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Testing the feasibility and effectiveness of a fall Steller's eider molt survey in southwest Alaska

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ABSTRACT Since 1992, U.S. Fish and Wildlife Service, Migratory Bird Management has flown a spring aerial survey in southwest Alaska to monitor trends in the Pacific population of Steller's eiders and improve understanding of habitat use and timing of spring migration. Due to constraints with the traditional spring survey, we sought to test the feasibility of an alternative monitoring approach using photography of fall molting flocks along the Alaska Peninsula. Our goal was to determine whether different survey timing and methods could provide a more precise and cost effective annual index to track the Pacific Steller's eider population. We reasoned that a fall photographic survey could be more effective based on: 1) better timing (molt being easier to target than spring staging, as flocks are sedentary), improved flock estimation (better precision using photographs than ocular estimates alone), and weather (early fall typically has longer periods of favorable weather). From 27-30 August 2012, we conducted photographic surveys of molting Steller's eiders at major lagoons along the Alaska Peninsula (King Salmon to Izembek NWR), with replicate surveys at the Seal Islands and at Izembek and Nelson lagoons. Combined counts for the Alaska Peninsula totaled 50,404 birds, with an average of 9,764 birds at Seal Islands, 35,549 birds at Nelson lagoon, 4,418 birds at Izembek lagoon, and 943 birds scattered between Port Moller (602) and Port Heiden (341). Results from 2012 provided defensible population estimates and repeatable methodology. We discuss the feasibility of photographic methods, compare current and historic Steller's eider population surveys, and outline benefits and constraints of a fall survey as an index to the Pacific population.

KEY WORDS Alaska, Steller's eider, population index, photographic survey, molt, *Polysticta stelleri*

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Since 1992, the U.S. Fish and Wildlife Service's (USFWS) Migratory Bird Management Program has flown spring aerial surveys in southwest Alaska to monitor trends in the Pacific population of Steller's eiders

(*Polysticta stelleri*) and improve understanding of habitat use and timing of spring migration (Larned 1992-2012). Although the traditional spring survey (hereafter "SW Spring") has been the primary index for Steller's eiders in the Pacific population for 20 years, several sources of potential error limit inference of the data. This, combined with high costs and difficult flying conditions, led us to investigate different methods, including the feasibility of an alternative, fall aerial photo survey of molting Steller's eiders along the Alaska Peninsula.

Our motivation to explore an alternative fall molting survey was guided by three major concerns associated with the "SW Spring" survey; 1) timing, 2) flock estimation bias, and 3) weather. For a consistent annual estimate of the Pacific Steller's eider population, the target component of the birds must be surveyed when all or most of the population is within a defined area. In the "SW Spring" survey, birds were counted during staging between Bechevin Bay and Nunivak Island (Larned 1992-2012). Optimal timing was determined using real-time satellite imagery of sea ice and weather forecasts, sometimes combined with satellite locations from satellite implanted Steller's eiders (Larned 2012). In the early years of the traditional survey (1992-1999), within-year survey replicates were conducted to capture variation in location and timing of migratory flocks. However, more recent monetary and logistical constraints have curbed that strategy, resulting in a single, annual survey. Given the transitory nature of the birds during spring staging, the current "SW Spring" survey may not capture the majority of the target population on any single annual survey. In contrast, a fall survey would occur when most of the population is sedentary (Flint et al. 2000), and appropriate survey timing would be easier to achieve during the month-long (flightless) molt period.

A consistent annual population index would also benefit from minimization of flock estimation bias (often inherent in ocular surveys), and safe, logistically favorable survey conditions. Flock estimation bias can be more easily quantified with a combination of ocular estimates and aerial photography. Aerial photography has been successfully employed in other migratory bird surveys of large flocks (e.g., Larned 2012; wintering spectacled eiders; *Somateria fischeri*). However, attempts at such aerial photography during previous "SW Spring" surveys were of limited utility, due to synchronous diving behavior and bird movement during that time (Larned pers. comm.). Observers found that flocks tended to flush, split, and join with other flocks more frequently during the spring (possibly as a consequence of migration), resulting in more frequent under- or double-counting (W. Larned pers. comm.). In contrast, fall birds are mostly flightless, or at least more reluctant to fly, resulting in an opportunity for more complete flock photographs (i.e., all birds on the surface) and a likely reduction in double- or under-counting.

Spring weather over the large study area of the traditional "SW spring" survey (all of southwest Alaska) is generally less predictable and more complicated than fall patterns over the smaller Alaska Peninsula area. Less predictable spring weather can compromise safety and visibility; minimizing opportunities to fly during optimal times when the target population is available for observation. Additionally, strong winds and storms sometimes trigger mass migrations in spring, again resulting in an unknown portion of the target population unavailable for observation. Annual variation in ice conditions further contribute to the variability, as ice patterns can also affect migration timing. Finally, although Steller's eiders typically prefer nearshore staging areas, surveys during the spring can require flights well off-shore (e.g., birds have been documented crossing Bristol Bay; W. Larned pers. comm.). This is a place and season where rescue efforts could be extremely difficult. In contrast, early fall typically has longer periods of favorable weather and more predictable storm systems. Moreover, the landscape is still open (pre-freeze-up) and major molting flocks along the Alaska Peninsula are in protected lagoons, well within gliding distance of shore.

Objectives

1) Evaluate photographic methodology including camera/lens combinations, shooting positions, altitudes, and flight patterns.
2) Determine the most appropriate survey area for a fall molting survey in southwest Alaska, focusing on estuaries with known high molting densities.
3) Evaluate daily environmental conditions (primarily, effects of tide on bird distribution) to determine best survey timing.
4) Determine the use of photographic and ocular techniques to measure survey biases.
5) Compare and/or contrast the photographic survey and other Steller's eider surveys.
6) Estimate numbers of molting Steller's eiders in Nelson and Izembek lagoons, as well as other areas with large molting aggregations.

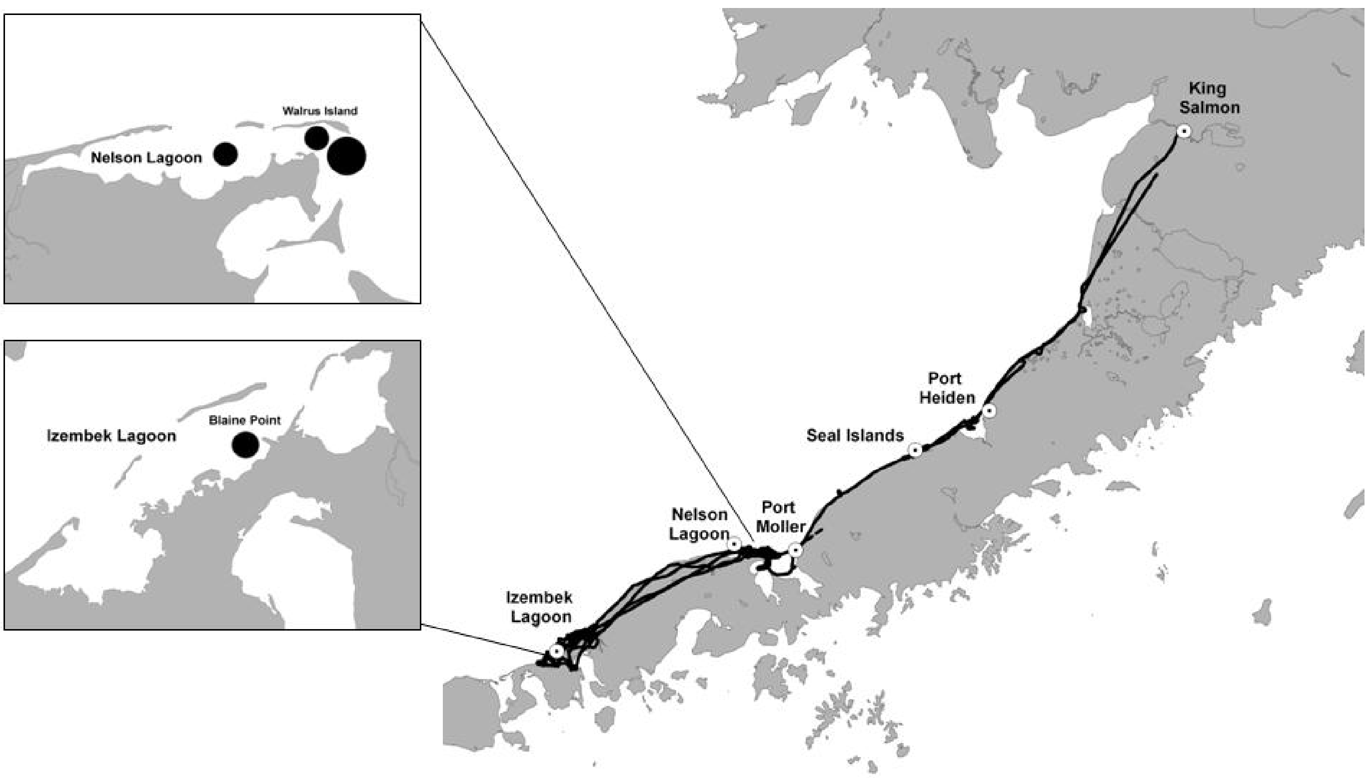

Figure 1. Track of survey flights (27-30 Aug. 2012) and lagoons in which molting Steller's eiders were photographed along the Alaska Peninsula. Inset boxes show areas of primary aggregations (black dots) observed at Izembek and Nelson lagoons.

STUDY AREA

Our study area encompassed major lagoons along the north side of the Alaska Peninsula (Fig. 1), with focused photographic surveys of large molt flocks in Port Heiden, Seal Islands, Port Moller, and Nelson and Izembek lagoons (Fig. 1). These lagoons along the north side of the Alaska Peninsula comprise a series of shallow estuaries protected by long, narrow, and partially vegetated barrier islands or spits, and are areas which have historically been selected by Steller's eiders for spring and fall staging and molt (Dau et al. 2000).

METHODS

Aerial Survey

Our survey crew consisted of pilot (Heather Wilson), right front observer (Bill Larned), and left rear photographer (Tim Bowman). We used a Quest Kodiak-100 aircraft on Wipline 7000 amphibious floats to conduct all survey flights. We flew all photographic surveys with ~10° of flaps, at an average altitude of 215 m (700 ft; range 400-800 ft) above ground level. Photographs were taken obliquely through the second to last window on the pilot (port) side of the aircraft (Fig. 2). We used a Canon 5D Mark II SLR® digital still camera (21 megapixel resolution) with an image-stabilizing lens (70-200 mm f4) and standard camera settings (shutter priority, photographing between 1/1000 and 1/1600, ISO 800, and auto-exposure). After photographing various flocks en route to Nelson and Izembek lagoons on 27 August 2012, we discovered that many photos were blurry due to plexiglas window distortion. This effect was particularly noticeable while shooting at oblique angles through the rear windows of the Kodiak aircraft. To minimize image distortion, as well as accommodate long, linear molting flocks, we maneuvered the plane to position the photographer over the flock as close to vertically as possible (i.e., holding the plane in a slight 'slip' while the photographer positioned the camera lens flush with the plexiglas, thereby photographing as straight down as possible). This enabled the entire flock to be kept in view continuously by the pilot, while also allowing the photographer to capture long linear strings of birds with a series of overlapping photographs, in a single pass.

Figure 2. Quest Kodiak-100 survey aircraft used on the fall molt survey of Steller's eiders along the Alaska Peninsula in 2012. The arrow points to the second to last window on the left (port) side of the aircraft through which photographs were taken. A simulated model of a rectangular window port (indicated by a yellow arrow) would allow the photographer to pan and shoot though an open window, decreasing plexiglas image distortion. The port would be hinged at its bottom edge and could be opened and closed during flight. (See the pre-existing port near the front of the pilot's side window, as an example).

Distinct flocks were photographed in their entirety at 700 ft AGL, or for long, linear flocks, by climbing to higher altitudes where the entire flock could be captured with a series of overlapping photos taken in linear sequence or in alternating directions (i.e., a "zig-zag" pattern). We explored flock behavior in response to successive over-flights at varying altitudes and the effect of tide cycle on flock distribution by conducting replicate counts at Nelson lagoon during both high and low tide cycles. The front right-seat (starboard) observer recorded hand-written and electronic notes in coordination with the photographer. These notes detailed photo sequence, area covered, and flock information. We used a GPS-linked data recording program on a laptop computer (Butler et al. 1995) to display the track file of the aircraft over topographic moving maps of the survey area. This allowed the pilot to easily distinguish which areas had been flown or needed further coverage in real-time, during survey flights.

Image analysis

Upon return from the field, we created a spreadsheet of all photos and notes, and delineated series of photos that comprised single flocks. From notes, we also deciphered which photos were of sufficient resolution to be acceptable for analysis and which survey areas had complete coverage. A technician analyzed images using photographic editing software (Adobe Photoshop CS-4 extended) following methods outlined by Larned et al. (2012) for spectacled eiders. Our primary objective was to obtain the best total estimate for each flock. Because sex or age of molting Steller's eiders could not be distinguished in aerial photographs, we included all birds in one count group (i.e., no sex-age classification). To avoid undercounting or double-counting in overlapping serial images, we simultaneously displayed adjacent images and drew "match lines" on each image using a Photoshop "DRAW" tool (see example photo in Fig. 3). Using the Photoshop COUNT extension, we positioned the curser over each bird to be counted and clicked the mouse, leaving a mark and incremental number over each bird. Steller's eiders were typically in distinct (very clumped), single species flocks, making species identification straightforward. However, we did encounter at least two mixed species flocks, containing Pacific common eiders (*S. mollisima v. nigrum*), Steller's eiders, and black scoters (*Melanitta nigra*). Due to distortion through the plexiglas window and the varying relative size of birds in photos associated with variation in flight altitude, common eider females could sometimes be difficult to distinguish from Steller's eiders. To assist with differentiation, we developed a set of ad hoc criteria to help distinguish between the two species in photographs (Appendix 1).

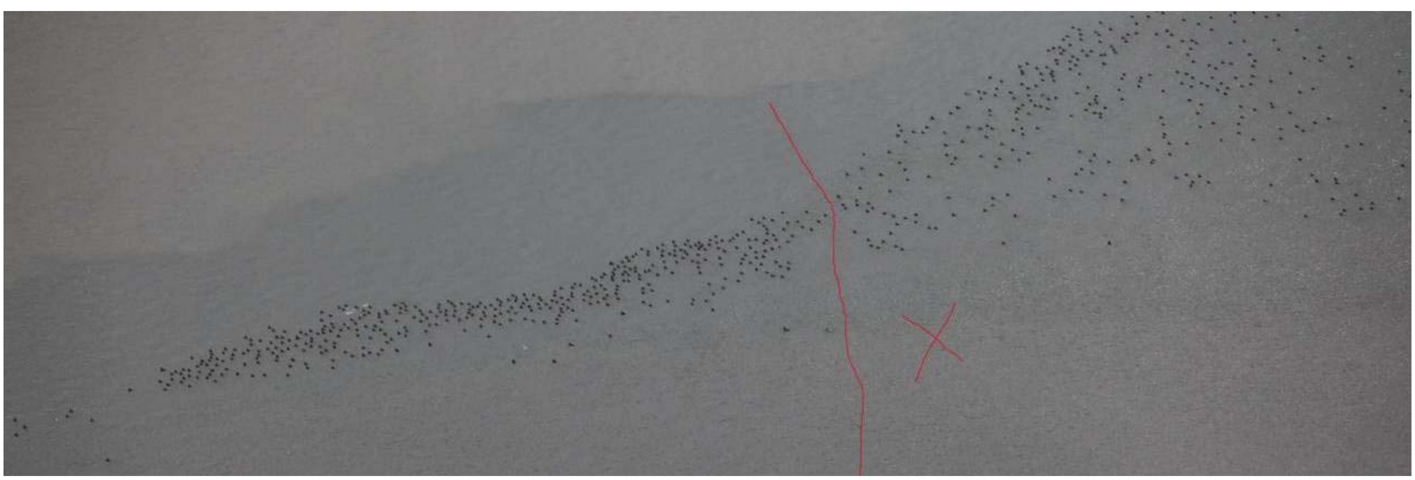

Figure 3. Typical photo from a series used to count a long, linear flock of molting Steller's eiders at Nelson Lagoon, August 30, 2012. The red line and "X" delineate the portion of the photo that overlapped with the next photo and thus, had already been counted.

Count data from each photo containing a portion of a flock were entered into a spreadsheet and summed to derive total counts for each flock. Then flock counts within each major lagoon system were summed and location averages were calculated where replicates occurred. We derived an index to the total Alaska Peninsula population by summing all location averages.

Results

Aerial survey

From 27-30 August 2012, we conducted photographic surveys of molting Steller's eiders at major lagoons along the Alaska Peninsula (King Salmon to Izembek NWR), with replicate surveys at the Seal Islands and Izembek and Nelson lagoons. Total flight time was 16.6 hrs, with approximately 10 hrs of photographing or searching for flocks and 6.6 hrs of transiting the aircraft to/from Anchorage (see Appendix 2: Itinerary).

Figure 4. Photo of a small flock of molting Steller's eiders (196) at Izembek Lagoon taken at low altitude; left: zoomed in, right: original scale.

The characteristic tight clustering of birds within Steller's eider flocks was evident (Figs. 3, 4) throughout the photographic survey. However, many higher altitude identifications were confirmed by reviewing photographs in flight and/or making low passes on flocks (Fig. 4). Most birds photographed at our standard survey altitude (700 ft) appeared uniformly dark brown or black with no evident plumage patterns. Larger species, such as king (*S. spectabilis*) and common eiders, and black scoters, were identified in some photographs, but better resolution may have been achieved if plexiglas window distortion could have been avoided (see suggestion in Fig. 2). Although "slipping" the aircraft relative to the flock was a reasonable short-term solution for the survey in 2012, more extensive consideration of this technique would be required if it were to be employed as a long-term strategy. A better alternative would be a port installed on the photographer's window (see Fig. 2, yellow arrow), that would improve photo quality and simplify aircraft positioning for flock photography. Request for engineering related to this window modification has been initiated with Quest Aircraft Company (H. Wilson, Sept. 2012).

Molting Steller's eiders rarely dove on our first overflight at 600-800 ft, but were more likely to dive on successive overflights, even at relatively high (700-800 ft) altitude. It was apparent that 700 ft AGL and 1-2 passes provided a good balance of complete flock coverage and adequate resolution for identification and counting. We also discovered that scattered groupings of birds tended to coalesce into tighter clusters in response to our flights approximately 1 mi. away from the flock at altitudes of >1000ft AGL. In some cases, such as high tide at Nelson lagoon, we were not able to obtain satisfactory photo coverage of widely dispersed flocks without this type of procedure. Based on our experience in 2012, and given favorable weather, a similar future photographic survey (without replicates) could be completed in 1-2 days, and a survey with replicates would likely require 2-4 days. Although our flights did not coincide with peak tide cycles at Nelson or Izembek lagoons, at Izembek we found birds were best photographed at low tide when they were concentrated in channels. Overall, having appropriately consolidated flocks was the single most important factor in effective photography for this survey. Large scattered groups simply could not be photographed because the photographer could not be sure of what had been covered. Nelson lagoon, as with Izembek, was best photographed at low tide. However, even at higher tides we found it was possible to "herd" birds into tighter formations for easier to photographing.

Table 1. Numbers of molting Steller's eiders at selected locations along the Alaska Peninsula 27-30 August 2012, as counted from aerial photographs.

Location	Date(s)	Rep 1	Rep 2	Average	Proportion of total
Port Heiden	30-Aug			**341**	<0.01
Seal Islands	27, 30-Aug	8,136	11,392	**9,764**	0.19
Port Moller	27-Aug			**602**	0.01
Nelson lagoon	27, 30-Aug	35,218	35,879	**35,549**	0.71
Izembek lagoon	27, 28-Aug	5,375	2,921	**4,148**	0.08
TOAL				**50,404**	

Image analysis

We captured a total of 659 photos, of which, 269 were used for counting. Analysis was done by a single technician and required approximately 8 work days to complete. We estimated a total of 50,404 birds. Proportionally, 0.71 were in the Nelson lagoon complex and 0.19 at Seal Islands (Table 1). Most of the birds we counted at Nelson lagoon were near Walrus Island, whereas the majority at Izembek lagoon were near Blaine Point (Fig. 1).

Comparison with other surveys

Several major differences exist between the traditional "SW Spring" survey and surveys conducted during the molt period, but the primary difference is that surveys conducted in spring versus fall do not index the same portion of the Pacific Steller's eider population. The "SW Spring" survey counts the portion of the population that is available within the survey area at the time the survey is conducted. Of these birds, it is expected to include all sexes and ages. In contrast, fall molt surveys count all adult males, failed breeding females, and birds of both sexes that have not yet started breeding. They do not include successfully breeding females or their broods, nor other Steller's eiders that molt elsewhere (e.g., other areas of Alaska or Russia). That said, the point estimate for our summed fall molting population index "Fall Molt" in 2012 was most similar to that of the "SW Spring"survey's 3-yr average (2010-2012) of 62,965 (Larned 2012; Fig. 5), and was even more similar to the actual 2012 SW Spring survey point estimate of 59,638. Thus, in a general sense, the difference between the SW Spring survey (the historical Pacific population index) and our fall photographic survey in 2012 equated to ~9-12,000 more birds being seen in spring, than fall. It is important to note that the fall molt survey conducted in 2012 excluded several lesser, but potentially important Steller's eider molting areas (e.g., Nunivak Island, Kuskokwim Shoals, Chagvan Bay, and Kamishak Bay, Appendix 3), and it is possible that if photographed, coverage of these areas may have resulted in a larger overall population index.

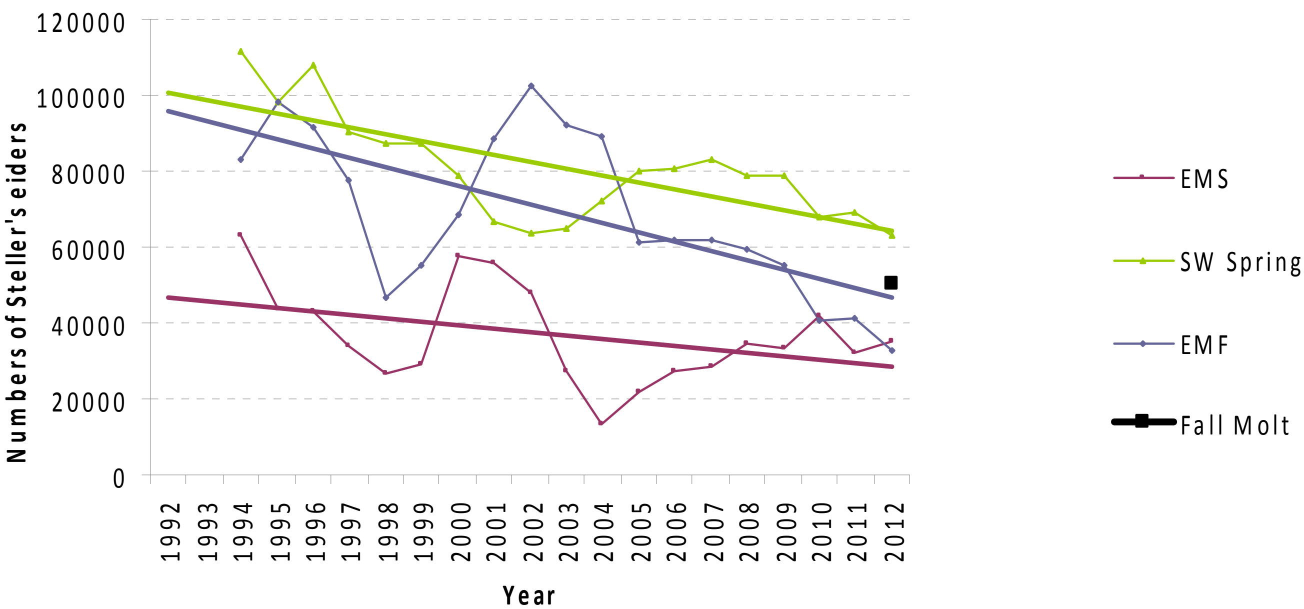

Figure 5. Comparative population trends for the Pacific population of Steller's eiders among four Alaskan surveys; the EMS (Emperor Goose Spring survey; Dau and Mallek 2011), the EMF (Emperor Goose Fall survey; Mallek and Dau 2012), the "SW Spring"survey (Larned 2012), and our fall photographic molting survey (Fall Molt; this study, black box on graph).

Our comparison of population trends from the "SW Spring" with those collected during spring (EMS) and fall (EMF) emperor goose surveys along the Alaska Peninsula (Dau and Mallek 2011, Mallek and Dau 2012), revealed high annual variability in all surveys, but extremely similar population trends among the three ("SW Spring" = 0.98, EMS= 0.98, EMF= 0.98; Fig. 5), with all three historic surveys indicating a consistent decline (e.g., EMS -3.5%/yr, EMF -4.2%/yr, "SW Spring" -2.7 %/yr) in the Pacific population of Steller's eiders between 1992 and 2012 (Fig. 6). On average, the "SW Spring" survey counted 12,000 more Steller's eiders than observed on the EMF survey; the difference potentially reflecting females that had successfully nested and were missing from the fall count. Finally, our average count of only 4,148 birds at Izembek lagoon, was similar to the ocular estimate made 3 weeks later during the EMF survey (5,076; C. Dau pers. comm.), and these estimates of Steller's eiders molting at Izemebek lagoon represent a substantial decrease from historical counts (average = 40,464 (1977-85) C. Dau pers. comm., 46,056; Petersen 1981), as well as a continuation of the -5.6% annual decline (1977-present) noted by C. Dau (pers. comm).

Discussion

Relative to the "SW Spring"survey, a fall Steller's eider photographic survey appears to offer reduced survey complexity, improved safety, and cost-efficiency (ideal timing and easier logistics). Our initial results suggest that the survey is both operationally feasible and could provide consistent fall counts of molting birds;

potentially providing adequate data for monitoring the Pacific population of Steller's eiders in a manner similar to historical surveys. Our 2012 results suggested the most appropriate fall molt survey areas along the Alaska Peninsula are the Seal Islands, and Nelson and Izembek lagoons, as these three locations comprised 99% of the molting birds we surveyed (with 71% at Nelson lagoon alone). We suggest all the major lagoons along the Peninsula should be scanned for flocks and photographed when birds are evident, but photographs at these three primary areas should comprise the core of the survey. However, expansion of the survey to include molt areas outside of the Alaska Peninsula could be explored in an effort to better understand the relative importance of the three aforementioned sites, and document the full distribution of molting Steller's eiders.

Although we did not directly address the applicability of the photographic methods to estimate observer error in 2012, comparing one (non-pilot) observer's ocular estimates to photographic counts, could be accomplished on future surveys with increased funding for additional flight hours. Continued comparisons between Steller's eider counts on the EMF ocular survey (Mallek and Dau 2012) and the photographic molt survey should also be made to assess correspondence between the two surveys. Theoretically, the two surveys should be counting many of the same birds (although timing and techniques are slightly different), with the photographic survey covering less area, but offering potential for enumerating Steller's eiders with more precision than the EMF survey (a survey largely focused on emperor geese). Comparisons between the counts could potentially be used to examine estimation error at the major molting sites or reveal shifts in distribution away from major, historical molting areas.

Overall, all three Alaska Peninsula surveys indexing Steller's eiders in Alaska, have shown similar population trends, indicating their high degree of agreement, despite large annual variation. The relatively high concordance between the "SW Spring"survey and EMF survey suggests a fall molt survey could be a good surrogate for the "SW Spring"survey. Given the relatively large degree of annual variation in the EMF survey, we suggest the photographic survey be conducted annually to best interpret population fluctuations.

Finally, we acknowledge that appropriate interpretation of a molt survey for indexing the Pacific Population of Steller's eiders must be considered carefully. Despite the many benefits of a molt-based index, variation in fall molt counts could be confounded with variation in production. Molt migration generally involves non-breeders or failed breeders (Salomonsen 1968, Hohman et al. 1992) with highest numbers expected at molt sites in years of poor breeding success (Reed et al. 2003). Thus, abundance estimates derived from molt surveys represent a combination of population size and current breeding conditions, and separation of the two can be difficult. For Steller's eiders, years of successful reproduction (Quakenbush et al. 2004) would result in fewer adult females being present during early molt at Alaska Peninsula lagoons, and therefore, only a portion of the population (i.e., mostly adult males) being counted in those years. Information from Barrow and/or Russian breeding areas, as well as banding data from Izembek and Nelson lagoons from past decades, could be useful in helping to interpret annual variation in presence of breeding females during the early molting period. For example, recent Nelson lagoon banding data suggests that the percentage of juvenile and female birds ranged from <11-19% (2006-10; T. Bowman pers. comm.) based on molt drives typically conducted two weeks later than the photographic survey). However, age and sex ratios and/or brood patch observations collected during molt banding (C. Dau pers. comm), as well as breeding data from only two isolated study sites (one in Barrow and one in Russia), may not be adequate indicators of annual productivity for reliably qualifying variation in Alaska Peninsula molt surveys.

General recommendations

Given the strong agreement in population trends between the EMS and EMF surveys and the "SW Spring"survey, as well as comparable point estimates among all surveys and our 2012 fall molt photographic survey, we believe the fall molt survey would be an efficient alternative to the "SW Spring"survey, and should be continued with further exploration of appropriate geographic scope. Information on annual productivity throughout Steller's eider's range would also help to better interpret variation in future molt survey counts. Additionally, continued comparison between the fall molt survey (this study) and EMF survey (Mallek and Dau 2012) is warranted to provide information on potential shifts in distribution and accuracy of estimates.

Specific recommendations

1. A 3-person survey crew is ideal. This would be comprised of a pilot (left-front), observer (right-front), and photographer (left-rear) shooting out the forward window of the exit door (2nd to last window on port side.
2. Front seat observers should obtain simultaneous, replicate, ocular estimates of photographed flock sizes.
3. A port should be installed in the second to last window on the port side of the Kodiak (see Fig. 2). *Having a port on the window would help immensely, both in photo quality and in aircraft orientation and positioning to photograph flocks. Oblique shots of flocks with the Canon 5D are generally adequate for counting purposes, but could be improved by not having to shoot through the Plexiglas window. Shooting through an open window would produce crisper photographs and would allow photographing flocks at greater distances, reducing the chance of birds diving.*
4. At a minimum, the Steller's eider index should include Izembek and Nelson lagoons, and Seal Islands. Surveys of additional areas would add complexity and cost, but better ensure that changes in distribution of molting birds would be detected.
5. Izembek is best photographed at low tide when birds are concentrated in channels.
6. Nelson lagoon should be attempted at low tide as well, although at higher tides it may be possible to "herd" birds into tighter formations that are easier to photograph.
7. Local area observations of tide level should be used to correct inaccuracies in published tide tables (especially at Port Moller/Nelson lagoon).
8. Photographer should record frames shot and any specific notes about each frame that would help in reconciling photos later on.
9. The photographer should make the initial review of photos and associated notes to:
    a. Identify duplicate photos of the same flock, select the best photo, and delete others
    b. Create a text file documenting contents of each frame (or series of frames) and any notes that will help the photo analyst determine how successive photos orient with each other
10. Contacts should be made with the appropriate refuge staff at Becharof and Izembek NWRs several weeks ahead of the survey to secure bunkhouse lodging, a vehicle, aircraft tie-downs and/or hangar space, etc.
11. For potential lodging in Nelson lagoon, contact either Butch at Tides Inn, or Jennie/Gunnar Johnson.

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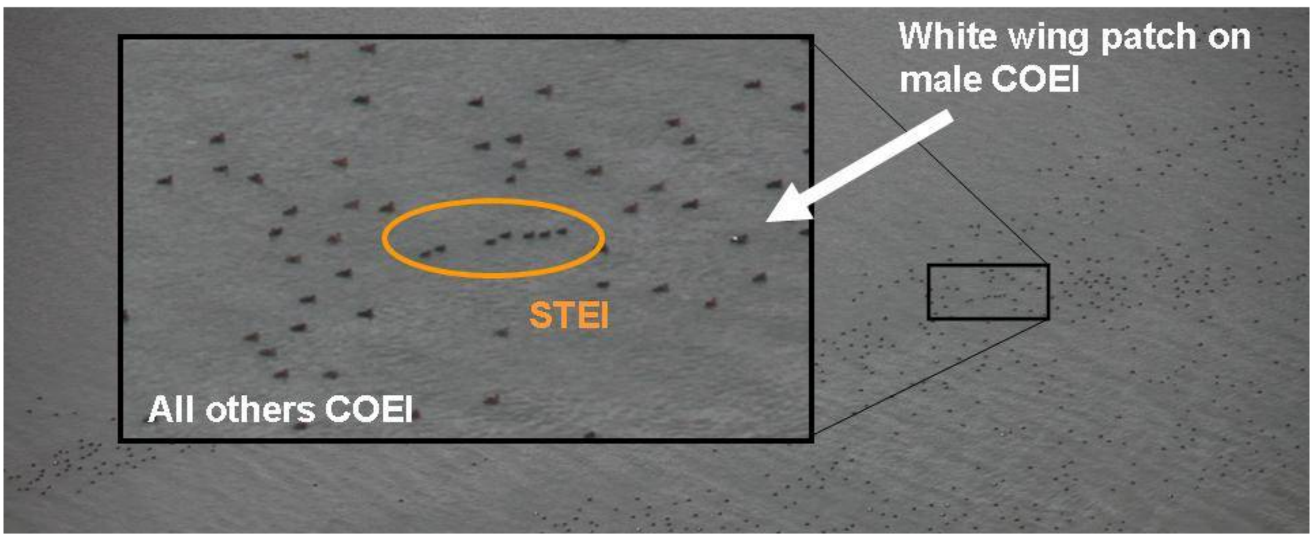
Appendix 1. Tips for distinguishing common eiders from Steller's eiders

<u>Common eiders:</u>

- Generally larger size
- Obvious white in male plumage
- Orange/lighter bill
- Head and neck more obvious (Steller's eiders appear as one little blob)
- More color contrast between male and female common eiders than with Steller's eiders:

    Female common eiders generally are lighter brown
    Males common eiders are dark brown, often w/white patches
    Steller's eiders are uniform dark brown, regardless of sex



4321.jpg (Nelson rep 2 8/30/12)

Appendix 2. Trip itinerary.

8/27/2012:	Depart Anchorage for King Salmon. Re-fuel King Salmon. Survey and scan for flocks King Salmon to Cold Bay, photographing at Port Heiden, Seal Islands, Port Moller, some at Nelson and Izembek lagoons. Land Cold Bay and overnight at Izembek NWR bunkhouse.
8/28/2012:	Survey Izembek lagoon, then refuel in Cold Bay and depart to survey Nelson lagoon. Survey Nelson lagoon, then land and remain for two nights at Nelson lagoon (mechanical and weather problems)
8/30/2012:	Conduct second replicate at Nelson lagoon and Seal Islands enroute to King Salmon. Land King Salmon and overnight at the Becharof NWR bunkhouse
9/1/2012:	Depart King Salmon for Anchorage. Land Anchorage, end of survey.

Appendix 3. Major Steller's eider molting locations and estimates of numbers of birds from surveys and historical observations.

Area	Average numbers	Year(s)/Details	Source
Nunivak Island	~2,000	Historically	C. Dau, citing B. McCaffery
Kuskokwim Shoals	5,101	2000	McCaffery pers. comm.
	5,439	1996	Larned and Tiplady 1996
Chagvan Bay	1,300	(1-2 wks before molt)	D. Weir obs, in C. Dau
Kamishak Bay	2,190	2005	W. Larned 2005
	2,566	2005-2006, (range: 2,225-2907)	D. Rosenberg 2007
Port Heiden	9,775	(including 9000 subadults)	Petersen 1981
	341	2012	Wilson et al. 2013 (this report)
Seal Islands	~2,000		C. Dau pers. comm.
	1,695	1979	Petersen 1981
	9,764	2012	Wilson et al. 2013 (this report)
Nelson lagoon	39,567	n=10, (range: 29,690-57,988)	C. Dau pers. comm.
	44,711	1979	Petersen 1981
	107,519	1977	Petersen 1981
	35,549	2012	Wilson et al. 2013 (this report)
Izembek lagoon	40,464	1977-85 (range: 9887-77,735)	C. Dau pers. comm.
	46,056	1979	Petersen 1981
	18,952	1987-97 (range: 10,179-30,363)	C. Dau pers. comm.
	12,553	1998-2008 (range:4,619-24,673)	C.Dau pers. comm.
	6680	2009-2012 (range:3892-9704)	C. Dau pers. comm.
	5076	2012	C. Dau pers. comm.
	4,148	2012	Wilson et al. 2012

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