Alaskan Oilfield Development and Glaucous Gulls

Dear Editor:

In their recent paper, Noel et al. (2006) evaluated data about glaucous gull (*Larus hyperboreus*) numbers on the Arctic Coastal Plain to determine whether they have increased over time and whether apparent changes were related to anthropogenic food inputs into the environment related to oilfield development. Such information is important because an increasing glaucous gull population on the Arctic Coastal Plain may predispose ground-nesting avian species to increased predation levels. To "test" this idea, the authors evaluated several U.S. Fish and Wildlife Service (USFWS) aerial survey data sets collected during the breeding season on the Arctic Coastal Plain, analyzed a long-term aerial survey data set they collected on the Central Beaufort Sea (CBS) lagoons adjacent to the Prudhoe Bay Oilfield, and analyzed variation through time in the number of glaucous gull nests on barrier islands near the oilfields. The authors either directly or indirectly conclude that the Prudhoe Bay oilfields have not led to changes in glaucous gull numbers on the Arctic Coastal Plain.

We disagree with these conclusions for several reasons. First, the authors failed to develop a priori hypotheses (and predictions) related to study objectives (which were unstated). Such critical thinking beforehand requires selection of appropriate explanatory variables that are relevant to the question(s), preventing the sort of exploratory analyses used by the authors, which can lead to spurious correlations between parameters and response variables (Burnham and Anderson, 2002). In contrast, confirmatory analyses that evaluate a priori hypotheses, using explanatory variables that are biologically meaningful (relevant to the proposed hypotheses) and have predicted effects, increase the scope and validity of inferences. In this study, for example, the authors used data obtained from a long-term aerial survey of long-tailed ducks (*Clangula hyemalis*) to evaluate glaucous gull numbers (see Johnson et al., 2005). This retrospective approach resulted in inclusion of extraneous predictor variables that the authors tried to eliminate by conducting an initial correlation analysis "to increase the power of the regression and ANCOVA analyses" (p. 69). This type of data dredging violates statistical protocol and results in nonsensical, often "significant" results that have little biological meaning relative to proposed hypotheses. For example, the authors included wave height as an explanatory variable in models of gull abundance even though it has little biological relevance. Overall, we feel the authors shed little light on the actual factors influencing glaucous gull distribution and abundance.

Second, we believe the use of glaucous gull nests as a response variable in their analyses is a poor choice because of the highly variable and imprecise counts of nests. For example, island nest counts suffered from differences in survey methods (aerial versus ground counts), variation in the timing of the surveys (early June to late July), and differences in search effort (from one-time visits to repeated counts throughout the nesting season). Although the authors acknowledge that aerial survey data may be misleading, they decided to compare aerial survey counts to ground counts anyway, and on the basis of their analysis detected a significant difference in gull nests between the 1970–74 and 1975–85 periods. Why the authors presented these results, when they are admittedly confounded, is unclear.

In addition, there is potential for large intra- and interannual variation in both gull numbers and nest counts, which makes it difficult to detect "population trends." Unpredictable events, such as the major storm in the CBS on 10 August 2000, likely led to dramatic declines in gull nests on barrier islands (2000: 66 nests, 2001: 43 nests, 2002: 12 nests; Flint et al., 2003:93). Reduction in number of nests was likely "real" because survey effort was relatively high and methods were standardized within and among years. Given the large inherent variation in numbers of nests even using standardized methods, one is left to question the validity of conducting long-term trend analyses of data using methodology that is largely unstandardized (i.e., for effort among and within habitats and among and within years).

Third, the authors' indicators of human activity and disturbance are problematic. Instantaneous observations (point estimates in space and time) of human activity are not likely to reflect oilfield disturbance adequately or accurately, particularly in a cumulative sense. Collecting such information would be like noting the presence of boats while counting loons on lake transects, without taking into account the number of cabins, which may be indicative of a much higher level of disturbance, but are not detected (or counted) during the surveys. Thus, the authors' conclusion that "human activity for individual transects was not significantly correlated with glaucous gull density" (p. 72) may not be particularly meaningful in the overall context of quantifying disturbance. The authors apparently attempted to correct for this by summing levels of human activity (designated as "D" in Table 1), or by categorizing a given survey into one with or without disturbance ("IDIST"). In our opinion, this approach does little to resolve the problem.

Fourth, the authors incorrectly plotted the distribution of gulls across the Arctic Coast (Fig. 1, p. 67) by not including gulls observed in segments 190–214 (see Fig. 2 and Tables 1 and 2 in Dau and Anderson, 2001, 2002) in their totals for segments 19 and 20 (i.e., transects adjacent to the Prudhoe Bay oilfields). These segments were counted and reported independently in the unpublished manuscripts so that more detailed analyses could be done near the oilfields. Had Noel et al. included the barrier island data in their treatment, segments 19 and 20 would account for roughly 9% and 4%, respectively, of the total number of gulls observed along the coast. There is clearly a noteworthy spike in gull numbers adjacent to the oilfield that was somehow missed or not included. In fact, when gull numbers for segments 19 and 20 are compared to those for adjacent transects (13–18, and 21–24), gull numbers along the oilfield transects are even

higher than those on transects adjacent to coastal villages. Thus, the authors' assertion that gull numbers are lower at Prudhoe Bay compared to villages on the Arctic Coastal Plain does not appear to be correct (or was misinterpreted).

Fifth, we believe the authors incorrectly assumed that their use of aerial surveys of the CBS lagoons would allow adequate evaluation of the potential effects of oilfield development on glaucous gull distribution and abundance. Aerial survey transects included in their study were preferentially located in coastal lagoons so they could sample molting long-tailed ducks adequately over time. This sampling strategy was almost certainly insufficient and inappropriate to address questions related to glaucous gull distribution and abundance. The small numbers of gulls encountered during their surveys (generally less than 300, Table 2) compared to numbers of gulls counted across the Arctic Coast during USFWS surveys (2703 to 7031, Dau and Larned, 2005; 8762 to 18529, Larned et al., 2005) suggest that the authors in fact had a sample that was both inadequate (a small, unknown fraction of the target population) and more importantly, unrepresentative (i.e., biased) from which to infer a cause-and-effect relationship relative to oilfield development. Thus, we believe the unstated and primary assumption that the population of gulls sampled by their aerial surveys reflects the "true" population was violated.

Sixth, we take issue with the statement that gulls breeding on the CBS are "not typical of a growing gull population" and thus are doing poorly (the opposite of what might be predicted if oilfield development were providing additional anthropogenic food inputs). The authors base this statement on a comparison of active nests and average clutch size of gull nests on the CBS and the Yukon-Kuskokwim Delta. We feel such a comparison at best is meaningless, and at worst is misleading given the potential for differences in the various factors, both ultimate (e.g., female endogenous reserves, female age, female experience) and proximate (e.g., pre-laying food availability, predator abundance, spring phenology), that control nest initiation and clutch size of gulls nesting in these two regions. In addition, the CBS and Yukon-Kuskokwim studies used different methodology, and the reliability of the counts in both studies is likely to be poor (see Bowman et al., 2004). Even if such a comparison were valid, the limited nature of the CBS data (available only from 1999 to 2001) severely restricts the ability to infer cause-and-effect relationships related to oilfield development.

Seventh, we disagree with the authors when they state that the strong positive correlation between the number of glaucous gull nests and number of common eider (*Somateria mollissima v-nigrum*) and snow goose (*Chen caerulescens caerulescens*) nests indicates that some common environmental variable, and not refuse from oilfield development, may be regulating population size in these species (Fig. 7, p. 76). Ignoring for a moment that counts of nests are likely unreliable (see above), it seems plausible that the authors were simply tracking some factor(s) (e.g., variation in predator numbers) influencing nesting success, and not population size per se. This seems probable given that the authors were

using number of active nests and not total nests of each species. We also believe that it is highly unlikely that some unknown, but common environmental variable influences population sizes of all three species similarly. Ultimate factors influencing nesting decisions and clutch size almost certainly vary among species. In addition, proximate factors probably also differ among species, especially considering that (1) gulls nest substantially earlier than either eiders or geese, (2) nest initiation by eiders and possibly snow geese is proximately determined by the availability of open water around islands, whereas gulls initiate nesting when islands are still ice-choked, and (3) gulls depredate eider and snow goose nests. Thus, it seems improbable that a single causative agent (including oil development) is regulating the numbers of all three species.

Finally, we think the authors' claim—that they can evaluate the influence of disturbance on gulls by comparing the number of gulls counted during aerial surveys in a Reference (i.e., control) Area and an Industrial (i.e., treatment) Area within the CBS (Table 2, p. 71)—to be false (see Fischer et al., 2002; Fischer and Larned, 2004). The authors failed to point out that because of increased levels of industry- and research-related disturbance in their Reference Area during the late 1990s and early 2000s, their Reference Area was not a "true" experimental control. Interestingly, this very point was noted in a companion paper that evaluated changes in long-tailed duck numbers (Johnson et al., 2005). These issues severely limit the data that are useable for their analysis, to only those data collected before 1999. A review of the data in Table 2 indicates that the remaining data (i.e., when information from both Industrial and Reference areas was available) is limited to 1978–81, 1984, and 1989–91. Within these years, aerial survey data were frequently restricted to only one or two survey months (not all three) and often did not include complete surveys in both the Reference and Industrial areas at the same time (lacks temporal overlap). Therefore, we believe that the initial analysis was likely flawed, and further, that available data lack the resolution necessary to evaluate changes in glaucous gull numbers through time.

An alternative to the standard alpha-based parametric procedures, which we feel is more appropriate, would be to evaluate gull numbers (or density, controlling for effort) as a function of biologically meaningful explanatory variables within a suite of candidate models using an information theoretic approach (Burnham and Anderson, 2002). The suite of models would include a global model (i.e., all biologically relevant main effects, covariates, and interactions decided on a priori), as well as a null model, with the "best" model having the lowest AIC value (or AIC_c; corrected for small sample size) and highest model weight (w_i), reflecting the model's probability of being the best-fitting model of those considered (Burnham and Anderson, 2002). Such an approach may be more appropriate for exploratory analysis of "messy" data given that gull numbers tend to be highly variable, both spatially and temporally, and because this procedure incorporates a "penalty" for overfitting models.

To be clear, we are not advocating the view that glaucous gull numbers or nests have increased or remained stable during the period studied, nor are we suggesting that oilfield development has affected important population parameters of glaucous gulls. Rather, our primary goal of this letter was to suggest that the data used by Noel et al. to assess potential effects of oilfield development on glaucous gull distribution and abundance appear to lack sufficient replication (within and among years and across areas) and resolution (both spatial and temporal), and at best, the statistical procedures employed led to largely spurious results with limited inference to the target population.

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Sincerely,

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Dear Editor:

Lanctot and Gleason offer critical comments on our paper about glaucous gull (*Larus hyperboreus*) distribution and abundance along the central Beaufort Sea coast of Alaska. We thank Lanctot and Gleason for considering our paper, and we respond to their various points by clarifying the data and rationale for analyses presented in our paper.

Point 1. The stated objective of our paper was to "review existing data for trends in glaucous gull numbers on Alaska's Arctic Coastal Plain (ACP)" and to "analyze two historical datasets from the Prudhoe Bay region to evaluate the influence of this industrial development on glaucous gulls" (p. 66). Contrary to the assertion by Lanctot and Gleason, we did not evaluate relationships between gull numbers and the availability of anthropogenic food. Nor did we conclude, either directly or indirectly, "that the Prudhoe Bay oilfields have not led to changes in glaucous gull numbers on the ACP."

Characterization of our analyses as "data dredging" is incorrect. The categorical structure of the analytical design was dictated by the design of the surveys used to collect the data. The exploratory analysis was restricted to covariates that could be used to explain the extent of sighting and identification of birds in coastal aerial monitoring surveys (Johnson, 1990; Johnson and Gazey, 1992; Johnson et al., 2005). For example, wave height and the associated "white-caps" directly influence glaucous gull detectability and observer efficiency. Such exploratory analysis of covariates does not violate statistical protocol; many texts (e.g., Milliken and Johnson, 2002) recommend this procedure.

Data concerning glaucous gull numbers in coastal and inland habitats of the ACP were used to establish a context for the presentation of data collected in the Prudhoe Bay region. Similarly, glaucous gull nest data from the Yukon-Kuskokwim Delta were used to make comparisons with Beaufort Sea data.