MEMORANDUM

20 August 2020

From: Christian Zimmerman, Center Director, Alaska Science Center

To: FILE

Subject: Responses to Director Reilly Questions - Open-File Report 2020-1087: **Analyses on Subpopulation Abundance and Annual Number of Maternal Dens for the U.S. Fish and Wildlife Service on Polar Bears (*Ursus maritimus*) in the Southern Beaufort Sea, Alaska**

In response to Director Reilly's questions, I have conferred with the authors of the Open-File Report (OFR) to edit the report and respond to questions. The OFR received initial Bureau Approval on 11 July 2020. The revised version was cleared by the Bureau Approving Official on 17 August 2020, but has not yet been released awaiting a decision to proceed from Director Reilly.

The report authors briefed DOI Leadership and others about the OFR findings on 2 July 2020. During that briefing, Dr. Reilly asked a series of questions to the authors about the OFR, and subsequently asked that the report be modified to respond to those questions prior to its public release. Dr Reilly also provided two verbal comments on the report to Geoff Plumlee ~two weeks following the briefing. Based on those comments and questions, the OFR was revised in accordance with USGS Fundamental Science Practices. Those questions, responses, and descriptions of edits are included in Table 1 below.

On 18 August 2020, Alaska Science Center (ASC) received an additional set of questions from Geoff Plumlee [GP], based on his notes from his conversation that day with Director Reilly. Many of those questions were more general in nature concerning how data were gathered, what data were included in the OFR, and how the report is based on empirical data. I conferred with the Authors and provide answers to these questions as follows:

[GP] He mentions that he is hearing about discrepancies between what we are seeing and what Canadians are seeing, and that the State is already questioning what we are doing.
ASC Response: First, it is not clear what concerns have been expressed by the State. We have not distributed the OFR or manuscript to anyone at the State, so it is not clear that they have been able to evaluate the report. Regarding "what the Canadians are seeing"— again, we are not aware of what this question references. The Alaska Science Center has been collaborating with the Canadians (Yukon, Northwest Territory biologists) on abundance studies since 2017, and US and Canadian research findings during those collaborations have been similar given differences in the proportion of the population area that occurs in Alaska (78%) and Canada (22%). In 2017, USGS and Canada partnered on an aerial survey. The US crew observed 13 groups (i.e., 1 or more individuals) of bears and the Canadian crews (2 flight crews) observed 5 groups of bears.

In 2019, we started a multi-year mark-recapture study with our Canadian colleagues. That spring, the US crew observed 62 bears and the Canadian crew observed 38 bears.

[GP] Basic question that he has—his sense is that the denning, mortalities that are assumed are based on models based upon on models, which he is concerned lead to compounding errors that are not discussed in the report.
ASC Response: It is not clear what is meant by "..based on models based upon models…" Perhaps it's based on an interpretation of how the term "model" is used (as noted below)? The derivation of the point estimates for both studies in the Open File Report are empirically based (more below).

[GP] He wants to understand specifically how those links between models occur.
ASC Response: The estimation of terrestrial dens is directly linked to actual den data plus data from prior studies of population abundance, demography, reproductive success, and den substrate preference. The foundation of this analysis is the population estimate of 908 bears (Bromaghin et al. 2015), which is the most recently available Southern Beaufort Sea (SBS) population-wide (sampling effort in both the US and Canada) estimate for the SBS. Other parameters required to develop an estimate of the number of dens (shown in Table 1 of the OFR) include the proportion of adult females with cubs of the year (pAFC0) in the population, the proportion of dens that are successful (pDensuccess), and the proportion of dens that occur on land (pLand) versus sea ice. There may be some confusion over the word "model". It is common in the wildlife literature to use "model" when describing operations to estimate a parameter based on one or more variables, and to describe a process used to generate estimates and levels of uncertainty through simulation. In the OFR, we are using "model" to describe the latter approach— to derive point estimates of parameters based on data from the reference population. The derivation of these point estimates is empirically based.

[GP] He says we need to be as quantitative as possible.
ASC Response: The survival/abundance and den estimation efforts described in the OFR are based on data collected from field studies and those data are publicly available. The analyses were conducted by experienced quantitative ecologists. The methods employed to estimate survival and abundance are widely accepted and have been used for decades. The method used to estimate the number of terrestrial dens is based on the method used in a recent peer-reviewed journal publication (Wilson and Durner 2020), with the only notable difference being that a step was added to the estimation process that allowed for the characterization of uncertainty around the point estimates. This additional step represents an improvement to the process. The OFR was reviewed by 3 statisticians and 2 biologists and no substantive concerns over the approaches used were raised.

[GP] How do know where dens are? We should be able to document where every one is on the map.
ASC Response: The USGS Data Series titled "Catalogue of Polar Bear (Ursus maritimus) Maternal Den Locations in the Beaufort and Chukchi Seas and Nearby Areas, 1910–2018" (Durner et al. 2020) includes information on how dens were detected and locations determined. Detection

methods include direct observation (for example by coastal residents and industry), remote sensing (e.g., FLIR surveys by industry), and the examination of location and sensor data collected from satellite-tagged individuals. The quality (i.e., location error) of den site locations varies among detection methods and with the type of substrate (land or sea ice) on which a den is situated. Land-based dens detected through direct observation generally have the most precise locations, followed by land-based dens detected via FLIR or from satellite-tag location data. Dens detected on sea ice have the largest location errors because ice is a moving substrate.

For the current OFR, and as described in the report, we used the den catalogue— which contains geo-referenced locations of dens— as the basis for quantifying variation in the proportion of dens likely to occur on land versus ice, and within coastal plain management units of interest. We used only dens detected between 2000-2015 using VHF and satellite tag data. We chose to only use dens detected between those years because prior research (Fischbach et al. 2007; Olson et al. 2017) indicates that a switch from primarily ice-based to land-based denning occurred after the year 2000. We chose to use only dens detected using VHF and satellite tags because those detections most closely represent a random sample compared to other detection methods. That selection process yielded 132 dens, 71 of which were on land. All 132 dens were mapped (see Figure 2 of the report). It is not practical to expect to be able to map the locations of all dens in the population, "mark" or count all individuals in the population, etc. — that is why the field of wildlife biology/ecology uses sampling-based analytical approaches. Finally, it is important to reiterate that the objective of the "den estimation" component of the OFR was not to map (predict) locations of where dens were likely to occur. The objective was to estimate the median number (and associated uncertainty) of dens likely to occur in different regions of the coastal plain.

[GP] How do you get at early exit from dens and translate that into cub mortality? There are no carcasses, no censusing reported.

ASC Response: As described in the report, this information comes from the Rode et al. (2018) publication. In that study, females that entered dens were considered reproductively successful if they were observed with cubs within 100 days after den emergence. Females that denned but were observed without cubs within 100 days after emergence were considered unsuccessful. Reproductive success was visually confirmed via radiotracking or random encounter during ongoing mark-recapture efforts (i.e., typical field season activities). Mortality rates for cubs within their first year can be as high as 40–75% (Ramsay and Stirling 1988, Elowe and Dodge 1989, Wiig 1998), and the Rode et al. (2018) study couldn't rule out that the time between denning and subsequent observation could have influenced observations of reproductive outcomes. So, that study also measured the number of days between den emergence and subsequent observation of females to determine if there was a potential effect on the observation of cubs, and no evidence of an effect was found. The study did find that reproductive success was higher for females denning on land than on sea ice, and that mean denning duration for females that produced cubs that survived until observation post-emergence was about 15 days longer than the denning duration of females that were later observed without cubs.

[GP] Tagging- the report says that there were 27 tags supposedly, but in his discussions with the team when he was in Alaska, they said that most of those tags did not work. Should be able to plot tracks of bears from those tags. Can see where they go motionless, therefore where they are denning. Should end up with deterministic assessment of how dens were identified. Not clear in the report. He wants to be much more comfortable with what we are reporting.

ASC Response: We could not find mention of 27 tags in the OFR. Our discussion with Director Reilly when he was in Alaska was about satellite ear tag units we were testing in 2018 and 2019. We did mention that most of those tags failed, but they were not used in the study described in the OFR. ***"Should be able to plot tracks of bears from those tags. Can see where they go motionless, therefore where they are denning."*** *— this is basically what was done in many instances, but with more nuance. As we note in the OFR, we used den data collected during 2001-2015 from radiocollared bears (and included in the USGS Data Series titled "Catalogue of Polar Bear (Ursus maritimus) Maternal Den Locations in the Beaufort and Chukchi Seas and Nearby Areas, 1910–2018" (Durner et al. 2020). The catalog provides details on how dens were detected, which included analyzing location and sensor data from satellite tags and collars. As alluded to in this comment above from the Director, we used location data to determine when bears "localized" and remained sedentary. We used collar sensor data (when available) to confirm that bears had substantially reduced their movements and that temperatures reflected bears were inside dens (when bears are in dens, temperature readings from sensors are substantially higher than ambient temperatures [Olson et al. 2017]).*

Table 1. Author reconciliation of questions from Director Reilly posed during 2 July 2020 briefing, and from comments made subsequently by Director Reilly to Geoff Plumlee [GP] ~two weeks after the July 2 briefing.

Question or Comment	Reconciliation
[GP] There is a lot of "could", "may", "suggest", and similar (what he views as imprecise) wording in the OFR.	We have revised the OFR to ensure that the language used is appropriate to describe the certainty or uncertainty in the analyses and results. Ultimately, decisions about how to use these data falls to US Fish and Wildlife Service and they will base those decisions on the estimates and credible intervals reported. We have been careful to revise language so that we do not unduly influence the interpretation of the results as calculated. In the Discussion section, we deleted the following paragraph because it did not directly address the analyses reported in the OFR. Deleted: ~~Arctic-wide, the extent of sea ice present in September (when sea ice reaches its annual minimum~~

	~~extent) has declined at a rate of -13.4 percent decade^{-1} from 1979–2014 (Serreze and Stroeve, 2015). In the SBS, the period of time that the shallow, biologically productive waters of the continental shelf were mostly covered by ice decreased at a rate of ~17 days decade^{-1} from 1979–2014 (Stern and Laidre 2016). Preserving adequate sea ice availability is key to the long-term persistence of polar bears (Amstrup and others, 2008; Atwood and others, 2016b; U.S. Fish and Wildlife Service, 2017). However, until sea ice loss is stabilized, the management of key activities that have the potential to act as stressors, such as industrial development, may serve to slow population declines and thereby improve the prospects of viable polar bear populations when sea ice habitats reach a new equilibrium. The needs of both the Department of the Interior and industry can be met by maintaining efforts to collect data on polar bear abundance, survival, and denning, along with developing an understanding of factors that are important to denning success and cub survival. Those data are critical for informing assessments of population status (as mandated by the MMPA and ESA) and developing future Incidental Take Regulations (ITR's) that are targeted to ensure the likelihood that regulatory actions do not unnecessarily impact industrial activities.~~
[GP] The methods seem to be assumptions built on assumptions, and there is too much uncertainty in the results.	First, both of the studies are based on real data (see the data releases), not assumptions. There is annual variation in all the data and that is totally normal for a non-laboratory research study on wild animals and particularly for a species that is shifting much of its behavior from sea ice to land. Uncertainty, as reflected in the credible intervals (Bayesian variant of Confidence Intervals) fall within the range of previously reported and reviewed studies as described in the ORF. Quantifying uncertainty is a good thing and we would be criticized by peer-reviewers if we had not calculated those credible

	intervals. By quantifying uncertainty, we have actually improved upon earlier work for estimating the number of dens as that study did not calculate uncertainty. If the levels of uncertainty were smaller, such as plus or minus one, we would receive many questions about how we obtained such a perfect data set (i.e., one that could account for every bear and every den). The levels of uncertainty presented are expected, understood, and within the range of prior estimates from other studies, which make for good independent checks that our modeling efforts were appropriate.
Why was the abundance estimate of 908 used for the denning analyses when the average abundance estimate since 2006 is 565 with a 95% confidence interval of 340-920?	The denning analysis was conducted for the entire Southern Beaufort Sea (SBS) polar bear subpopulation as defined by the IUCN – including the Canadian portion of the SBS subpopulation, whereas, the population estimates reported in this OFR are for only the Alaska portion of the SBS subpopulation. Thus, we used the last population estimate available for the entire SBS subpopulation (2010). Since, our population estimates indicate that the Alaska portion is stable and without change since 2006, we think using the 2010 estimate for the entire SBS subpopulation is appropriate for the denning analyses. In providing requirements for this study, FWS requested all analyses at the SBS subpopulation level (both USA and Canada), but because tags have not been deployed in the Canadian portion of the SBS subpopulation, we were not able to develop population estimates for the entire SBS subpopulation. The denning analyses are an improvement over the previous reported analyses (Wilson and Durner 2020) because this analysis includes estimates of parameter uncertainty in providing the spatial estimates needed by FWS. EDITS to OFR: We realize that some confusion was created in how "population" and "subpopulation" was used throughout the report and have revised the report to clarify. We have revised the report to more consistently use this language throughout the report so it is clear when analyses are referring to the SBS

	subpopulation (as defined by IUCN) and the Alaska Portion of the SBS subpopulation.
How many bears were wearing radiocollars or some other transmitter device during the period of the den abundance study (2000-15)?	During the time period used in the denning analyses, a total of 352 electronic transmitters were deployed among those years. The locations of dens used in the analysis was based on multiple lines of evidence including: electronic tags, dens identified by industry, and dens identified by scientists. All of these dens are included in the Maternal Den Catalogue (Durner et al. 2020). No changes were made in the OFR as the data used for denning is clearly defined in the data releases and Durner et al (2020).
Can denning success data be used to derive abundance estimates?	Not on its own, but it could be used to inform the derivation of abundance estimates. For example, the probability of successful denning could be included as a parameter in a matrix population model. Parameters in these models often include estimates of probabilities of adult females transitioning into different reproductive states (e.g., breeding, non-breeding, re-breeding), conditional on survival, over successive years. If sufficient data are available, probabilities of breeding adult females producing single or twin cub litters, and successfully weaning litters can be integrated into matrix models. Developing a matrix population model for the 2002-16 data would take substantial effort and time. No changes were made to the OFR. This would represent new science and we do not have sufficient information at this time to conduct this study. We will include this as a possibility for future research.
Can we provide information on the probability of successful denning by region?	While we have a pretty large (for polar bears) dataset of den observations, we do not have enough data on den success to determine if the probability of successful denning differs between sea ice, the 1002 Area, Colville to Canning region, and the NPR-A. One of the datasets (USGS Alaska Science Center, Polar Bear Research Program, 2018) we used to estimate den abundance was originally used in a publication by Rode et al (2018) to characterize den phenology (i.e., timing of den entry and emergence) and reproductive

	success from 1985-2013. That study found that reproductive success appeared to be higher for bears that denned on land than for those that denned on sea ice. It did not, however, characterize reproductive success for land-based dens across different management areas. As an example, in the Rode et al. (2018) dataset, 40 dens with sufficient data were detected between 2000-13 (the den abundance study spans 2000-15). Twelve dens occurred on the sea ice, 17 occurred in the Colville to Canning region, and the remaining 11 occurred elsewhere on land. Data on successful denning are difficult to acquire, primarily because you need to re-sight family groups after their emergence from dens in order to confirm cub survival. No changes were made to the OFR. In the requirements provided by FWS, they specifically requested analyses of den distribution and not probability of denning success by region. This is a topic that we are currently pursuing and will continue to research. Any reporting on this, at this time, would be premature and not add information needed by FWS at this time.
For the Colville to Canning region, can we surmise anything about probability of disturbance?	Based on our data, we cannot provide an estimate of the probability of human activities disturbing polar bears while they are in their dens. There are relatively few data points available for an analysis of this type (i.e., known dens, known disturbances, observations of bears in response to the disturbance). In part, this is due to how data on disturbances are reported. The USFWS has management responsibility for polar bears and incidents of disturbance are reported to them (not to the USGS) by Industry. The most current assessment of the potential for human activities to disturb denning bears in Alaska relied on data collected from 1975-2017 (Larson et al. 2020). Briefly, Larson et al. (2020) characterized the behavioral responses of bears during >100 interactions with humans occurring over the denning period (November-April). They found that the most common interaction at dens involved smaller machinery (37%), followed by aircraft (26%), people

	on foot (20%), and large machinery (17%). Approximately 23% of all interactions resulted in no discernible response from bears, 40% elicited a change in posture or vigilance, 29% caused the bear to move away from the den, and 8% resulted in abandonment of a den. The results reported by Larson et al. (2020) are generally consistent with previous research characterizing the risk of disturbance to denning bears. For example, Amstrup (1993) documented the responses, or lack thereof, of denning bears to various types of human activities from 1981-1992. Activities observed near dens included aircraft overflights, small and large vehicle traffic, industrial operations, and seismic survey. Amstrup (1993) found that of the 12 denning bears exposed to human activities, 2 left their dens and re-denned, and 1 left temporarily. An additional 2 bears may have left their dens but that could not be confirmed. Other work has investigated the potential for sound and vibration to disturb denning bears by instrumenting artificial dens to identify distance thresholds over which sound and vibration are detectable. Blix and Lentfer (1992) instrumented artificial dens with sound and vibration (accelerometer) sensors and found that most sounds and vibrations generated from typical industry activities (e.g., seismic survey, drilling activity, vehicle traffic) were undetectable when dens were >100 m from the sound and/or vibration source. McGillivray et al. (2003) used a similar approach and found that the maximum distance vehicle noise was detected above background noise in the dens ranged from <500 m to 2000 m. Of the personnel transport vehicles regularly used, large tracked vehicles produced the loudest noises, while smaller tracked vehicles and pick-up trucks produced the quietest. Helicopter noise was well above background levels in the den until helicopters were at least 1000 m from the den.

	Collectively, these studies suggest Industry's best practice of maintaining a 1-mile buffer zone around dens effectively minimizes the risk of disturbance. No changes were made to the OFR since this question goes beyond the requirements provided by FWS. Our continued work with industry on this topic is ongoing and will be reported in the future.

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