Monitoring

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Monitoring 2016

Thaxter, C. B., V. H. Ross-Smith, J. A. Clark, N. A. Clark, G. J. Conway, E. A. Masden, H. M. Wade, E. H. K. Leat, S. C. Gear, M. Marsh, C. Booth, R. W. Furness, S. C. Votier, and N. H. K. Burton. 2016. Contrasting effects of GPS device and harness attachment on adult survival of Lesser Black-backed Gulls *Larus fuscus* and Great Skuas *Stercorarius skua*. *Ibis* **158**:279–290.

(Abstract)

Telemetry has become an important method for studying the biology and ecology of animals. However, the impact of tracking devices and their method of attachment on different species across multiple temporal scales has seldom been assessed. We compared the behavioural and demographic responses of two species of seabird, Lesser Black-backed Gull *Larus fuscus* and Great Skua *Stercorarius skua*, to a GPS device attached using a crossover wing harness. We used telemetry information and monitoring of breeding colonies to compare birds equipped with a device and harness, and control birds without an attachment. We assessed whether tagged birds have lower short-term breeding productivity or lower longer term overwinter return rates (indicative of overwinter survival) than controls. For Great Skua, we also assessed whether territory attendance within the breeding season differed between tagged and control birds. As with previous studies on Lesser Black-backed Gull, we found no short-term impacts on breeding productivity or long-term impacts on overwinter return rates. For Great Skua, there was no evidence for impacts of the device and harness on territory attendance or breeding productivity. However, as found by a previous study of Great Skuas using a different (body) harness design, there was strong evidence of reduced overwinter return rates. Consequently, a device attached using a wing harness was considered suitable for long-term deployment on Lesser Black-backed Gulls, but not on Great Skuas. These findings will inform the planning of future tracking studies.

Monitoring 2015

Minton, C. D. T. 2015. The value of annual volunteer input to the operations of the Victorian Wader Study Group. *Stilt* **67**:19-21.

(Abstract)

The Victorian Wader Study Group, as with many other ornithological fieldwork bodies, is entirely managed and operated by volunteer effort. An attempt has been made to quantify the main components of this in order to demonstrate the monetary value of such in-kind volunteer input, the level of which is not widely appreciated. It is estimated that the annual volunteer

effort is at least 14,048 person hours. If this is costed at the standard Victorian Government Coastcare recommended level of $30 per hour, this equates to an annual value of $421,440. Vehicle transport costs incurred by volunteers taking part in fieldwork activities (costed at $1 per vehicle kilometre) add a further $121,800. Airfares for the two visits to King Island each year are $7,520. Additional costs associated with equipment (consumables, maintenance, and depreciation) are $26,000 per annum. The net value of the volunteer contribution needed to undertake VWSG activities annually is therefore estimated at $576,760. As volunteering represents a major contribution to research and monitoring, these in-kind inputs need to be recognised, inter alia, when requests for funding support from external bodies are made.

Taylor, C. M., D. B. Lank, and B. K. Sandercock. 2015. Using local dispersal data to reduce bias in annual apparent survival and mate fidelity. *The Condor* **117**:598-608.

(Abstract)

In mark–recapture studies conducted on fixed-area study sites, apparent (or ‘‘local’’) survival (/) is the product of the probabilities of true survival (S) and site fidelity to the sampling area (F). If marked individuals permanently emigrate from the study site, apparent survival will be biased low relative to true survival. Similarly, estimates of mate fidelity will be biased high because site fidelity is typically higher for individuals that reunite with their previous mates than among pairs that divorce. Here, we develop a method for calculating site fidelity that takes plot boundaries into account, based on a dispersal model estimated from local movements within a fixed study site. We use dispersal estimates to adjust apparent survival and mate fidelity for the effects of short-distance movements out of a fixed area. We demonstrate our method with a retrospective analysis of a published study of 2 species of sandpipers breeding sympatrically at a field site in western Alaska. Estimates of survival probability increased by 0.01–0.03 for males and 0.07–0.08 for females in both species. The larger adjustments for females were expected based on their longer local dispersal movements. Adjusted mate fidelity estimates were lower than the original estimates by 0.04–0.07. Use of local movement data to estimate site fidelity cannot account for permanent emigration due to long-distance movements and, if such movements occur, our adjusted estimates of / remain a function of true survival and site fidelity. Nevertheless, our method can reduce bias in demographic parameters resulting from local dispersal movements, improving estimates of annual survival and mate fidelity for use in demographic models.

Stephenson, P. J., N. D. Burgess, L. Jungmann, J. Loh, S. O’Connor, T. E. E. Oldfield, W. Reidhead, and A. Shapiro. 2015. Overcoming the challenges to conservation monitoring: integrating data from in-situ reporting and global data sets to measure impact and performance. *Biodiversity* **16**:68–85.

(Abstract)

If parties to the Convention on Biological Diversity (CBD) and their partners are to report effectively on progress against national, regional and global biodiversity conservation goals, data will need to be collected at multiple levels. Global data sets, many gathered using remote sensing, offer partial solutions but need to be complemented by field-level observations to provide the resolution necessary to track conservation measures in a meaningful way. This paper summarises efforts made by the conservation organisation WWF, working with partners, to integrate 10 indicators of relevance to CBD parties into its global monitoring system and to use global data sets and data from field programs to determine progress against multi-level goals and to assess program performance and impacts. Integration of in-situ and ex-situ data into reporting dashboards tailored to WWF's needs allowed some degree of assessment of progress and adaptive management of the program portfolio. Indicator trends were most favourable (on track) for protected area (PA) coverage and market share of sustainable commodities, and least favourable (worsening) for species offtake, species populations, wildlife trade, habitat fragmentation and Ecological Footprint. The most useful indicators – which could be disaggregated to provide trends at local levels relevant to WWF field programs – were species populations, habitat cover and fragmentation, PA coverage and PA management effectiveness. However, challenges remain if local and global monitoring objectives are to be aligned, including the need for increased collection of data by field projects, improved harmonisation of indicators, and greater sharing of data in formats of use to practitioners. We advocate wider adoption by governments and civil society organisations of indicators with the dual function of tracking delivery of CBD Aichi Targets as well as monitoring national, regional and ecoregional level conservation programs, and urge more NGOs and academic bodies to support capacity building and data collection.

Méndez, V., G. E. Austin, A. J. Musgrove, V. H. Ross-Smith, R. D. Hearn, D. A. Stroud, S. R. Wotton, and C. A. Holt. 2015. Use of environmental stratification to derive non-breeding population estimates of dispersed waterbirds in Great Britain. *Journal for Nature Conservation* **28**:56–66.

(Abstract)

Population estimates provide a baseline to inform conservation and management decisions. In this paper, we present a novel method to derive non-breeding population estimates of waterbirds in Great Britain. We combined Wetland Bird Survey (WeBS) data with a detailed environmental stratification to calculate population estimates for widely dispersed waterbird species, populations of which tend to be relatively poorly monitored by WeBS and other established schemes. These stratification-based estimates were then compared with published estimates, most of which were derived using extrapolations based on WeBS information and a small number of intensive surveys. We discuss the limitations and merits of the stratification method, and conclude by suggesting the species for which future use of the approach would be most appropriate for derivation of population estimates. We also outline potential ways to improve the baseline information on abundance of widely dispersed non-

breeding waterbirds in Great Britain.

Zimmerman, G. S., J. R. Sauer, K. Fleming, W. A. Link, and P. R. Garrettson. 2015. Combining Waterfowl and Breeding Bird Survey Data to Estimate Wood Duck Breeding Population Size in the Atlantic Flyway. *The Journal of Wildlife Management* **79**:1051–1061.

(Abstract)

We combined data from the Atlantic Flyway Breeding Waterfowl Survey (AFBWS) and the North American Breeding Bird Survey (BBS) to estimate the number of wood ducks (*Aix sponsa*) in the United States portion of the Atlantic Flyway from 1993 to 2013. The AFBWS is a plot-based survey that covers most of the northern and central portions of the Flyway; when analyzed with adjustments for survey time of day effects, these data can be used to estimate population size. The BBS provides an index of wood duck abundance along roadside routes. Although factors influencing change in BBS counts over time can be controlled in BBS analysis, BBS indices alone cannot be used to derive population size estimates. We used AFBWS data to scale BBS indices for Bird Conservation Regions (BCR), basing the scaling factors on the ratio of estimated AFBWS population sizes to regional BBS indices for portions of BCRs that were common to both surveys. We summed scaled BBS results for portions of the Flyway not covered by the AFBWS with AFBWS population estimates to estimate a mean yearly total of 1,295,875 (mean 95% CI: 1,013,940–1,727,922) wood ducks. Scaling factors varied among BCRs from 16.7 to 148.0; the mean scaling factor was 68.9 (mean 95% CI: 53.5–90.9). Flyway-wide, population estimates from the combined analysis were consistent with alternative estimates derived from harvest data, and also provide population estimates within states and BCRs. We recommend their use in harvest and habitat management within the Atlantic Flyway.

Aceves-Bueno, E., A. S. Adeleye, D. Bradley, W. T. Brandt, P. Callery, M. Feraud, K. L. Garner, R. Gentry, Y. Huang, I. McCullough, I. Pearlman, S. A. Sutherland, W. Wilkinson, Y. Yang, T. Zink, S. E. Anderson, and C. Tague. 2015. Citizen Science as an Approach for Overcoming Insufficient Monitoring and Inadequate Stakeholder Buy-in in Adaptive Management: Criteria and Evidence. *Ecosystems* **18**:493–506.

(Abstract)

Adaptive management is broadly recognized as critical for managing natural resources, yet in practice it often fails to achieve intended results for two main reasons: insufficient monitoring and inadequate stakeholder buy-in. Citizen science is gaining momentum as an approach that can inform natural resource management and has some promise for solving the problems faced by adaptive management. Based on adaptive management literature, we developed a

set of criteria for successfully addressing monitoring and stakeholder related failures in adaptive management and then used these criteria to evaluate 83 citizen science case studies from peer-reviewed literature. The results suggest that citizen science can be a cost-effective method to collect essential monitoring information and can also produce the high levels of citizen engagement that are vital to the adaptive management learning process. The analysis also provides a set of recommendations for citizen science program design that addresses spatial and temporal scale, data quality, costs, and effective incentives to facilitate participation and integration of findings into adaptive management.

van der Werf, J., J. Reinders, A. van Rooijen, H. Holzhauer, and T. Ysebaert. 2015. Evaluation of a tidal flat sediment nourishment as estuarine management measure. *Ocean & Coastal Management* **114**:77-87.

(Abstract)

The tidal flats in the Eastern Scheldt tidal basin (The Netherlands) are eroding as a result of the construction of the storm surge barrier. These intertidal areas are important foraging grounds for birds and therefore it is important to mitigate the negative effects of erosion. As a pilot, a small part (20 ha) of the Galgeplaat tidal flat in the middle of the Eastern Scheldt was nourished with 130,000 m3 of sediment in 2008. This paper investigates this tidal flat nourishment using a large set of morphological and ecological monitoring data from 2008 to 2012. The nourishment proved effective in mitigating the negative effects of tidal flat erosion. The elevated tidal flat provides a foraging area for birds that is available for a longer period. The nourished area was relatively stable, giving time for the recovery of benthic macrofauna such that birds can benefit from the longer exposure time. Therefore, we conclude that sediment nourishments are an effective management measure to counteract the negative consequences of tidal flat erosion in the Eastern Scheldt, and have potential for other estuaries worldwide.

Thomas, H. L., P. A. R. Hockey, and G. S. Cumming. 2015. Solving the challenges of monitoring mobile populations: insights from studies of waterbirds in southern Africa. *Ostrich* **86**:169-178.

(Abstract)

Highly mobile species are difficult to monitor. It is often unclear from abundance estimates whether a population is genuinely declining or simply elsewhere. If the spatial and temporal scales of monitoring are inadequate, the data will only be useful if the signal is very strong (i.e. the change in population size is large). We explored the ability of three major databases – the Southern African Bird Atlas Project (SABAP), the Coordinated Waterbird Counts (CWAC) and

the South African Bird Ringing Unit (SAFRING) – to reveal the movement patterns of a highly mobile African waterbird, the Red-billed Teal *Anas erythrorhyncha*. Only ring recovery data provided clear evidence of long-distance movement. All three data sets were compromised to varying degrees by methodological biases and spatial and/or temporal resolutions that prevented the detection of movement patterns. By incorporating abundance estimates, increasing and quantifying sampling effort, and extending coverage at the data collection stage, the potential for these data sets to contribute to our understanding of bird movements could be greatly improved. Monitoring programmes for mobile species must be tested at an early stage to assess their ability to explain spatial and temporal population variation at the scales at which such variation occurs.

Ringelman, K. M., C. K. Williams, and J. M. Coluccy. 2015. Assessing Uncertainty in Coastal Marsh Core Sampling for Waterfowl Foods. *Journal of Fish and Wildlife Management* **6**:238-246.

(Abstract)

Quantifying foraging resources available to waterfowl in different habitat types is important for estimating energetic carrying capacity. To accomplish this, most studies collect soil-core samples from the marsh substrate, sieve and sort food items, and extrapolate energy values to wetland or landscape scales. This is a costly and time-intensive process; furthermore, extrapolation methods yield energy estimates with large variances relative to the mean. From both research and management perspectives, it is important to understand sources of this variation and estimate the number of soil cores needed to reduce the variance to desired levels. Using 2,341 cores collected from freshwater and salt marsh habitats at four sites along the Atlantic Coast, we examined sampling variation and biological variation among sites and habitats. When we removed extreme outliers in the data caused by large animal food items found in a small core sample, estimates of energy density decreased by an order of magnitude for most habitats. After removing outliers, we found inconsistent geographical variation among habitat types that was especially pronounced in freshwater and no evidence for within-season temporal depletion of food resources for any site or habitat. We used a Monte Carlo simulation approach to estimate the optimal number of cores (minimizing both cost and estimated variance) sampled in each habitat type. Across most contexts, a reduction in the coefficient of variation reached diminishing returns near 40 core samples. We recommend that researchers explicitly address outliers in the data and managers acknowledge the imprecision that can arise from including or excluding outliers when estimating energy density at landscape scales. Our results suggest that collecting 40–50 cores per habitat type was sufficient to reduce the variance to acceptable levels while minimizing overall sampling costs.

Hostetter, N. J., B. Gardner, S. H. Schweitzer, R. Boettcher, A. L. Wilke, L. Addison, W. R. Swilling, K. H. Pollock, and T. R. Simons. 2015. Repeated count surveys help standardize multi-agency estimates of American Oystercatcher (*Haematopus palliatus*) abundance. *The Condor* **117**:354–363.

(Abstract)

The extensive breeding range of many shorebird species can make integration of survey data problematic at regional spatial scales. We evaluated the effectiveness of standardized repeated count surveys coordinated across 8 agencies to estimate the abundance of American Oystercatcher (*Haematopus palliatus*) breeding pairs in the southeastern United States. Breeding season surveys were conducted across coastal North Carolina (90 plots) and the Eastern Shore of Virginia (3 plots). Plots were visited on 1–5 occasions during April–June 2013. N-mixture models were used to estimate abundance and detection probability in relation to survey date, tide stage, plot size, and plot location (coastal bay vs. barrier island). The estimated abundance of oystercatchers in the surveyed area was 1,048 individuals (95% credible interval: 851–1,408) and 470 pairs (384–637), substantially higher than estimates that did not account for detection probability (maximum counts of 674 individuals and 316 pairs). Detection probability was influenced by a quadratic function of survey date, and increased from mid-April (~0.60) to mid-May (~0.80), then remained relatively constant through June. Detection probability was also higher during high tide than during low, rising, or falling tides. Abundance estimates from N-mixture models were validated at 13 plots by exhaustive productivity studies (2–5 surveys per week). Intensive productivity studies identified 78 breeding pairs across 13 productivity plots while the Nmixture model abundance estimate was 74 pairs (62–119) using only 1–5 replicated surveys per season. Our results indicate that standardized replicated count surveys coordinated across multiple agencies and conducted during a relatively short time window (closure assumption) provide tremendous potential to meet both agency-level (e.g., state) and regional-level (e.g., flyway) objectives in large-scale shorebird monitoring programs.

Andersson, K., C. A. Davis, G. Harris, and D. A. Haukos. 2015. An Assessment of Non-Breeding Waterfowl Surveys on National Wildlife Refuges in the Central Flyway. *Wildlife Society Bulletin* **39**:79–86.

(Abstract)

Many units of the National Wildlife Refuge System (NWRS) in the Central Flyway of the United States were established to conserve and enhance waterfowl populations. Consistent and continuous monitoring of waterfowl abundance on refuges is critical when evaluating the performance of individual refuges as well as the refuge system on a larger scale. It is also essential for providing metrics to determine progress toward established waterfowl use and abundance goals. Despite the considerable resources the U.S. Fish and Wildlife Service spend annually on waterfowl management within the NWRS, the quality of ongoing monitoring efforts outside the breeding season has never been systematically evaluated. We evaluated

the quality of historical (1949–2008) waterfowl monitoring data at refuge sites within the Central Flyway during the migration and wintering period (Oct–Mar). Ninety-six percent of all survey data sets were classified as being of good or fair quality overall. There were, however, some serious issues with the data sets, primarily concerning consistency in survey methodology and temporal survey coverage, as well as lack of coordination among refuges. One-third of the data sets were collected without the existence of a written survey protocol, creating uncertainty regarding methodological consistency over time. Evaluation of the NWRS's benefits to waterfowl as a whole may be severely hampered by temporally inconsistent survey coverage among and within survey sites. We suggest 7 improvements for future waterfowl surveys that will enhance quality and usability of NWRS survey data. Published 2014. This article is a U.S. Government work and is in the public domain in the USA.

Burger, J., M. Gochfeld, L. Niles, C. W. Powers, K. Brown, J. H. Clarke, A. Dey, and D. Kosson. 2015. Complexity of bioindicator selection for ecological, human, and cultural health: Chinook salmon and red knot as case studies. *Environmental Monitoring and Assessment* **187**:1-18.

(Abstract)

There is considerable interest in developing bioindicators of ecological health that are also useful indicators for human health. Yet, human health assessment usually encompasses physical/chemical exposures and not cultural well-being. In this paper, we propose that bioindicators can be selected for all three purposes. We use Chinook or king salmon (*Oncorhynchus tshawytscha*) and red knot (*Calidris canutus rufa*, a sandpiper) as examples of indicators that can be used to assess human, ecological, and cultural health. Even so, selecting endpoints or metrics for each indicator species is complex and is explored in this paper. We suggest that there are several endpoint types to examine for a given species, including physical environment, environmental stressors, habitat, life history, demography, population counts, and cultural/societal aspects. Usually cultural endpoints are economic indicators (e.g., number of days fished, number of hunting licenses), rather than the importance of a fishing culture. Development of cultural/societal endpoints must include the perceptions of local communities, cultural groups, and tribal nations, as well as governmental and regulatory communities (although not usually so defined, the latter have cultures as well). Endpoint selection in this category is difficult because the underlying issues need to be identified and used to develop endpoints that tribes and stakeholders themselves see as reasonable surrogates of the qualities they value. We describe several endpoints for salmon and knots that can be used for ecological, human, and cultural/societal health.

Hickey, R. J., G. B. Pearson, and T. Piersma. 2015. Advances in Large-scale Mudflat Surveying: The Roebuck Bay and Eighty Mile Beach, Western Australia examples. Pages 275-

289. in C. W. Finkl and C. Makowski, editors. Environmental Management and Governance: Advances in Coastal and Marine Resources. *Coastal Research Library* 8. Springer International Publishing, Switzerland.

(Abstract)

The shores of Roebuck Bay and Eighty Mile Beach in northwestern Australia are amongst the richest known intertidal mudflats worldwide. They are both listed as Wetlands of International Importance under the Ramsar Convention, primarily because of the high numbers of shorebirds that migrate to and from these sites every year. There are only a dozen or so areas in the world with extensive intertidal flats rich in shorebirds. Shorebird studies by a collaboration between The Department of Environment and Conservation, The University of Western Australia, The Royal Netherlands Institute for Sea Research, Central Washington University, Broome Bird Observatory, and local community volunteers in northwestern Australia have focused on understanding the geological and biological processes of coastal tidal mudflats. Studies have established that invertebrates are abundant and they are used for feeding by resident and migratory shorebirds. In addition to requiring equipment, software, and considerable organization, these labor intensive studies were only possible with the assistance of large numbers of community volunteers, professionals, and donated equipment.

Monitoring 2014

Kuhlmann Clausen, K., and J. Madsen. 2014. Effects of neckbands on body condition of migratory geese. *Journal of Ornithology* **155**:951–958.

(Abstract)

Ringing and marking are widely used techniques in avian ecology to assist studies of migration, survival and behaviour, and often used to estimate population sizes. Only rarely, however, have the effects of these markings on bird viability been thoroughly tested. Using an abdominal profile index of marked geese and body mass of recaptured birds previously marked, this study investigated the effect of neckbands on body condition of Pink-footed Geese *Anser brachyrhynchus* at different temporal scales, and evaluated to what extent capture, handling and banding affected these birds on short, medium and longer terms. Our results indicated that body condition of geese were negatively affected in the days immediately succeeding capture, but that only a minor effect persisted on a seasonal scale. We found no support for a long-term effect of neckbands on the body mass of individual birds, indicating that the capture and handling event might be the main contributory cause to the transitory decline in body condition. Pink-footed Geese thus seemed to habituate almost completely to the presence of neckbands, and the effects on long-term body condition can be expected to be minor. However, neckbands might still influence important lifehistory traits such as reproduction and survival by means of, e.g., altering social interactions, increasing predation or interfering with mate acquisition.

Thorup, K., F. Korner-Nievergelt, E. B. Cohen, and S. R. Baillie. 2014. Large-scale spatial analysis of ringing and re-encounter data to infer movement patterns: A review including methodological perspectives. *Methods in Ecology and Evolution* **5**:1337–1350.

(Abstract)

1. A major aim of bird ringing is to provide information about the migration and movements of bird populations. However, in comparison with demographic studies, little research has been devoted to improving quantitative inferences through large-scale spatial analyses. This represents a serious knowledge gap because robust information on geographical linkages of migratory populations throughout the annual cycle is necessary to understand the ecology and evolution of migrants and for the conservation and management of populations.

2. Here, we review recent developments and emerging opportunities for the quantitative study of movements of bird populations based on marked birds. Large-scale spatial analyses of ringing data need to account for spatiotemporal variation in re-encounter probability and the complexity of movement processes, including variability among individuals and populations in migration direction and distance.

3. We identify seven recent studies that used quantitative methods for large-scale spatial analyses of ringing and re-encounter data gathered by national ringing centres. In most cases, numbers ringed and recovered in a series of source and destination areas were used to derive estimates of the proportion of each source population travelling to each destination area. Where recovery data were sparse, precision was improved by incorporating information on re-encounter probabilities of similar species. When numbers ringed were not available, inferences could sometimes be drawn based on local recapture data from the source areas.

4. Studies to date illustrate that analyses of these large-scale ringing data sets can provide robust quantitative inferences. Further work is needed to develop these modelling approaches and to test their sensitivity to key assumptions using both real and simulated data. Data for all birds that were marked, not only those re-encountered, are often inaccessible and should be computerised in parallel with analytical developments. Further, there is great potential for the formal combination of re-encounter data with information from additional data sources such as counts and detailed movement data from radiotracking or data loggers. Because data from bird ringing operations cover long periods of time and exist in large quantities, they hold great promise for inferring spatiotemporal migration patterns, including changes in relation to climate, land use change and other environmental drivers.

Zbinden, N., M. Kéry, G. Häfliger, H. Schmid, and V. Keller. 2014. A resampling-based method for effort correction in abundance trend analyses from opportunistic biological records. *Bird Study* **61**:506-517.

(Abstract)

Capsule: Resampling data from biological records databases yielded abundance trend estimates better corrected for increasing observation effort.

Aims: To correct population trend estimates for the effects of annually changing observation effort in analyses of opportunistic data.

Methods: We developed a resampling-based abundance index for analysis of population trends based on opportunistic citizen-science observations. To correct for the huge recent increase in observation effort every year, we resampled (with replacement) a species-specific constant number of records from the data and computed our index. To validate our standardized index, we used counts from the national waterbird census as a benchmark.

Results: Over 22 winters (1991–2012), trend estimates based on resampled indices were substantially more similar to waterbird census-based trend estimates than were raw index-based trends. Raw index trends were off by 648% (se 72%) and typically overestimated trends, while trends computed from standardized indices were off by only 125–131% (se 12–13%) and over – and underestimated trends about equally frequently. Hence, our method of effort correction reduced the bias in trend estimates by a factor 5.

Conclusion: Our resampling method may be useful for improving trend analyses from collections of opportunistic biological records, as they become increasingly available, especially via the internet.

Peters, K. A., D. S. Mizrahi, and M. C. Allen. 2014. Empirical Evidence for Factors Affecting Searcher Efficiency and Scavenging Rates at a Coastal, Terrestrial Wind-Power Facility. *Journal of Fish and Wildlife Management* **5**:330–339.

(Abstract)

The rapid expansion of wind power development in recent years has accentuated the need to develop standard guidelines for identifying, assessing, and monitoring potential impacts to birds and bats. Although postconstruction mortality estimates generally take into account well-established sources of bias, including searcher efficiency and scavenging loss, methods for addressing these biases can be improved. Currently used bias-adjustment methods differ across studies, do not explicitly account for factors that may affect initial bias estimates, and often use averaged or assumed levels of bias. We examined scavenging and detection trial data from a 3-y study at a small, terrestrial windfarm in coastal New Jersey. Logistic regression models indicated that carcass size, substrate, and observer all affected carcass detection rates, with larger carcasses more likely to be detected than smaller carcasses, and those located on bare ground or grass more likely to be detected than those on gravel.

Known-fate mark–recapture models indicated that scavenging rates were highest within the first 3 d of placement, with some variation among seasons. We suggest that empirically based estimates of factors affecting observer detection and scavenging loss be generated for individual wind-farm mortality studies, because they likely vary across sites and could heavily bias resulting adjustment factors and mortality estimates.

Dickie, M., P. A. Smith, and H. G. Gilchrist. 2014. The Importance of Survey Timing on Shorebird Density Estimates at East Bay, Nunavut, Canada. *Waterbirds* **37**:394-401.

(Abstract)

Accurate estimates of population size and trends are often necessary for wildlife conservation, but imperfect and variable rates of detection can lead to substantially biased counts during surveys. The influence of survey timing relative to timing of breeding on the counts recorded for five shorebird species during transect surveys at East Bay, Nunavut, Canada, from 2000 to 2010 was examined. Transect counts varied widely among species and years, and transect counts were most strongly predicted by the density of nests found during more intensive surveys. However, after accounting for this variation, survey counts were influenced substantially by survey timing. Surveys carried out shortly after the median date of nest initiation (~2 days after) corresponded most closely to the densities of found nests, and if surveys were not within several days of the median date, the discrepancy between the two estimates was large. Although neither nest densities nor transect surveys are believed to be a perfect indication of local population status, these results suggest that the nearly inevitable variation in survey timing could introduce substantial bias into density estimates.

Deguchi, T., R. M. Suryan, and K. Ozaki. 2014. Muscle Damage and Behavioral Consequences from Prolonged Handling of Albatross Chicks for Transmitter Attachment. *The Journal of Wildlife Management* **78**:1302–1309.

(Abstract)

Capture and handling are essential methods for many studies of wild animals but can induce several harmful effects on individuals being studied. The relationship between physiological and behavioral responses in individuals exposed to these effects is not well known. We measured the blood level of muscle enzymes, aspartate aminotransferase (AST) and creatine kinase (CK), indicating muscle damage in handreared short-tailed albatross (Phoebastoria albatrus) chicks before and after prolonged restraint for transmitter attachment beyond the usual feeding. We analyzed the relationships between enzyme levels and albatross pre- and post-fledging behaviors. Prolonged restraint for transmitter

attachment elevated the blood levels of AST and CK in chicks. In chicks with higher levels of these enzymes, fledging date was earlier and the period to sustained flight after fledging was longer. These results indicated that prolonged handling for transmitter attachment on pre-fledging albatross chicks caused moderate muscle damage and behavioral changes before and after fledging. Although immediate post-fledging survival (the first 2 weeks at sea) did not appear to be affected, whether longer-term survival may be influenced is unknown. Reducing handling time for albatross chicks is important to reduce muscle damage and behavioral consequences.

Kesler, D. C., A. H. Raedeke, J. R. Foggia, W. S. Beatty, E. B. Webb, D. D. Humburg, and L. W. Naylor. 2014. Effects of Satellite Transmitters on Captive and Wild Mallards. *Wildlife Society Bulletin* **38**:557–565.

(Abstract)

Satellite telemetry has become a leading method for studying large-scale movements and survival in birds, yet few have addressed potential effects of the larger and heavier tracking equipment on study subjects. We simultaneously evaluated effects of satellite telemetry equipment on captive and wild mallards (Anas platyrhynchos) to assess impacts on behavior, body mass, and movement. We randomly assigned 55 captive ducks to one of 3 treatment groups, including a standard body harness group, a modified harness group, and a control group. Ducks in the control group were not fitted with equipment, whereas individuals in the other 2 groups were fitted with dummy transmitters attached with a Teflon ribbon harness or with a similar harness constructed of nylon cord. At the conclusion of the 14-week captive study, mean body mass of birds in the control group was 40–105 g (95% CI) greater than birds with standard harnesses, and 28–99 g (95% CI) greater than birds with modified harnesses. Further, results of focal behavior observations indicated ducks with transmitters were less likely to be in water than control birds. We also tested whether movements of wild birds marked with a similar Teflon harness satellite transmitter aligned with population movements reported by on-the-ground observers who indexed local abundances of midcontinent mallards throughout the non-breeding period. Results indicated birds marked with satellite transmitters moved concurrently with the larger unmarked population. Our results have broad implications for field research and suggest that investigators should consider potential for physiological and behavioral effects brought about by tracking equipment. Nonetheless, results from wild ducks indicate satellite telemetry has the potential to provide useful movement data.

Sauer JR, Zimmerman GS, Klimstra JD, Link WA. 2014. Hierarchical Model Analysis of the Atlantic Flyway Breeding Waterfowl Survey. *The Journal of Wildlife Management* **78**, 1050–1059.

(Abstract)

We used log-linear hierarchical models to analyze data from the Atlantic Flyway Breeding Waterfowl Survey. The survey has been conducted by state biologists each year since 1989 in the northeastern United States from Virginia north to New Hampshire and Vermont. Although yearly population estimates from the survey are used by the United States Fish and Wildlife Service for estimating regional waterfowl population status for mallards (*Anas platyrhynchos*), black ducks (*Anas rubripes*), wood ducks (*Aix sponsa*), and Canada geese (*Branta canadensis*), they are not routinely adjusted to control for time of day effects and other survey design issues. The hierarchical model analysis permits estimation of year effects and population change while accommodating the repeated sampling of plots and controlling for time of day effects in counting. We compared population estimates from the current stratified random sample analysis to population estimates from hierarchical models with alternative model structures that describe year to year changes as random year effects, a trend with random year effects, or year effects modeled as 1-year differences. Patterns of population change from the hierarchical model results generally were similar to the patterns described by stratified random sample estimates, but significant visibility differences occurred between twilight to midday counts in all species. Controlling for the effects of time of day resulted in larger population estimates for all species in the hierarchical model analysis relative to the stratified random sample analysis. The hierarchical models also provided a convenient means of estimating population trend as derived statistics from the analysis. We detected significant declines in mallard and American black ducks and significant increases in wood ducks and Canada geese, a trend that had not been significant for 3 of these 4 species in the prior analysis. We recommend using hierarchical models for analysis of the Atlantic Flyway Breeding Waterfowl Survey.

Pickens BA, King SL. 2014. Linking multi-temporal satellite imagery to coastal wetland dynamics and bird distribution. *Ecological Modelling* **285**, 1–12.

(Abstract)

Ecosystems are characterized by dynamic ecological processes, such as flooding and fires, but spatial models are often limited to a single measurement in time. The characterization of direct, fine-scale processes affecting animals is potentially valuable for management applications, but these are difficult to quantify over broad extents. Direct predictors are also expected to improve transferability of models beyond the area of study. Here, we investigated the ability of non-static and multi-temporal habitat characteristics to predict marsh bird distributions, while testing model generality and transferability between two coastal habitats. Distribution models were developed for king rail (*Rallus elegans*), common gallinule (*Gallinula galeata*), least bittern (*Ixobrychus exilis*), and purple gallinule (*Porphyrio*

martinica) in fresh and intermediate marsh types in the northern Gulf Coast of Louisiana and Texas, USA. For model development, repeated point count surveys of marsh birds were conducted from 2009 to 2011. Landsat satellite imagery was used to quantify both annual conditions and cumulative, multi-temporal habitat characteristics. We used multivariate adaptive regression splines to quantify bird–habitat relationships for fresh, intermediate, and combined marsh habitats. Multi-temporal habitat characteristics ranked as more important than single-date characteristics, as temporary water was most influential in six of eight models. Predictive power was greater for marsh type-specific models compared to general models and model transferability was poor. Birds in fresh marsh selected for annual habitat characterizations, while birds in intermediate marsh selected for cumulative wetness and heterogeneity. Our findings emphasize that dynamic ecological processes can affect species distribution and species–habitat relationships may differ with dominant landscape characteristics.

Roche EA, Shaffer TL, Anteau MJ, Sherfy MH, Stucker JH, Wiltermuth MT, Dovichin CM. 2014. Detection Probability of Least Tern and Piping Plover Chicks in a Large River System. *78* **4**, 709–720.

(Abstract)

Monitoring the abundance and stability of populations of conservation concern is often complicated by an inability to perfectly detect all members of the population. Mark-recapture offers a flexible framework in which one may identify factors contributing to imperfect detection, while at the same time estimating demographic parameters such as abundance or survival. We individually color-marked, recaptured, and re-sighted 1,635 federally listed interior least tern (*Sternula antillarum*; endangered) chicks and 1,318 piping plover (*Charadrius melodus*; threatened) chicks from 2006 to 2009 at 4 study areas along the Missouri River and investigated effects of observer-, subject-, and site-level covariates suspected of influencing detection. Increasing the time spent searching and crew size increased the probability of detecting both species regardless of study area and detection methods were not associated with decreased survival. However, associations between detection probability and the investigated covariates were highly variable by study area and species combinations, indicating that a universal mark-recapture design may not be appropriate.

Drever MC, Lemon MJF, Butler RW, Millikin RL. 2014. Monitoring populations of Western Sandpipers and Pacific Dunlins during northward migration on the Fraser River Delta, British Columbia, 1991–2013. *Journal of Field Ornithology* **85**, 10–22.

(Abstract)

The Fraser River Delta in British Columbia, Canada, is a globally significant stopover site for shorebirds, but the population status and trends of many species that use the site remain uncertain. We describe an ongoing program to monitor population trends of the two most abundant species, Western Sandpipers (*Calidris mauri*) and Dunlins (*Calidris alpina*), during northward migration. Counts of these species were conducted at a mudflat where large flocks assembled at mid-tide from 15 April to 15 May, 1991–2013, and we estimated species-specific counts as the product of daily total flock counts and species proportions obtained during supplementary sampling. The median peak count of both species combined was 177,000 birds, and occurred between 24 April and 3 May. Ratios (proportions) of the two species followed a predictable pattern during the migration period, with a low proportion of Western Sandpipers (3%–20%) in flocks before 20 April, followed by a rapid increase to 80%–100% between 25 April and 10 May and a variable decrease to 30%–80% by 15 May. Mean counts of Western Sandpipers showed no significant trend over the study period. Mean counts of Dunlins showed a non-linear trend, decreasing until 2001 and then increasing to 2013. Bias and random error in field counts were quantified by comparing field counts to counts made from photographs taken during surveys, and analysis revealed that field counts had a downward, but predictable, bias, accounting for >90% of birds present, with a stochastic error rate of 28.0%. Uncertainty in total population estimates was high after accounting for the effect of length of stay and sampling error. Population estimates suggested that 600,000 Western Sandpipers and 200,000 Dunlins typically passed through the site during northward migration. Our estimates indicate the usefulness of daily counts at major stopover sites during northward migration as an effective tool for monitoring shorebird populations, and underscore the need for conserving such sites.

Monitoring 2013

Soulliere GJ, Loges BM, Dunton EM, Luukkonen DR, Eichholz MW, Koch KE. 2013. Monitoring waterfowl in the Midwest during the non-breeding period: challenges, priorities and recommendations. *Journal of Fish and Wildlife Management* **4**, 395-405.

(Abstract)

Improved monitoring of waterfowl in the Midwest during the non-breeding period has been identified as a priority by the waterfowl management community (Soulliere *et al.* 2012b). Unbiased estimates of waterfowl abundance and distribution throughout the annual cycle would facilitate developing regional population and habitat objectives that are coordinated and connected to the NAWMP (Petrie et al. 2011). Waterfowl managers use population abundance objectives to quantify habitat objectives and frame conservation delivery strategies. Moreover, monitoring programs serve as a means to measure outcomes of management actions. They are needed to track changes in those quantitative metrics used

to define objectives as well as the outcome of management actions designed to impact the metrics. Population objectives based on statistically sound abundance estimates have been developed for breeding waterfowl in the Midwest, but objectives for migrating and wintering waterfowl have no estimates of precision and are based on a number of questionable assumptions (Soulliere *et al.* 2007). Developing regional population and habitat objectives for waterfowl during the non breeding period has posed a significant challenge due to the lack of unbiased data describing waterfowl distribution, abundance, composition, and migration and wintering chronology. Comprehensive waterfowl surveys across areas used by substantial numbers of non-breeding waterfowl would fulfill information needs at multiple scales. We provide the following recommendations to enhance waterfowl monitoring in the Midwest during the non-breeding period: To be most useful, monitoring programs must be part of a decision-making process with clear management objectives. At the state, regional, flyway, and species range-wide scales, stakeholders must generally agree on waterfowl management objectives, management questions, and identification of population and environmental monitoring strategies to address these questions. In addition, existing waterfowl monitoring programs as well as new needs should be prioritized and communicated to agency administrators so values are understood in relation to competing programs and limited budgets within government agencies. A comprehensive assessment of monitoring needs will enable stakeholders to better understand the role monitoring can play in population and habitat management decisions. Clearly stated management objectives and alternatives should guide development of monitoring protocols. Representatives of the USFWS Population Assessment Unit, Mississippi Flyway Council Technical Section, JVs, and NWRs should collaborate in developing a monitoring program, as these individuals typically coordinate regional-, state-, and NWR-scale waterfowl population and habitat management efforts. Cooperation will be essential to refine and expand non-breeding period surveys in the Midwest and the Mississippi Flyway. We recommend establishing a panel of experts to develop a framework for comprehensive surveys of non-breeding waterfowl in the Midwest, a Midwest Waterfowl Monitoring Team. This group should study similar monitoring efforts taking place in neighboring regions and may be expanded to a Mississippi Flyway Team with a Midwest Sub-team. A similar recommendation resulted from the MWS assessment (USFWS 2012). Specifically, the USFWS suggested “each Flyway form a MWS group to include States, JVs, NWR Inventory and Monitoring staff and USFWS Division personnel as appropriate to redesign this survey to achieve three major objectives: 1) refocus the survey on those species and or populations for which the survey information is used in annual harvest management decisions, 2) better tie survey results to specific habitats and JV implementation areas, and 3) address the outstanding safety concerns identified in this report, in part by eliminating areas that are of marginal value to addressing objectives 1 and 2.” The Flyway Waterfowl Monitoring Team (or Midwest Sub-Team) developing monitoring objectives should also have adequate representation by key non-government organizations and university waterfowl biologists (e.g., JV Science Team members), NAWMP Science Support Team members, and USFWS monitoring and survey specialists (i.e., USFWS Population Assessment Unit). The group should also include representation from pilots with experience flying waterfowl surveys and who are experienced with survey safety issues. A new (refined) coordinated monitoring approach for estimating populations during the non breeding period should be founded on the MWS, taking advantage of current dedicated monitoring resources improving protocols and expanding from mid-winter to spring (high biological value), and also maintaining a fall effort where

necessary (hunter-support focus). This program should include a statistical sampling frame that facilitates estimation of precision and reduces potential biases, while striving to limit cost increases beyond the current MWS through survey design and improved agency collaboration. Consideration must be given to the varied landscape eco-regions of the Midwest, but survey design must ultimately meet management objectives. A preferred monitoring approach in the Big Rivers Region would likely include a combination of the existing Illinois and Central Mississippi Rivers surveys and the experimental Wabash River survey (Illinois Natural History Survey) with the IWMM Initiative. During the Illinois and Central Mississippi Rivers surveys, habitat conditions are recorded, increasing our understanding of how habitat characteristics influence waterfowl abundance and distribution; however, it is a cruise survey assuming 100% detection probability and provides no estimates of precision. Alternatively, the experimental Wabash River survey incorporates a sampling design allowing for estimates of precision plus estimates of detection probability based on habitat characteristics. While this newly designed survey would provide an estimate of the abundance of each species within the surveyed area during a given point in time, replicate surveys within seasons would facilitate estimation of overall seasonal use (e.g., winter and spring use-days) as well as the duration individual species of waterfowl occur in the region. The IWMM Initiative could provide this additional information as well as other evidence to assess habitat management practices. The IWMM Initiative implemented on NWRs and other conservation lands across the Midwest and Mississippi Flyway can provide local abundance indications of individual species and factors influencing habitat selection. When pooled across areas, the information can be even more valuable to conservation planners. As indicated earlier, a well-developed regional survey would provide estimates of species-specific abundance during a specific point in time. However, when combined with additional migration chronology and distribution data provided by the IWMM Initiative (i.e., “migration curves”), estimates of total use days by season and species can be calculated. For example, let’s assume a regional 5 March aerial survey estimate of 150,000 is combined with a 75% (6000 / 8000 = 0.75) IWMM proportional estimate of peak abundance based on bi-weekly surveys within the area encompassed by the 5 March aerial survey (Figure 4). Regional peak abundance can be estimated at 200,000 (150,000 / 0.75 = 200,000), and total Species X use days (i.e., energy requirements for habitat calculations) in the planning region are calculated by multiplying the average daily abundance in the region by the number of days in the planning period. In other words, estimated total use days for the planning region are equivalent to the area under the IWMM-based migration curve (Figure 4) extrapolated to the area encompassed by the 5 March aerial survey. This approach assumes IWMM data are representative of regional populations and error related to multiple parameter estimates is acceptable. Nevertheless, the method offers a much improved means for generating regional use-day estimates compared to current techniques used by JVs. Preferred monitoring approaches for large open-waters of the Northern Lakes Region would reflect similar techniques currently used at Lake Ontario (Long Point Waterfowl) and Lakes St. Clair and Erie (Michigan DNR and Michigan State University). Inland river areas in the northern Midwest may require sampling design more similar to the Big Rivers Region. However, monitoring during ice-free winter periods and during spring migration will require an expanded transect-based survey (i.e., breeding survey protocol) in order to encompass myriad basins and increasingly wide waterfowl distributions. Similar to the Big Rivers Region recommendation, collaboration with the IWMM Initiative will provide a means to generate improved estimates of waterfowl use days (Figure 4) and energy

requirements in the Northern Lakes Region. The waterfowl management community will need to weigh values of a new non-breeding period survey effort against extant surveys and assess return on investment. Because multiple surveys per season are recommended for non-breeding waterfowl, starting in early January and occurring through the spring migration period, current surveys (e.g., weekly fall surveys, annual breeding survey in the Northern Lakes Region) may require de-emphasis. Furthermore, a scientifically sound winter-spring period survey occurring at a lower frequency (every two years) may provide a viable option. Scientists working on the IWMM Initiative must continue to communicate with Mississippi Flyway Council Technical Section and JV scientists as well as other NWR biologists. While a promising decision support tool for managers, the spatial scope of the initiative exceeds those of JVs and USFWS administrative regions. The IWMM Initiative would better realize its full potential with an administrative structure that fosters wide-ranging communication and coordination inside and outside the USFWS. The IWMM Initiative is positioned to provide leadership in integrating environmental monitoring at NWR, state, regional, and flyway scales. Scientists engaged in IWMM efforts have an opportunity to improve our understanding of how habitat modification can influence local waterfowl abundance, especially when linked to larger scale patterns of waterfowl abundance and environmental population drivers. Considering the number of NWRs and other conservation areas potentially contributing spatially-referenced population and habitat data to the IWMM effort, data management could become a significant challenge. Data management and retrieval protocols must provide conservation planners and researchers with effective access to this information to help ensure maximum value.

Gaston AJ, Francis CM, Nisbet ICT. 2013. Continued use of soft-metal bands on gulls in North America reduces the value of recovery data. *Journal of Field Ornithology* **84**, 403-415.

(Abstract)

Use of soft-metal (aluminum alloy) bands on gulls (Laridae) is known to result in high rates of band loss and, as a result, hard-metal (monel, incoloy, or stainless steel) bands are superior for most studies.However, the U.S. Bird Banding Laboratory (BBL) and the Canadian Wildlife Service Bird Banding Office continue to issue soft bands for use on gulls, and the BBL does not make specific recommendations about use of hard bands so many banders continue to use soft bands. For wholly marine species of gulls banded in North America since 1996, ~20% have been banded with soft bands; the proportion of soft bands used on partially freshwater gulls was ~70% up to 2009, but has since fallen to 40%. Using hierarchical Bayesian models in program MARK, we analyzed recovery data for three gull species and found that estimates of annual survival rates derived from soft bands (0.68–0.81) were lower than those derived from hard bands (0.85–0.96). Comparison of survival rates of Herring Gulls (*Larus argentatus*) in the Great Lakes basin and on the Atlantic coast provided no evidence that soft bands last longer in freshwater than saltwater. Band loss compromises many types of studies, including those assessing the possible effects of climate change. We recommend that use of soft bands on gulls be discontinued, and that banders be required to

use hard bands on these species in the future. The same consideration applies to other long-lived species, including some waterfowl and all albatrosses, pelicans, cormorants, shearwaters, petrels, terns, shorebirds, and alcids. Use of hard bands should be based on expectations about a species' longevity and evidence of band wear, rather than on whether or not it occurs in saltwater.

Péron G, Ferrand Y, Leray G, Gimenez O. 2013. Waterbird demography as indicator of wetland health: The French-wintering common snipe population. *Biological Conservation* **164,** 123–128.

(Abstract)

The population dynamics of waterbirds constitute an indicator of wetland conservation status. However, waterbird population censuses are difficult to implement because the individuals are very mobile within their range, and some species are elusive or breed in remote areas. Therefore, demographic models based on the estimation of survival and breeding success appear as a reliable alternative to population censuses. Here we present this model-based approach in the case of the French-wintering snipe population (*Gallinago gallinago*), which breeds mainly in Northern and Eastern Europe. Using a multi-state model to accommodate the mobile nature of waterbirds, we estimate snipe survival using a joint analysis of capture–recapture and ring-recovery data. Then, we use matrix population models to estimate the minimum recruitment rate required to maintain the population at its current size and derive a chart for using age ratio of ringed birds as indicator of population trend. Although we call for more data collection in order to reduce uncertainty, we conclude that occasional declines are likely after years with poor breeding success, but that the French-wintering snipe population is on average stable. Individual-based monitoring data and population modeling make it possible to use waterbirds as indicator species at the flyway scale.

Nicol S, Roach JK, Griffith B. 2013. Spatial heterogeneity in statistical power to detect changes in lake area in Alaskan National Wildlife Refuges. *Landscape Ecology* **28,** 507–517.

(Abstract)

Over the past 50 years, the number and size of high-latitude lakes have decreased throughout many regions; however, individual lake trends have been variable in direction and magnitude. This spatial heterogeneity in lake change makes statistical detection of temporal trends challenging, particularly in small analysis areas where weak trends are difficult to separate from inter- and intra-annual variability. Factors affecting trend detection include inherent variability, trend magnitude, and sample size. In this paper, we investigated

how the statistical power to detect average linear trends in lake size of 0.5, 1.0 and 2.0 %/year was affected by the size of the analysis area and the number of years of monitoring in National Wildlife Refuges in Alaska. We estimated power for large (930–4,560 sq km) study areas within refuges and for 2.6, 12.9, and 25.9 sq km cells nested within study areas over temporal extents of 4–50 years. We found that: (1) trends in study areas could be detected within 5–15 years, (2) trends smaller than 2.0 %/year would take >50 years to detect in cells within study areas, and (3) there was substantial spatial variation in the time required to detect change among cells. Power was particularly low in the smallest cells which typically had the fewest lakes. Because small but ecologically meaningful trends may take decades to detect, early establishment of long-term monitoring will enhance power to detect change. Our results have broad applicability and our method is useful for any study involving change detection among variable spatial and temporal extents.

Monitoring 2012 and earlier

2012

Van Dijk K, Oosterhuis R, Middendorp B, Majoor F (2012) New longevity records of Black-headed Gull, with comments on wear and loss of aluminium rings. *Dutch Birding* **34**, 20-31.

(Abstract)

Black-headed Gull (ringed as chick on 25 June 1978), seen at almost 33 years old.

Amano T, Okamura H, Carrizo SF, Sutherland WJ. 2012. Hierarchical models for smoothed population indices: The importance of considering variations in trends of count data among sites. *Ecological Indicators* **13**, 243–252.

(Abstract)

Population indices quantify changes in relative population sizes, which underpin much of basic ecology and conservation science. However, temporal changes in population counts may vary among survey sites for both ecological and artificial reasons, confounding existing population indices estimated without accounting for such variations. We created a smoothed hierarchical model, and compared its performance against the conventional approaches (generalized linear models and generalized additive models) and a non-smoothed hierarchical model using simulation data with a known nonlinear trend. The smoothed hierarchical model always estimated population indices with the best accuracy and precision; the performance of other models deteriorated substantially with increasing variation in trends of population counts

among sites, causing inaccurate estimation of population growth rates. The estimated variations in trends of population counts among sites for 233 out of 518 North American breeding bird species were larger than the value used in the simulation where there was a considerable difference in the performance between hierarchical models and the conventional approaches. These estimated variations in trends of population counts among sites were particularly large in gregarious waterbirds. These results suggest that the smoothed hierarchical model developed in this study should play an important role in accurately assessing population indices, particularly for gregarious waterbirds, using count data from large-scale, long-term surveys in the field.

Almaraz P, Green AJ, Aguilera E, Rendón MA, Bustamante J. 2012. Estimating partial observability and nonlinear climate effects on stochastic community dynamics of migratory waterfowl. *Journal of Animal Ecology* **81**, 1113–1125.

(Abstract)

1.Understanding the impact of environmental variability on migrating species requires the estimation of sequential abiotic effects in different geographic areas across the life cycle. For instance, waterfowl (ducks, geese and swans) usually breed widely dispersed throughout their breeding range and gather in large numbers in their wintering headquarters, but there is a lack of knowledge on the effects of the sequential environmental conditions experienced by migrating birds on the long-term community dynamics at their wintering sites.

2. Here, we analyse multidecadal time-series data of 10 waterfowl species wintering in the Guadalquivir Marshes (SW Spain), the single most important wintering site for waterfowl breeding in Europe. We use a multivariate state-space approach to estimate the effects of biotic interactions, local environmental forcing during winter and large-scale climate during breeding and migration on wintering multispecies abundance fluctuations, while accounting for partial observability (observation error and missing data) in both population and environmental data.

3. The joint effect of local weather and large-scale climate explained 31.6% of variance at the community level, while the variability explained by interspecific interactions was negligible (<5%). In general, abiotic conditions during winter prevailed over conditions experienced during breeding and migration. Across species, a pervasive and coherent nonlinear signal of environmental variability on population dynamics suggests weaker forcing at extreme values of abiotic variables.

4. Modelling missing observations through data augmentation increased the estimated magnitude of environmental forcing by an average 30.1% and reduced the impact of stochasticity by 39.3% when accounting for observation error. Interestingly however, the impact of environmental forcing on community dynamics was underestimated by an average 15.3% and environmental stochasticity overestimated by 14.1% when ignoring both observation error and data augmentation.

5.These results provide a salient example of sequential multiscale environmental forcing in a major migratory bird community, which suggests a demographic link between the breeding and wintering grounds operating through nonlinear environmental effects. Remarkably, this study highlights that modelling observation error in the environmental covariates of an ecological model can be proportionally more important than modelling this source of variance in the population data.

Buler JJ, Randall LA, Fleskes JP, Barrow Jr. WC, Bogart T, Kluver D. 2012. Mapping Wintering Waterfowl Distributions Using Weather Surveillance Radar. *PLoS ONE* ***7*** e41571

(Abstract)

The current network of weather surveillance radars within the United States readily detects flying birds and has proven to be a useful remote-sensing tool for ornithological study. Radar reflectivity measures serve as an index to bird density and have been used to quantitatively map landbird distributions during migratory stopover by sampling birds aloft at the onset of nocturnal migratory flights. Our objective was to further develop and validate a similar approach for mapping wintering waterfowl distributions using weather surveillance radar observations at the onset of evening flights. We evaluated data from the Sacramento, CA radar (KDAX) during winters 1998–1999 and 1999–2000. We determined an optimal sampling time by evaluating the accuracy and precision of radar observations at different times during the onset of evening flight relative to observed diurnal distributions of radio-marked birds on the ground. The mean time of evening flight initiation occurred 23 min after sunset with the strongest correlations between reflectivity and waterfowl density on the ground occurring almost immediately after flight initiation. Radar measures became more spatially homogeneous as evening flight progressed because birds dispersed from their departure locations. Radars effectively detected birds to a mean maximum range of 83 km during the first 20 min of evening flight. Using a sun elevation angle of 25u (28 min after sunset) as our optimal sampling time, we validated our approach using KDAX data and additional data from the Beale Air Force Base, CA (KBBX) radar during winter 1998–1999. Bias-adjusted radar reflectivity of waterfowl aloft was positively related to the observed diurnal density of radio-marked waterfowl locations on the ground. Thus, weather radars provide accurate measures of relative wintering waterfowl density that can be used to comprehensively map their distributions over large spatial extents.

Hochachka WM, Fink D, Hutchinson RA, Sheldon D, Wong W-K, Kelling S. 2012. Data-intensive science applied to broad-scale citizen science. *TRENDS in Ecology and Evolution* **27**, 130-137.

(Abstract)

Identifying ecological patterns across broad spatial and temporal extents requires novel approaches and methods for acquiring, integrating and modeling massive quantities of diverse data. For example, a growing number of research projects engage continent-wide networks of volunteers ('citizen-scientists') to collect species occurrence data. Although these data are information rich, they present numerous challenges in project design, implementation and analysis, which include: developing data collection tools that maximize data quantity while maintaining high standards of data quality, and applying new analytical and visualization techniques that can accurately reveal patterns in these data. Here, we describe how advances in data-intensive science provide accurate estimates in species distributions at continental scales by identifying complex environmental associations.

Szabo JK, Butchart SHM, Possingham HP, Garnett ST. 2012. Adapting global biodiversity indicators to the national scale: A Red List Index for Australian birds. *Biological Conservation* **148**, 61-68.

(Abstract)

The Red List Index (RLI), which uses information from the IUCN Red List to track trends in the projected overall extinction risk of sets of species, is among the indicators adopted by the world's governments to assess performance under the Convention on Biological Diversity and the United Nations Millennium Development Goals. For greatest impact, such indicators need to be measured and used at a national scale as well as globally. We present the first application of the RLI based on assessments of extinction risk at the national scale using IUCN's recommended methods, evaluating trends in the status of Australian birds for 1990–2010. We calculated RLIs based on the number of taxa in each Red List category and the number that changed categories between assessments in 1990, 2000 and 2010 as a result of genuine improvement or deterioration in status. A novel comparison between trends at the species and ultrataxon (subspecies or monotypic species) level showed that these were remarkably similar, suggesting that current global RLI trends at the species level may also be a useful surrogate for tracking losses in genetic diversity at this scale, for which no global measures currently exist. The RLI for Australia is declining faster than global rates when migratory shorebirds and seabirds are included, but not when changes resulting from threats in Australia alone are considered. The RLI of oceanic island taxa has declined faster than those on the continent or on continental islands. There were also differences in the performance of different jurisdictions within Australia.

2011

Wilson HB, Kendall BE, Fuller RA, Milton DA, Possingham HP. 2011. Analyzing Variability and the Rate of Decline of Migratory Shorebirds in Moreton Bay, Australia. *Conservation*

Biology **25**, 758-766.

(Abstract)

Estimating the abundance of migratory species is difficult because sources of variability differ substantially among species and populations. Recently developed state-space models address this variability issue by directly modeling both environmental and measurement error, although their efficacy in detecting declines is relatively untested for empirical data. We applied state-space modeling, generalized least squares (with autoregression error structure), and standard linear regression to data on abundance of wetland birds (shorebirds and terns) at Moreton Bay in southeast Queensland, Australia. There are internationally significant numbers of 8 species of waterbirds in the bay, and it is a major terminus of the large East Asian-Australasian Flyway. In our analyses, we considered 22 migrant and 8 resident species. State-space models identified abundances of 7 species of migrants as significantly declining and abundance of one species as significantly increasing. Declines in migrant abundance over 15 years were 43–79%. Generalized least squares with an autoregressive error structure showed abundance changes in 11 species, and standard linear regression showed abundance changes in 15 species. The higher power of the regression models meant they detected more declines, but they also were associated with a higher rate of false detections. If the declines in Moreton Bay are consistent with trends from other sites across the flyway as a whole, then a large number of species are in significant decline.

Rhodes JR, Jonzen N. 2011. Monitoring temporal trends in spatially structured populations: how should sampling effort be allocated between space and time? *Ecography* **34**, 1040-1048.

(Abstract)

Estimating temporal trends in spatially structured populations has a critical role to play in understanding regional changes in biological populations and developing management strategies. Designing effective monitoring programmes to estimate these trends requires important decisions to be made about how to allocate sampling effort among spatial replicates (i.e. number of sites) and temporal replicates (i.e. how often to survey) to minimise uncertainty in trend estimates. In particular, the optimal mix of spatial and temporal replicates is likely to depend upon the spatial and temporal correlations in population dynamics. Although there has been considerable interest in the ecological literature on understanding spatial and temporal correlations in species' population dynamics, little attention has been paid to its consequences for monitoring design. We address this issue using model-based survey design to identify the optimal allocation of sampling effort among spatial and temporal replicates for estimating population trends under different levels of spatial and temporal correlation. Based on linear trends, we show that how we should allocate sampling effort among spatial and temporal replicates depends crucially on the spatial and temporal correlations in population dynamics, environmental variation, observation error and the spatial variation in temporal trends. When spatial correlation is low and temporal correlation is high, the best option is likely to be to sample many sites infrequently, particularly when observation error and/or spatial variation in

temporal trends are high. When spatial correlation is high and temporal correlation is low, the best option is likely to be to sample few sites frequently, particularly when observation error and/or spatial variation in temporal trends are low. When abundances are spatially independent, it is always preferable to maximise spatial replication. This provides important insights into how spatio-temporal monitoring programmes should be designed to estimate temporal trends in spatially structured populations.

Arakida H, Mitsuhashi H, Kamada M, Koyama K. 2011. Mapping the potential distribution of shorebirds in Japan: the importance of landscape-level coastal geomorphology. *Aquatic Conservation: Marine and Freshwater Ecosystems* **148**, 61-68.

(Abstract)

1. Several recent studies have predicted potential habitats along coastal areas using large-scale physical environmental variables. However, no indices or methodologies for predicting tidal-flat habitats at a large spatial scale have been developed. Tidal flats housing large populations of shorebirds have been identified in semi-enclosed seas. Thus, bays are probably important topographic units for evaluating the locations of shorebirds' non-breeding habitats.

2. We developed a GIS-based methodology to extract "bay units" at any scale from coastline data. Using three environment variables: the area of the bay units at three spatial scales, the percentage of shallow water area in each bay unit, and the spring-tide range, we were able to predict tidal-flat habitats for six shorebird species with high accuracy (AUC>0.95, the sensitivity >90%).

3. Our results showed that the percentage of shallow water area in small- and medium-scale bays was the best predictor of tidal-flat habitats, followed by the area of bays at a large spatial scale. This indicates that the size (scale) of a bay and the percentage of shallow water present are highly related to the presence of tidal-flat habitats.

4. The prediction maps for individual species clearly showed differences in the distribution patterns of species. These maps were overlaid to identify potentially species-rich areas. This determined that tidal flats located in principal bays in Japan were likely to harbour shorebird habitats. Thus, it is imperative to pursue the conservation and restoration of the tidal flats in these bays.