage of total harvest; subsistence hunts as a percentage of total harvest; successful sport hunts as a percentage of total harvest; unsuccessful sports hunts as a percentage of tags used; and harvest as a percentage of total tags used. We checked data for normality and homogeneity of variances for each subpopulation between least concern and threatened groups. Assumptions were not met, and we used the nonparametric Wilcoxon rank sum test to compare harvest numbers between least concern and threatened groups. We tested significance at $p < 0.05$, $\alpha = 0.05$. We supplement our findings with ethnographic observations that the lead author has documented over the past 18 years with Inuit who harvest polar bears in the three management areas. We use these data and experiences to help interpret and explain the numbers and composition of the harvest before and after the US listing and to discuss implications for Inuit.

TABLE 1. Significance of difference between least concern ($n = 4$) and threatened ($n = 8$) groups in three polar bear subpopulations using the Wilcoxon Rank-Sum test.

Variable	Wilcoxon rank-sum test p -value and W -value					
	Northern Beaufort Sea		Southern Beaufort Sea		Viscount Melville Sound	
	p -value	W	p -value	W	p -value	W
Bears Harvested	0.11	6	0.55	20	0.73	13.5
Females (% Harvest)	0.20	24	0.55	12	0.10	6
SUB (% Harvest)	0.008**	0	0.047*	4	0.01*	4
SSH (% Harvest)	0.008**	32	0.03*	29	0.01*	28
USH (% Harvest)	0.008**	32	0.10	26	0.67	16
Harvest (% Tags used)	0.008**	0	0.19	8	0.22	12

Notes: ** p -values < 0.01 ; * p -values < 0.05

Abbreviations: SUB = Subsistence; SSH = Successful Sport Hunt; USU = Unsuccessful Sport Hunt

RESULTS

A total of 652 polar bears were harvested from the three subpopulations during the twelve harvest periods included in this analysis between 1 July 2004 and 30 June 2016. Of this total, 423 bears were harvested from the NB, 170 from the SB, and 57 from the VM subpopulations. In the twelve harvest periods included, the number of bears harvested never exceeded the quota.

We present results of the analysis comparing the numbers and composition of the harvest before and after the US listing separately for each subpopulation (Table 1).

Northern Beaufort Sea (NB)

No significant change occurred in the number of bears harvested in the NB per season after the change in conservation status in the US (Wilcoxon rank sum test, $p = 0.11$; Fig. 2a). No significant change occurred in the number of female bears harvested as a percentage of the total harvest after the listing (Wilcoxon rank sum test, $p = 0.20$; Fig. 2b). However, the percentage of bears harvested for subsistence relative to the total harvest significantly increased after the change in conservation status (Wilcoxon rank sum test, $p = 0.008$; Fig. 2d), and the percentage of successful sport hunts that made up the overall harvest significantly declined (Wilcoxon rank sum test, $p = 0.008$; Fig. 2e), as did the number of unsuccessful guided hunts as a percentage of tags claimed (Wilcoxon rank sum test, $p = 0.008$; Fig. 2f). Consistent with these findings, the number of bears harvested as a percentage of tags claimed was significantly higher after the listing (Wilcoxon rank sum test, $p = 0.008$; Fig. 2c).

Southern Beaufort Sea (SB)

No significant change occurred in the number of bears harvested in the SB per season after the change in conservation status in the US (Wilcoxon rank sum test, $p = 0.55$; Fig. 3a). No significant change occurred in the number of female bears harvested as a percentage of the total harvest after the listing (Wilcoxon rank sum test,

$p = 0.55$; Fig. 3b). However, the percentage of bears harvested for subsistence relative to the total harvest significantly increased after the change in conservation status (Wilcoxon rank sum test, $p = 0.047$; Fig. 3d), and the percentage of successful sport hunts that made up the overall harvest significantly declined (Wilcoxon rank sum test, $p = 0.03$; Fig. 3e). There was no significant change in the number of unsuccessful sport hunts as a percentage of tags claimed (Wilcoxon rank sum test, $p = 0.10$; Fig. 3f) or in the number of bears harvested as a percentage of tags claimed (Wilcoxon rank sum test, $p = 0.19$; Fig. 3c) after the listing.

Viscount Melville Sound (VM)

No significant change occurred in the number of bears harvested in the VM per season after the change in conservation status in the US (Wilcoxon rank sum test, $p = 0.73$; Fig. 4a). Nor did any significant change occur in the number of female bears harvested as a percentage of the total harvest after the listing (Wilcoxon rank sum test, $p = 0.10$; Fig. 4b). However, the percentage of bears harvested for subsistence relative to the total harvest significantly increased after the change in conservation status (Wilcoxon rank sum test, $p = 0.01$; Fig. 4d), and the percentage of successful sport hunts that made up the overall harvest significantly declined (Wilcoxon rank sum test, $p = 0.01$; Fig. 4e). No significant change occurred in the number of unsuccessful sport hunts as a percentage of tags claimed (Wilcoxon rank sum test, $p = 0.67$; Fig. 3f) or in the number of bears harvested as a percentage of tags claimed (Wilcoxon rank sum test, $p = 0.22$; Fig. 4c) after the listing.

DISCUSSION

The finding that there was no significant change in the number of polar bears harvested or in the sex composition of the harvest in the three subpopulations after the US listing shows that the co-management system in the ISR has been successful at regulating a sustainable harvest, even after support for guided hunting was withdrawn. The result

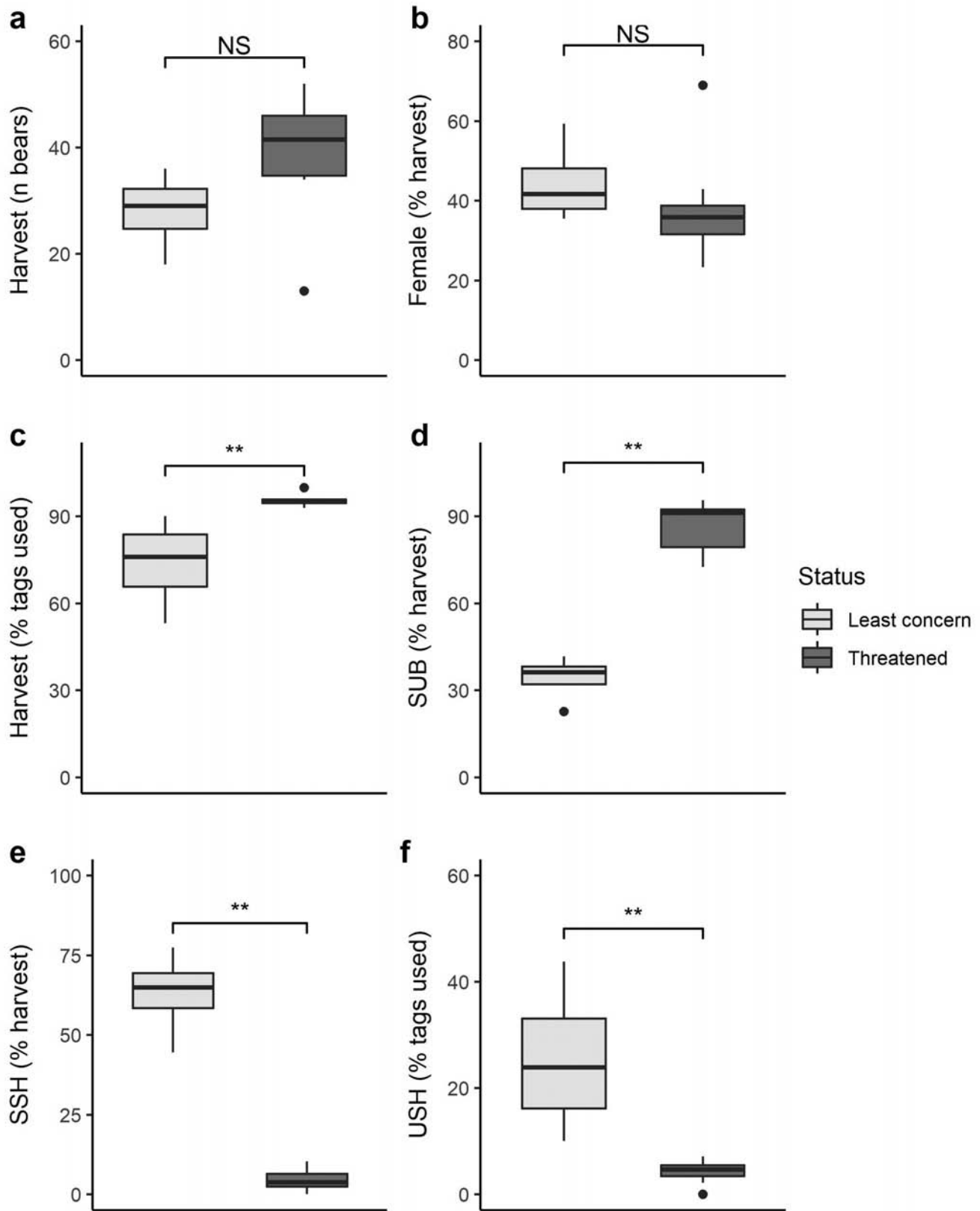


FIG. 2. Number (or percentage) of polar bears harvested per season in the Northern Beaufort Sea subpopulation before (1 July 2004–30 June 2008) and after (1 July 2009–30 June 2016) the change in conservation status. From top left to bottom right: a) number of bears harvested; b) female bears as percentage of harvest; c) bears harvested as percentage of tags claimed; d) percentage of harvest for subsistence (SUB); e) percentage of harvest for sport (successful harvest); and f) percentage of tags claimed for sport (unsuccessful harvest). Probability values indicate significant differences between groups at $\alpha = 0.05$ using the Wilcoxon rank sum test (** = < 0.01, * = < 0.05, NS = not significant) for least concern (n = 4) and threatened (n = 8) groups.

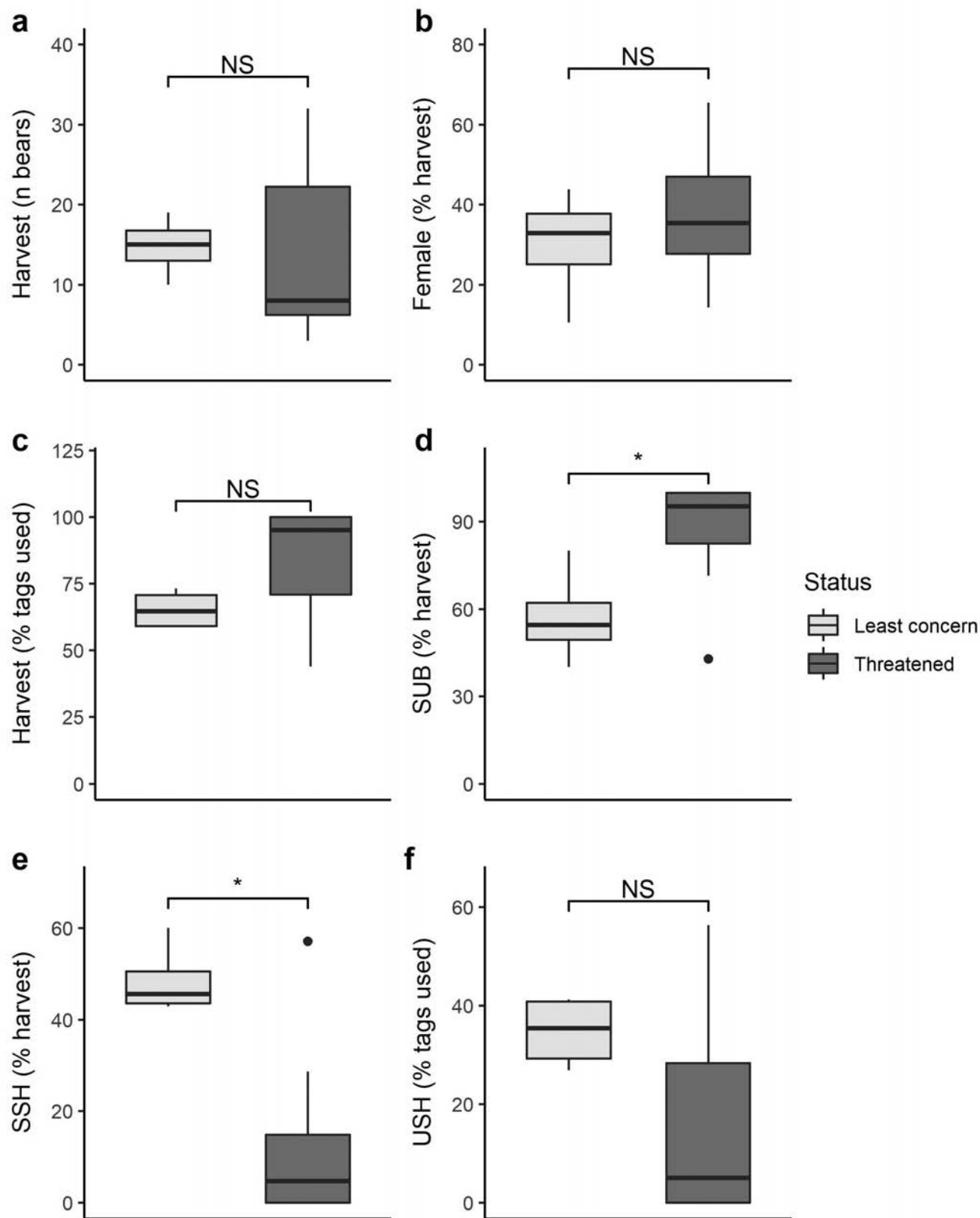


FIG. 3. Number (or percentage) of polar bears harvested per season in the Southern Beaufort Sea subpopulation before (1 July 2004–30 June 2008) and after (1 July 2009–30 June 2016) the change in conservation status. From top left to bottom right: a) number of bears harvested; b) female bears as percentage of harvest; c) bears harvested as percentage of tags claimed; d) percentage of harvest for subsistence (SUB); e) percentage of harvest for sport (successful harvest); and f) percentage of tags claimed for sport (unsuccessful harvest). Probability values indicate significant differences between groups at $\alpha = 0.05$ using the Wilcoxon rank sum test (** = < 0.01 , * = < 0.05 , NS = not significant) for least concern ($n = 4$) and threatened ($n = 8$) groups.

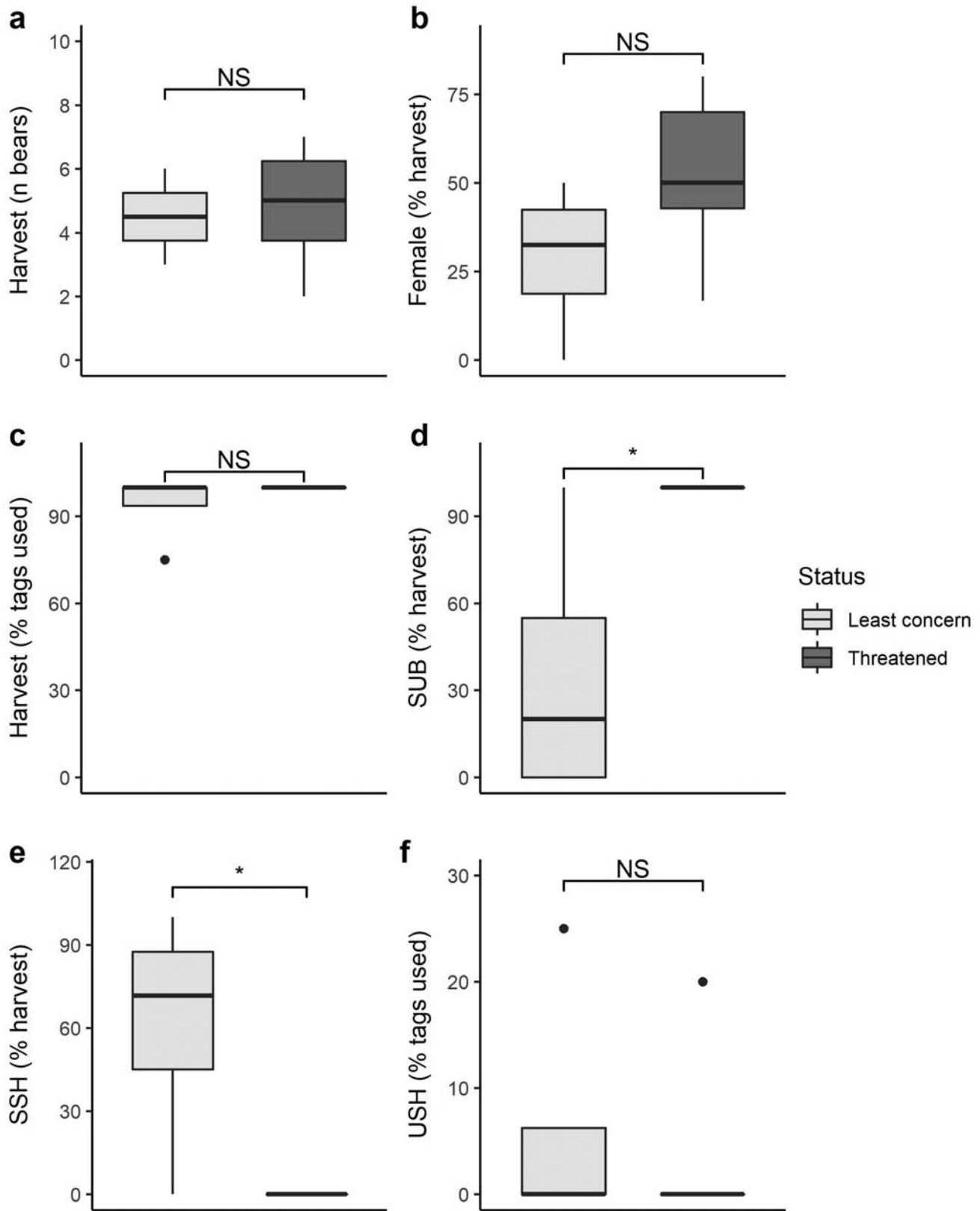


FIG. 4. Number (or percentage) of polar bears harvested per season in the Viscount Melville Sound subpopulation before (1 July 2004–30 June 2008) and after (1 July 2009–30 June 2016) the change in conservation status. From top left to bottom right: a) number of bears harvested; b) female bears as percentage of harvest; c) bears harvested as percentage of tags claimed; d) percentage of harvest for subsistence (SUB); e) percentage of harvest for sport (successful harvest); and f) percentage of tags claimed for sport (unsuccessful harvest). Probability values indicate significant differences between groups at $\alpha = 0.05$ using the Wilcoxon rank sum test (** = < 0.01 , * = < 0.05 , NS = not significant) for least concern ($n = 4$) and threatened ($n = 8$) groups.

that, in each of the three subpopulations, the percentage of guided hunts that made up the overall harvest declined after the US listing was to be expected; this appears to relate directly to the listing and ban on trophies entering the US, which decreased demand on the part of sports hunters. Two possible explanations for the result showing that the percentage of subsistence hunts that made up the overall harvest increased in the same period are that first, polar bear harvesting is culturally important to Inuit, and second, contrary to possible assumptions about the greater economic value of guided hunts, the economics of guided hunting versus subsistence harvesting are actually comparable.

Harvesting a polar bear is an important marker of culture and identity for Inuit. Traditionally, harvesting a polar bear was a valued aspect of manhood, and this continues to be relevant today (Joint Secretariat, 2015). Even if a bear is harvested for a guided hunt, this cultural group understands the Inuit guide to be the real hunter, the one who actually took the bear. It has long been commonplace for people in Ulukhaktok to say that “John got a bear” and not “John’s hunter got a bear.” Indeed, the lead author has often heard elders say that it was great to see young people carrying on their traditions, even if the guides are not that young. The sentiment is that people are continuing to harvest polar bears using dog teams, taking younger helpers with them, and sharing meat within the community. This is why the cultural importance of harvesting polar bears is likely at least a partial explanation for the increase in the number of subsistence harvests over the years after the US listing. And while the motivation for the harvest, both guided and subsistence, might appear to be economic, the data suggest this may be a minor aspect of the practice (Wenzel, 1983). Inuit have continued to harvest polar bears after the US listing despite the loss of income from the guided hunt and uncertainty in the price of pelts.

Guided hunts seem like they generate a lot of cash income, but the hidden costs mean the Inuit guide does not necessarily benefit beyond the initial injection of cash. In 2008, an Inuit guide in Ulukhaktok earned on average approximately Can\$8500 for guiding a polar bear hunt. From this, he had to pay for fuel and supplies to support three people using two snowmobiles for a two-week trip, and all maintenance costs for his dog team before and after the trip. In the end, he might have broken even, but the real economic value was that the Can\$8500 was a large up-front payment. This capital would enable hunters to, for example, purchase a new snowmobile they could use for subsistence well after that particular trip. Guided hunts usually include one or two helpers. In 2008 they earned, on average, Can\$3500 and were required to provide their own snowmobile, sled, and camping supplies. Unlike guided hunts, a subsistence harvest does not require use of a dog team to pursue the bear or the substantial equipment needed to guide multi-day expedition hunts. Instead, hunters now undertake many subsistence harvests as day trips on a snowmobile pulling a sled with the necessary resources for themselves—i.e.,

gas, oil, naphtha (fuel for stove), and food—rather than to support a sport hunter, helper, and dog team. If successful, the hunter also has the option to sell the pelt for some income. This may be more economical in terms of time and expense than a guided hunt, but subsistence harvests do not always capture many of the benefits of guided hunts described by Freeman and Wenzel (2006).

A downside to the collapse of guided hunts is the lost opportunity for training. A guided hunt provides a venue for generating and sharing knowledge about caring for a dog team and harvesting polar bears. Specifically, helpers travel with the guide and learn about navigating on sea ice, running dogs, camping in the winter, and tracking bears. Inuit recognize these training opportunities as important in capacity building in the younger generation in the area of subsistence competency. The young people, in turn, gain respect in the community by providing vital, tangible benefits: harvested, shared country foods (Pearce et al., 2015). Research on the transmission of land skills among Inuit men in Ulukhaktok found that only a few younger-generation respondents had acquired the skills important for harvesting polar bears compared with older respondents, and that they had learned these skills from their grandparents, all of whom had, at some point, guided polar bear sport hunts (Pearce et al., 2011). Further, the younger respondents who had participated in a polar bear harvest and had learned some polar bear harvesting skills acknowledged that they had yet to learn the detailed knowledge about polar bear harvesting held by their elders (e.g., how to track a bear and how to identify a bear’s gender and size from observation) (Pearce et al., 2011). Lacking the economic incentive and capacity that a guided hunt provides, it is likely that fewer younger generation Inuit will participate in polar bear harvesting under the tutelage of an experienced teacher.

Our hypothesis that the number of polar bears harvested as a percentage of tags claimed would increase after the US listing was correct for the NB, but not for the SB or MV subpopulations. Before the US listing, a portion of the tags claimed were from unsuccessful sport hunts, meaning Inuit guides were paid and some of the benefits of the guided hunt were realized, but a bear was not harvested. In the NB after the US listing there was a significant decrease in the percentage of unsuccessful sport hunts as a percentage of tags used and a significant increase in the number of bears harvested as a percentage of tags used. It appears that tags that would have previously been used by guided hunts (successful and unsuccessful) are now being used by subsistence harvests, for which a tag can be re-issued until a successful harvest is achieved. That said, Inuit could have harvested more bears for subsistence during the seasons before the US listing and still have been well under the quota. This finding suggests that Inuit have adapted the polar bear cultural economy from guided hunts to subsistence harvests, from which they are able to generate some income from the sale of the pelt if they choose to. A likely explanation for why this trend was not observed for

the SB relates to reported unsuccessful sport hunts in the 2008–09 ($n = 9$) and 2009–10 ($n = 5$) harvest periods and a change in boundaries as of 2013–14. It is possible that, during these two harvest periods, American hunters paid for and attended the hunt but did not harvest a bear because of the US listing and import ban. Also, the change in boundaries nearly halved the quota for the SB, resulting in fewer bears being harvested. The absence of the trend in the VM was likely because most guided hunts before the listing were successful. It takes a considerable amount of time, resources, and effort to reach the Viscount Melville area from Ulukhaktok and Cambridge Bay, which is possibly why guided hunts persisted until they harvested a bear.

The number of polar bears harvested for subsistence after the US listing and an increase in the price paid for a polar bear pelt suggest that hide price may motivate the subsistence harvest. The highest numbers of polar bears harvested during the study period were in the harvest periods 2010–11 (81), 2011–12 (88 bears), and 2012–13 (70 bears), during which time prices paid for polar bear hides reached record highs. In 2013, the top price paid for a polar bear pelt from Canada was Can\$21,115, nearly three times the top price paid for a hide in 2008 (Can\$7400) (Cooper, 2015). However, the income generated from subsistence harvests through the sale of pelts depends on the size and quality of a pelt and is sensitive to changes in global markets, whereas the income generated from a guided hunt is guaranteed, regardless of whether a polar bear is harvested or the size and quality of the pelt. Other income generated from a guided hunt that is not captured in a subsistence harvest includes tips to the guide and helper, payments for food and accommodation in the community, purchases of local arts and crafts, and other transportation and incidental costs associated with the visiting hunter's travel and stay in the community.

CONCLUSION

In this paper, we have examined how polar bear harvesting strategies changed in response to the rapid decline in guided hunting within the SB, NB, and VM polar bear subpopulations. Although there may be factors other than the US listing that could influence the numbers and composition of the polar bear harvest, the combination of the listing of polar bears as a threatened species and subsequent ban on the importation of polar bear products into the US largely account for the decline in guided hunts. The results show that subsistence harvests have made up for the decline in guided hunts in the three subpopulations after the listing, resulting in no significant change in the number of polar bears harvested or the sex composition of the

harvest. Notably, in the 12 years of harvest data included in this analysis, Inuit have always been within their harvest quotas.

Based on future climate and sea ice models, current science shows that the SB subpopulation is likely to decline, and the NB and VM are likely to remain stable (Joint Secretariat, 2017). The results show that co-management boards are successfully managing harvest levels in the three subpopulations and have been responsive to emerging scientific and traditional knowledge on changes in sea ice and polar bear health, as demonstrated by the change to SB boundaries and reduction of the overall harvest quota in the SB and NB from 112 tags in 2004–05 to 98 tags in 2015–16. Given that the premise of the US listing is that continued warming and loss of sea ice will lead to population declines in polar bears, it is logical that the listing and ensuing ban on the importation of polar bear products into the US would apply to subpopulations deemed sensitive to these changes, rather than to all subpopulations.

The results suggest that Inuit motivations for harvesting polar bears are driven by the cultural importance of the harvest, as well as the opportunity to earn income. A subsistence harvest is an important cultural activity for Inuit, but it does not bring with it a guaranteed income. Nor does it necessarily bring the same training opportunities or secondary cash inputs that a guided hunt can. Before the US listing, the polar bear harvest was a combination of guided and subsistence hunts, which afforded Inuit the benefits of both. The US listing and rapid decline in guided hunts did not affect the number of polar bears harvested, but it did disrupt the Inuit cultural economy.

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