BRACHYRAMPHUS MURRELET TRENDS AND THE PRINCE WILLIAM SOUND, ALASKA, SURVEYS: A RESPONSE TO HODGES AND KIRCHHOFF

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SUMMARY

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As part of the Symposium on Population Status and Trends of Kittlitz's Murrelet (*Brachyramphus brevirostris*; *Marine Ornithology* 39) we analyzed survey data in Prince William Sound (PWS), Alaska, between 1989 and 2007, and concluded there has been a per annum decline in Kittlitz's Murrelets of 5% (identified birds only) to 13% (modeled with unidentified murrelets incorporated) (Kuletz *et al*. 2011a). In a recent Comment, Hodges & Kirchhoff (2012) argued that there is no evidence of a decline in PWS; rather, our results were due to suspected misidentification of murrelet species and use of anomalously high estimates in some years. Here we review their arguments and conclude that there is no justification for their assumptions, and further, that there remains strong evidence for a decline in Kittlitz's Murrelets in PWS.

INTRODUCTION

A recent Comment (Hodges and Kirchhoff 2012) disputes survey results and our analyses of population trend for Kittlitz's Murrelet *Brachyramphus brevirostris* in Prince William Sound (PWS), Alaska (Kuletz *et al*. 2011a). Hodges and Kirchhoff conclude that evidence of a decline in Kittlitz's Murrelet (KIMU) in PWS between 1989 and 2007 is erroneous, primarily due to species misidentification. Here we explain why the arguments proposed by Hodges and Kirchhoff are unsupported.

As background, the PWS sound-wide surveys constitute the longest running, consistent time series for marine birds in Alaska. Following the *Exxon Valdez* oil spill, the US Fish and Wildlife Service (USFWS) conducted 12 sound-wide surveys from 1989 to 2012 during July. Kuletz *et al*. (2011a) was written when 10 survey results were available spanning 1989–2007; for some comparisons, it included a 1972 FWS population estimate. The USFWS surveys were conducted from three 8 m vessels, each with crews of three people. Since 1989, the same 325–350 randomly selected transects in shoreline and pelagic strata have been surveyed over a 3-week period for a total of about 1 800 km per year. These surveys have been used to assess population trends and marine bird communities following the *Exxon Valdez* oil spill (Agler *et al* 1998, 1999; Irons *et al*. 2000; Kendall and Agler 1998; Lance *et al*. 2001).

The main premises in Hodges and Kirchhoff are as follows: (1) Because of the higher proportion of Marbled Murrelets (*B. marmoratus*; MAMU) in PWS, even a small misidentification rate would result in disproportionate inflation of KIMU estimates; (2) KIMU recorded in areas "outside their core habitat" must have been MAMU that were misidentified as KIMU; (3) large numbers of unidentified *Brachyramphus* murrelets in some years in combination with (their claim of) misidentification of species resulted in unusually high population estimates of KIMU in those early years of the data set; (4) if two anomalous years are omitted and two years from a separate survey are added, there is no evidence of a population decline.

While we have always recognized the issues of unidentified birds and anomalous years, we do not agree with the logic or conclusions reached in Hodges and Kirchhoff. Indeed, the model used in Kuletz *et al*. (2011a) to estimate population trends in PWS was developed to deal with the low proportion of identified murrelets in some years as well as unusually high or low bird counts in some years, and did not rely on a simple apportionment of unidentified birds based on the identified birds.

THE DECLINE IN TOTAL BRACHYRAMPHUS MURRELETS

Before we consider the identification issue, we note that Hodges and Kirchhoff did not discuss trends of *Brachyramphus* murrelets (see Kuletz *et al*. 2011a), which include all KIMU, MAMU and unidentified murrelets combined. It is generally agreed that observers can distinguish birds of this genus from other seabird species. Between 1989 and 2007 the PWS data reveal an undisputed decline in the total number of *Brachyramphus* murrelets from ~110 000 to ~35 000 individuals, a decline of approximately 68%, and omitting or retaining the anomalous 1993 year does not alter this decline (Kuletz *et al*. 2011a). A similar trend in KIMU and MAMU populations in PWS (Kuletz *et al*. 2011a) would not be unexpected, given these are congeneric species with similar body size and large overlap in diet and distribution.

If the decline in *Brachyramphus* murrelets was due solely to decreases in the MAMU population while KIMU numbers stayed fairly constant (as proposed by Hodges and Kirchhoff), then the proportion of *Brachyramphus* murrelets that were KIMU would have changed from a 10-year average of ~7% to 30% over that time period, and MAMU and KIMU population sizes should have begun to converge.

Instead, the KIMU proportion, which averaged ~10% in the early years (1989–1993) was ~7% in 2005 and 2007, and, more recently (2010 and 2012), KIMU constituted only 3%–4% of identified *Brachyramphus* (Cushing *et al*. 2012); these facts are irreconcilable with Hodges and Kirchhoff's conclusion that KIMU populations have remained unchanged since 1989. Under the Hodges and Kirchhoff scenario, one would also expect the ratio of MAMU to KIMU to diminish as a function of year, as total Brachyramphus declined, but there is no relationship between the MAMU:KIMU ratio and year ($r^2 = 0.12$; $P = 0.35$). Finally, Hodges and Kirchhoff do not mention the 1972 data, which when included indicates a decline in total *Brachyramphus* murrelets (1972–2007) of ~80% and a per annum decline of 18% for KIMU (Kuletz *et al*. 2011a). We did include the 1972 survey data in some model runs because, as in the 1989–2007 surveys, transects were randomly selected, were sound-wide, and were not selected with respect to KIMU density or habitat.

CHANGES IN MURRELET DISTRIBUTION ARE NOT EVIDENCE FOR MISIDENTIFICATION

A key argument made by Hodges and Kirchhoff is that murrelets recorded as KIMU must have been misidentified during years when large numbers were found outside their "core area" of northern PWS fjords. This is a circular argument based on what is "typical" murrelet habitat; the assertion is that murrelets observed in open waters of central PWS, or in the eastern and southern glacially influenced fjords, did not belong there; therefore, they must have been misidentified. The number of birds allocated to the "Unidentified *Brachyramphus*" category was high in some years, but this does not mean that birds identified to species were incorrect; rather, fewer birds were identified to species overall.

In Hodges and Kirchhoff Fig. 2, the authors alter the distribution maps we presented in Kuletz *et al*. (2011a, Fig. 3) and show only those KIMU observations that they assert were recorded "outside their core areas." Although this misrepresents our distribution data, it does illustrate that, in every year, KIMU did in fact occur outside their "core areas," albeit in much higher numbers in 1989 and 1993. Four of the co-authors of Kuletz *et al*. (2011a) have worked in PWS over the course of three decades and have observed KIMU in these "non-core" areas while working on other projects. One area designated by Hodges and Kirchhoff as outside KIMU habitat is the southeast portion of PWS, yet a fisheries bycatch study by the National Oceanographic and Atmospheric Administration recorded KIMU taken by gillnets (literally, birds in the hand) in this area during 1990 and 1991 (Day *et al*. 1999). During the 2010 and 2012 sound-wide surveys, when 96% of murrelets were identified to species, relatively high densities of KIMU were found near Knight Island and in the southeast corner of PWS (Cushing *et al*. 2012), similar to what was observed in 1989 and 1993.

OTHER EXPLANATIONS FOR CHANGES IN MURRELET DISTRIBUTION

There are several likely explanations for high numbers of KIMU in pelagic and southern waters of PWS in 1989 and 1993. First, the *Exxon Valdez* oil spill occurred in March of 1989. Hodges and Kirchhoff dismiss suggestions that the oil spill and associated vessel traffic affected KIMU distribution in 1989 (Kuletz *et al*. 2011a), because KIMU breeding areas were not in the main spill zone. However, unusually high vessel and air traffic were pervasive in PWS that year. More importantly, most of the spill-related murrelet mortality and consequent disruption to breeding pairs occurred in April south of PWS and before murrelets returned to their breeding areas (Kuletz 1996). Second, in 1989 there was also evidence of an ocean regime shift in the North Pacific (Hare and Mantua 2000), which could have affected seabird distributions in the Gulf of Alaska (GOA). Third, in 1993 all *Brachyramphus* murrelets (not just KIMU) had anomalously large populations in PWS, as did common murres (*Uria aalge*; McKnight *et al*. 2008). These "population explosions" coincided with a large 1993 ENSO in the North Pacific, which created anomalously warm temperatures in the GOA while PWS remained relatively cool (Piatt and Van Pelt 1997, Pearson *et al*. 1999). The influx of alcids into PWS in 1993 could have arguably been in response to broad-scale environmental conditions in the northern GOA.

Distribution patterns considered atypical for *Brachyramphus* murrelets have been observed in other regions, including Glacier Bay (Piatt *et al*. 2011), southeast Alaska (Kissling *et al*. 2007, 2011) and Cook Inlet (Kuletz *et al*. 2011b). In all of these regions, KIMU may be found in waters well away from tidewater glaciers and glaciated fjords, but still generally in waters influenced by (and downstream of) glacial river outflows. Glacial-marine waters exist in virtually all corners of PWS, including outside of the presumed core area assigned by Hodges and Kirchhoff. Recently, Allyn (2012) documented "density explosions" in specific areas of PWS that historically did not have many KIMU. For all of the reasons listed above, selecting data based on preconceived notions of where certain species should be found has the potential to introduce bias into the analysis of trends, particularly given the rapid changes occurring in the North Pacific.

SOUND-WIDE VS. INTENSIVE KITTLITZ'S MURRELET SURVEYS

Hodges and Kirchhoff cite the Kuletz *et al*. (2003) intensive KIMU surveys in 2001 as additional evidence of where KIMU should be found. However, the 17 fjords surveyed for this (and the following 2009) project were pre-selected because they consistently had observations of KIMU or were adjacent fjords with similar habitat, and the intensive survey did not include central (offshore) or eastern PWS. Because of the different objectives and study designs, Kuletz *et al*. (2011a) considered the two types of surveys to be independent estimates of population size, and not appropriate for a combined statistical analysis. Nonetheless, Hodges and Kirchhoff used the 2001 and 2009 intensive surveys to bolster their case for a stable KIMU population (Hodges and Kirchhoff, Fig. 3) by applying a correction factor to the 2001 and 2009 data to estimate counts in "non-core" areas and thereby deriving a sound-wide population estimate for KIMU those two years. This may or may not be appropriate during a normal year, but would be misleading if >12% of KIMU occured outside core areas.

Once Hodges and Kirchhoff have manipulated the 2001 and 2009 intensive surveys to combine them with the sound-wide surveys, and omitted the 1989 and 1993 data (claiming high misidentification rates because of KIMU outside core areas), they finally arrive at their non-significant exponential trend. Kuletz *et al*. (2011a) discussed the possibility that KIMU populations had stabilized at a lower level during the 2000s, based on similar results from the last sound-wide (2005, 2007) and intensive (2001, 2009) surveys, but argued that additional surveys would be needed to verify the trend, particularly with only two sample points for the intensive surveys.

CONCLUSION

The USFWS sound-wide surveys span a 23-year period and represent over 20 000 km of survey effort, approaching the suggested 15 surveys to detect a 5% annual decline (Kissling *et al*. 2007). We emphasize that *Brachyramphus* murrelets in PWS declined by about 68% between 1989 and 2007 with no concurrent increase in the proportion of KIMU among identified murrelets. While acknowledging issues of species identification and years with anomalous counts, we think that the data provide compelling evidence for a major decline of KIMU in PWS that may have stabilized during the 2000s. Unfortunately, since Kuletz *et al*. (2011a) was published, surveys in 2010 and 2012 indicate further decline (Cushing *et al*. 2012). We encourage interested parties to read the published, peer-reviewed articles cited by Hodges and Kirchhoff.

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