

### In this review:

#### A. Recent articles with abstracts

O/A denotes an open access article or journal

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Masero, J.A., Castro, M., Estrella, S.M., and Perez-Hurtado, A. **Evaluating impacts of shellfish and baitworm digging on bird populations: short-term negative effects on the availability of the mudsnail *Hydrobia ulvae* to shorebirds.**

*Biodiversity and Conservation* 17(4): 691-701, 2008.

**Notes:** Many shorebird populations show evidence of declines. To identify the causes is a key issue in developing comprehensive shorebird conservation plans. In coastal areas, shorebirds are vulnerable to effects of shellfish and baitworm digging, including reduction of the food supply. The mudsnail *Hydrobia ulvae* is often reported to be the dominant inhabitant of intertidal mudflats, and is common in the diet of migrating and wintering shorebirds. This prosobranch mollusc lives at or just below the surface of intertidal mudflats, so it might be directly damaged and killed or buried within the mud by hand diggers. We studied the short-term effects of digging by hand on the availability of mudsnail to shorebirds. Twenty centimetres deep core samples were collected from undisturbed and recently disturbed intertidal mud. The total mudsnail density and biomass per core sample was similar in disturbed and undisturbed mud. However, mudsnail density and biomass were significantly lower in disturbed mud than in undisturbed mud when only the upper five centimetres of the mud were compared. If only the mudsnails found in this surface layer are potentially available for shorebirds, the available mudsnail density and biomass fraction for shorebirds had decreased by  $62.6 \pm 11.4\%$  and  $75.7 \pm 7.2\%$  in disturbed mud, respectively. The potential impact of this decreasing mudsnail fraction on shorebirds is addressed.

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Dugan, J.E., Hubbard, D.M., Rodil, I.F., Revell, D.L., and Schroeter, S. **Ecological effects of coastal armoring on sandy beaches.** *Marine Ecology: An Evolutionary Perspective* 29(s1): 160-170, 2008.

**Notes:** Use of coastal armoring is expected to escalate in response to the combination of expanding human populations, beach erosion, and sea level rise along the coasts. To provide a conceptual framework, we developed hypotheses concerning the ecological effects of beach habitat loss associated with coastal armoring. As beaches narrow in response to armoring, dry upper intertidal zones should be lost disproportionately, reducing the habitat types available and the diversity and abundance of macroinvertebrates. Predators, such as shorebirds, could respond to a combination of (i) habitat loss; (ii) decreased accessibility at high tides; and (iii) reduced prey availability on armored beaches. To examine those predictions, zone widths and the distribution and abundance of macroinvertebrates and birds were compared on paired armored and unarmored segments of narrow bluff-backed beaches in southern California. Our results supported the predictions and revealed some unexpected effects of armoring on birds. Dry upper beach zones were lacking and mid-beach zones were narrower (>2 times) year-round on armored segments compared to adjacent unarmored segments. The abundance, biomass and size of upper intertidal macroinvertebrates were also significantly lower on armored segments. Shorebirds, most of which were foraging, responded predictably with significantly lower species richness (two times) and abundance (>3 times) on armored segments. Gulls and other birds (including seabirds), which use beaches primarily for roosting, were also significantly lower in abundance (>4 times and >7 times respectively) on armored segments, an important unexpected result. Given the accelerating pressures

on sandy beaches from coastal development, erosion and rising sea levels, our results indicate that further investigation of ecological responses to coastal armoring is needed for the management and conservation of these ecosystems.

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Barber-Meyer, S.M., Kooyman, G.L., and Ponganis, P.J. **Trends in western Ross Sea emperor penguin chick abundances and their relationships to climate.** *Antarctic Science* 20(1): 3-11, 2008.

**Notes:** The emperor penguin (*Aptenodytes forsteri*) is extremely dependent on the extent and stability of sea ice, which may make the species particularly susceptible to environmental change. In order to appraise the stability of the emperor penguin populations at six colonies in the western Ross Sea, we used linear regression analysis to evaluate chick abundance trends (1983-2005) and Pearson's r correlation to assess their relation to two local and two large-scale climate variables. We detected only one significant abundance trend; the Cape Roget colony increased from 1983 to 1996 ( $n = 6$ ). Higher coefficients of variation in chick abundances at smaller colonies (Cape Crozier, Beaufort Island, Franklin Island) suggest that such colonies occupy marginal habitat, and are more susceptible to environmental change. We determined chick abundance to be most often correlated with local Ross Sea climate variables (sea ice extent and sea surface temperature), but not in consistent patterns across the colonies. We propose that chick abundance is most impacted by fine scale sea ice extent and local weather events, which are best evaluated by on-site assessments. We did not find sufficient evidence to reject the hypothesis that the overall emperor penguin population in the Ross Sea was stable during this period.

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Grémillet, D., Pichegru, L., Kuntz, G., Woakes, A.G., Wilkinson, S., Crawford, R.J.M., and Ryan, P.G. **A junk-food hypothesis for gannets feeding on fishery waste.** *Proceedings of the Royal Society of London [B]* 275(1639): 1149-1156, 2008.

**Notes:** Worldwide fisheries generate large volumes of fishery waste and it is often assumed that this additional food is beneficial to populations of marine top-predators. We challenge this concept via a detailed study of foraging Cape gannets *Morus capensis* and of their feeding environment in the Benguela upwelling zone. The natural prey of Cape gannets (pelagic fishes) is depleted and birds now feed extensively on fishery wastes. These are beneficial to non-breeding birds, which show reduced feeding effort and high survival. By contrast, breeding gannets double their diving effort in an attempt to provision their chicks predominantly with high-quality, live pelagic fishes. Owing to a scarcity of this resource, they fail and most chicks die. Our study supports the junk-food hypothesis for Cape gannets since it shows that non-breeding birds can survive when complementing their diet with fishery wastes, but that they struggle to reproduce if live prey is scarce. This is due to the negative impact of low-quality fishery wastes on the growth patterns of gannet chicks. Marine management policies should not assume that fishery waste is generally beneficial to scavenging seabirds and that an abundance of this artificial resource will automatically inflate their populations.

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Waugh, S.M., Baker, G.B., Gales, R., and Croxall, J.P. **CCAMLR process of risk assessment to minimise the effects of longline fishing mortality on seabirds.** *Marine Policy* 32(3): 442-454, 2008.

**Notes:** We describe the process used in the fisheries management system of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) to minimise seabird bycatch, and the risk-assessment methodology developed to assist this. We examine the progress of several Regional Fishery Management Organisations in taking steps to address seabird bycatch. CCAMLR has the most advanced system of management among the RFMOS covered in this review, and has made the most demonstrable progress in reducing seabird bycatch levels in its longline fisheries. A combination of proven mitigation measures, extensive monitoring by independent observers, annual expert review of seabird bycatch rates and evolving fishery and mitigation practices have been instrumental in reducing seabird bycatch in CCAMLR fisheries.

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Peck, D.R., Faulquier, L., Pinet, P., Jaquemet, S., and LeCorre, M. **Feral cat diet and impact on sooty terns at Juan de Nova Island, Mozambique Channel.** *Animal Conservation* 11(1): 65-74, 2008.

**Notes:** Feral cat *Felis catus* predation on seabirds has been well documented; however, details regarding shifts in feral cat diet in relation to seabird availability, seabird predation rate and impact on seabird population dynamics are scarce. Here, we present

data documenting a seasonal shift in feral cat diet at Juan de Nova Island, Mozambique Channel. We also quantify sooty tern *Sterna fuscata* predation by feral cats and examine the impact on sooty terns over both the short term (by removing individual cats from sub-colonies) and over the longer term by highlighting their influence on population growth rate ( $\lambda$ ) using a deterministic matrix model. Cat diet shifted dramatically from insects, rats and mice outside the tern breeding season to primarily terns when terns were breeding. The predation rate of sooty terns at Juan de Nova was estimated at 5.94 terns cat<sup>-1</sup> day<sup>-1</sup>, with a proportion of these (22%) being killed without being consumed ('surplus kills'). When only one cat was removed from each sub-colony, tern predation declined tenfold in the short term. From our matrix model, the annual growth rate for sooty terns was 1.01 in the absence of cat predation. It remained above one until a predation impact equivalent to approximately three times the estimated cat density (12.04 per km<sup>2</sup>) was incorporated. Our results demonstrate that cats preferentially predate and have an impact on breeding sooty terns at Juan de Nova, and that an increase in cat density could lead to negative effects on population growth, despite the large breeding tern population.

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Jones, H.P., Tershy, B.R., Zavaleta, E.S., Croll, D.A., Keitt, B.S., Finkelstein, M.E., and Howald, G.R. **Severity of the effects of invasive rats on seabirds: A global review.** *Conservation Biology* 22(1): 16-26, 2008.

**Notes:** Invasive rats are some of the largest contributors to seabird extinction and endangerment worldwide. We conducted a meta-analysis of studies on seabird-rat interactions to examine which seabird phylogenetic, morphological, behavioral, and life history characteristics affect their susceptibility to invasive rats and to identify which rat species have had the largest impact on seabird mortality. We examined 94 manuscripts that demonstrated rat effects on seabirds. All studies combined resulted in 115 independent rat-seabird interactions on 61 islands or island chains with 75 species of seabirds in 10 families affected. Seabirds in the family Hydrobatidae and other small, burrow-nesting seabirds were most affected by invasive rats. Laridae and other large, ground-nesting seabirds were the least vulnerable to rats. Of the 3 species of invasive rats, *Rattus rattus* had the largest mean impact on seabirds followed by *R. norvegicus* and *R. exulans*; nevertheless, these differences were not statistically significant. Our findings should help managers and conservation practitioners prioritize selection of islands for rat eradication based on seabird life history traits, develop testable hypotheses for seabird response to rat eradication, provide justification for rat eradication campaigns, and identify suitable levels of response and prevention measures to rat invasion. Assessment of the effects of rats on seabirds can be improved by data derived from additional experimental studies, with emphasis on understudied seabird families such as Sulidae, Phalacrocoracidae, Spheniscidae, Fregatidae, Pelecanoididae, Phaethontidae, and Diomedidae and evaluation of rat impacts in tropical regions.

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Botto, F., Mendez-Casariago, A., Valinas, M., and Iribarne, O. **Spatial heterogeneity created by burrowing crabs affects human impact on migratory shorebirds.** *Estuaries and Coasts* 31(1): 134-143, 2008.

**Notes:** We show that, as previously described, there are conflicts between areas used by people and shorebirds. However, we propose that burrowing organisms add complexity to the shorebird-human interaction that should be taken into account for management and conservation. This is because SW Atlantic mudflats are dominated by high densities (up to 60 crabs m<sup>-2</sup>) of a strong bioturbator, the burrowing crab *Neohelice granulata* (= *Chasmagnathus granulatus*). These crabs affect the habitat use and foraging performance of shorebird species. The two-banded plover *Charadrius falklandicus* feed more in burrow areas whereas the yellowlegs *Tringa* spp. and the white-rumped sandpiper *Calidris fuscicollis* tend to avoid burrow areas. We evaluated the effect of human recreational activities on shorebirds, taking into account shorebird-crab interaction, during shorebird migratory periods (November to April) of 2001, 2002, and 2003. This study was performed at the Mar Chiquita coastal lagoon (37°40' S, Argentina). Results showed that people only rarely used the extensive soft bottom intertidals dominated by burrowing assemblages of *N. granulata* because the soft sediments make walking difficult. Therefore, human impact is reduced for the two-banded plover. However, for several migratory shorebirds that also avoid burrow areas, these areas act as suboptimal alternative areas when human impact is important in their preferred habitats. When human activity is low, shorebirds remain foraging in the area but they decrease their feeding intakes. The extensions of burrow areas differ among estuaries and are likely to generate between-estuaries differences as stopover sites for shorebirds. Also, other species that form large burrowing assemblages can have a similar impact on shorebird-human interactions.

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Rolland, V., Barbraud, C., and Weimerskirch, H. **Combined effects of fisheries and climate on a migratory long-lived marine predator.** *Journal of Applied Ecology* 45(1): 4-13, 2008.

**Notes:** 1. The impact of climate on marine ecosystems is now well documented, but remains complex. Climate change may interact with human activities to effect population dynamics. In addition, in migratory species conditions are different between the breeding and wintering grounds, resulting in more complex dynamics. All these possible effects should be considered to predict the future of endangered species, but very few studies have investigated such combined interactions. 2. As a case study, we assessed the relative impact of fisheries and of oceanographic conditions in breeding and wintering sites on adult survival and breeding success of a population of the endangered black-browed albatross *Thalassarche melanophrys* in the Kerguelen Islands, Southern Indian Ocean. This study was based on long-term monitoring of individually marked individuals (1979-2005) and identification by tracking studies and band recoveries of the oceanic feeding zones used during breeding and non-breeding seasons. 3. Breeding success was variable until 1997 and then declined gradually, from 0.88 to 0.48 chicks per egg laid. It was favoured by positive sea-surface temperature anomalies (SSTA) and trawl fishery during the breeding period, whereas it was negatively affected by positive SSTA around Tasmania, where the species winters. Adult survival was  $0.918 \pm 0.004$  on average and increased with SSTA during incubation, but decreased significantly with high tuna longlining effort in the wintering zone. 4. Our analyses show that demographic parameters were influenced by both climate and fisheries in both breeding and wintering grounds, but with different effect size. Black-browed albatross breeding success was more favoured by trawlers' offal and discards than by any of the seasonally/spatially oceanographic conditions, whereas their survival was equally affected by tuna longline fishery through incidental by-catch and spring SSTA. 5. Synthesis and applications. Our work underlines that a comprehensive knowledge of the life history of a species in all the habitats used is important to disentangle the respective roles of environmental conditions and human factors on population dynamics. Identification of these effects is required when proposing effective conservation measures, because the conservation of threatened species may depend on their wintering country's exclusive economic zones.

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Brinker, D.F., McCann, J.M., Williams, B., and Watts, B.D. **Colonial-nesting seabirds in the Chesapeake Bay region: Where have we been and where are we going?** *Waterbirds* 30(Special Publication 1): 93-104, 2007.

**Notes:** Over the past one hundred years, dramatic changes have taken place in populations of colonial-nesting seabirds that breed within Chesapeake Bay and the Maryland-Virginia coastal region. Populations of species that were decimated by extensive market hunting in the late nineteenth century recovered, additional species colonized the region and in the past ten years many species have declined. During 2003, over 72,000 pairs of seabirds of thirteen species bred within the region. Breeding population sizes are presented and population trends evaluated based on benchmark census information from 1977 and regional censuses compiled during 1993 and 2003 by the states of Maryland and Virginia. Since the 1970s, Brown Pelicans (*Pelicanus occidentalis*) and Double-crested Cormorants (*Phalacrocorax auritus*) expanded into the region and now represent six percent of the seabird guild. Gull populations have exhibited important changes and have affected other seabird species. Significant population declines have occurred in Black Skimmers (*Rynchops niger*), Gull-billed Terns (*Sterna nilotica*), Royal Terns (*Sterna maxima*), and Common Terns (*Sterna hirundo*). Since 1993, populations of thirteen seabird species have declined, many significantly. Conservation challenges for seabird species in the region include: 1) habitat change and loss as a result of sea-level rise, 2) increasing mammalian predator populations, 3) competition for colony sites, 4) human infrastructure conflicts, and 5) changing fisheries populations and harvest. Conserving and managing colonial-nesting seabirds in the coming decades as the human population continues to increase in the mid-Atlantic region will present significant challenges to future generations.

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Oswald, S.A., Bearhop, S., Furness, R.W., Huntley, B., and Hamer, K.C. **Heat stress in a high-latitude seabird: effects of temperature and food supply on bathing and nest attendance of great skuas *Catharacta skua*.** *Journal of Avian Biology* 39(2): 163-169, 2008.

**Notes:** Birds such as great skuas *Catharacta skua* adapted for successful breeding at high latitudes may experience problems of heat dissipation in mild climates. Great skuas spend time bathing at freshwater sites close to breeding territories and here, we examine impacts of heat stress on bathing, foraging and nest attendance of adults during three breeding seasons with marked variation in the availability of prey (1-group sandeels *Ammodytes marinus*). Adults exhibited diurnal variation in bathing activity that matched heat-stress conditions. Moreover more birds bathed on days of higher average heat stress, suggesting that bathing plays a role in thermoregulation. Bathing numbers were lower in years of poor food availability, when adult attendance

at territories was low, probably because lower attendance reduced the opportunity for parents to bathe without leaving chicks unattended. Chicks are normally guarded by female parents and fed by males but under conditions of low food availability territorial attendance of breeding pairs was particularly low on days of high heat stress, with chicks regularly left unattended at air temperatures exceeding 14°C. Unattended chicks are at risk of being killed by neighbouring conspecifics and survival of chicks to fledging was low in the two years of low sandeel stocks. Our study indicates that for great skuas, indirect effects of climate change on prey stocks and direct effects on heat stress experienced by adults may be additive.

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Mallory, M.L. and Forbes, M.R. **Does sea ice constrain the breeding schedules of high Arctic Northern Fulmars?** *Condor* 109(4): 894-906, 2007.

**Notes:** The Northern Fulmar (*Fulmarus glacialis*) is a pelagic seabird that breeds across 25 degrees of latitude, from the boreal to the high Arctic oceanographic zones. We examined the breeding schedule of fulmars in the remote Cape Vera colony in the Canadian high Arctic, a marine region covered by sea ice much of the year, to determine if the timing of breeding and colony attendance patterns of birds differed from the breeding phenology of fulmars in colonies farther south. Cape Vera fulmars arrived at the colony later in the year, spent less time at the colony before egg-laying, and took a significantly longer prelaying exodus from the colony compared to fulmars nesting in more southerly colonies. After egg-laying, however, patterns of colony attendance by fulmars in the high Arctic were similar to patterns for fulmars in southern colonies; this part of the fulmar breeding schedule may be inflexible. The differences in breeding schedules across the species' range might reflect behavioral adaptations by arctic-nesting birds to accommodate the physical and biological limitations imposed by extensive sea ice near arctic colonies, particularly early in the breeding season. Given that climate warming and corresponding reductions in sea ice are taking place in the Arctic, it remains to be determined whether fulmars in the high Arctic have the behavioral flexibility in their breeding phenology to compensate for rapidly occurring changes in their environment.

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Daunt, F., Wanless, S., Greenstreet, S.P.R., Jensen, H., Hamer, K.C., and Harris, M.P. **The impact of the sandeel fishery closure on seabird food consumption, distribution, and productivity in the northwestern North Sea.** *Canadian Journal of Fisheries and Aquatic Sciences* 65(3): 362-381, 2008.

**Notes:** In the North Sea, the lesser sandeel (*Ammodytes marinus*) is the target of an industrial fishery and the principal prey of many top predators. Because of concerns about potential effects on predators, the sandeel fishery off eastern Scotland was closed in 2000, and local sandeel abundance increased subsequently. To examine whether closure benefitted sandeel-dependent seabirds, we compared summer sandeel consumption, at-sea distributions, and breeding success of seven species with fishery removals and abundance of older (1+ group) and young-of-the-year (0 group) sandeels from 1996 to 2003. Breeding success of black-legged kittiwake (*Rissa tridactyla*), a species that has declined in recent decades, was related to abundance of both 1+ group (the age class targeted by the fishery) and 0 group sandeels. The proportion of 0 group consumed by kittiwakes and proportion of the kittiwake population foraging in the area were linked to 0 group abundance. None of these parameters in the other seabird species were associated with sandeel abundance. Our results suggest that fishery closure can have a beneficial impact on top predators sensitive to variation in abundance of the target species, although environmental conditions before and after closure are also likely to be critically important.

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Dias, M.P., Peste, F., Granadeiro, J.P., and Palmeirim, J.M. **Does traditional shellfishing affect foraging by waders? The case of the Tagus estuary (Portugal).** *Acta Oecologica* 33(2): 188-196, 2008.

**Notes:** Estuarine intertidal flats are often exploited by humans and waders since they provide food, particularly shellfish. This raises important conservation issues. Waders can be affected by shellfishing activities in multiple ways, such as a reduction of the available shellfish, disturbance by the presence of shellfishers on their feeding areas, and changes in micro-habitat, due to sediment reworking. In this study we quantified the impact of traditional shellfishing on waders in the Tagus estuary. Particular attention was given to hand-raking of clams *Scrobicularia plaria*, which constitutes most of the consumed food by waders. Shellfishers did not cause a relevant depletion of clams for waders; they removed less than 0.3% of its total production and focused on size classes that were usually not taken by birds. Hand-raking caused temporary changes in the vertical distribution and availability of invertebrate prey in the sediment. However, this did not affect the bird's feeding rates, presumably because prey availability remained above the threshold at which intake rates are expected to decline. The presence of shellfishers in the

birds foraging areas potentially affects waders by keeping them away from foraging areas, but even the most affected species lost less than 10% of their foraging grounds due to this factor. Overall, we conclude that the current low harvesting levels of shellfishing are compatible with the preservation of the estuary as a key site for waders. Nevertheless, simulations showed that traditional shellfishing could have much greater potential to affect waders through disturbance than through prey removal. The results for the Tagus show that even small harvest rates, representing a negligible loss of food for waders and potentially considered sustainable by shellfish managers, could have a great impact on waders due to increased disturbance. This effect of disturbance likely occurs in most estuaries and should be taken into consideration when planning shellfish harvesting in important wader feeding areas.

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Laich, A.G. and Favero, M. **Spatio-temporal variation in mortality rates of White-chinned Petrels *Procellaria aequinoctialis* interacting with longliners in the south-west Atlantic.** *Bird Conservation International* 17(4): 359-366, 2007.

**Notes:** The White-chinned Petrel *Procellaria aequinoctialis* is the second most commonly captured species by Argentinean longliners. The severe declines that this species has experienced in some of its populations (e.g. South Georgia islands) have been principally attributed to incidental mortality associated with longliners. In this study we analyse the spatio-temporal variability in the mortality rates of White-chinned Petrels on the Patagonian Shelf and the effects that environmental and operational variability have on such mortality. The average capture rate ( $\pm 1$  SD) for the period 1999-2003 was  $0.014 \pm 0.090$  White-chinned Petrels for every 1,000 hooks deployed. Higher capture rates were observed when short longlines were deployed. Capture rates were not affected by the wind speed or by the time to the full moon. The distribution of the captures differed throughout the year. During autumn-winter most captures took place in the north of the Patagonian Shelf, whereas during spring-summer incidental captures occurred principally to the south between 45°S and 50°S.

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Crowe, O., Austin, G.E., Colhoun, K., Cranswick, P.A., Kershaw, M., and Musgrove, A.J. **Estimates and trends of waterbird numbers wintering in Ireland, 1994/95 to 2003/04.** *Bird Study* 55(1): 66-77, 2008.

**Notes:** *Capsule* There has been a decline in the numbers of waterbirds wintering in Ireland between 1994/95 and 2003/04, including a 5% decline in wildfowl and an 11% decline in waders. *Aims* To provide estimates of numbers and trends in relative abundance of selected waterbird species wintering on the island of Ireland. *Methods* Waterbird counts were undertaken at key wetland sites in Ireland each winter (September to March) between 1994/95 and 2003/04. For each species, estimates were calculated for two five-season periods (1994/95-1998/99 and 1999/2000-03/04), while trends in relative abundance were analysed over the entire ten-season period. Counts were modelled using a multiplicative log-linear index model, with site, year and month factors. *Results* National estimates of overwintering numbers were produced for 42 species of waterbirds, and used to produce all-Ireland 1% thresholds (which are used to evaluate the importance of wetland sites). In winter, large proportions of several populations occur in Ireland, particularly Whooper Swan *Cygnus cygnus*, Greater White-fronted Goose (Greenland race) *Anser albifrons flocirostris*, Brent Goose (Canadian Light-bellied race) *Branta bernicla brota* and Black-tailed Godwit *Limosa limosa islandica*. Of the 39 species for which trends were measured, 18 showed annual declines in excess of 2%, while ten species had increased. Numbers of the remaining 11 species were relatively stable. For many species, the trends measured appear to be continuations of longer-term changes since the 1970s. *Conclusion* These most recent estimates of waterbird numbers have been improved compared with those previously generated, due to improved levels of coverage and better analytical methods. This study highlights that there have been significant changes in the numbers of waterbirds wintering in Ireland over the past 30 years. The fact that many of these trends parallel wider flyway-scale population trajectories implies that large-scale drivers (e.g. climate change) may be responsible. However, many of the observed declines are likely to be a consequence of increased economic development which has led to direct habitat loss to industrial and residential development.

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Zino, F., Hounscome, M.V., Buckle, A.P., and Biscoito, M. **Was the removal of rabbits and house mice from Selvagem Grande beneficial to the breeding of Cory's shearwaters *Calonectris diomedea borealis*?** *Oryx* 42(1): 151-154, 2008.

**Notes:** The breeding success of Cory's shearwaters *Calonectris diomedea borealis* at its important Atlantic colony on Selvagem Grande has been monitored periodically at two study plots since 1982. A successful eradication programme was implemented to remove two alien invasive mammals, rabbits *Oryctolagus cuniculus* and house mice *Mus musculus*, from the island during 2002. The availability of long-term breeding data for Cory's shearwaters on Selvagem Grande provided a unique opportunity to

study the effects of the removal of rabbits and mice on seabird breeding. Annual observation of approximately 400 Cory's nests showed that significantly more birds fledged from both study sites in the five breeding seasons after the eradication than in the 13 seasons prior to it for which reliable breeding data were available. The numbers of young birds present at the time of fledging were an average of 47 and 23% greater than pre-eradication numbers at the two study sites. The eradication of rabbits and mice was simultaneous and, therefore, it was impossible to attribute the increased breeding success of Cory's shearwaters to the removal of one or other species. However, both are known to have adverse impacts on the breeding of nesting seabirds. These observations provide important justification for the implementation of further programmes for the removal of alien invasive mammals from oceanic islands.

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Tulp, I. and Schekkerman, H. **Has prey availability for arctic birds advanced with climate change? Hindcasting the abundance of tundra arthropods using weather and seasonal variation.** *Arctic* 61(1): 48-60, 2008.

**Notes:** Of all climatic zones on earth, Arctic areas have experienced the greatest climate change in recent decades. Predicted changes, including a continuing rise in temperature and precipitation and a reduction in snow cover, are expected to have a large impact on Arctic life. Large numbers of birds breed on the Arctic tundra, and many of these, such as shorebirds and passerines, feed on arthropods. Their chicks depend on a short insect population outburst characteristic of Arctic areas. To predict the consequences of climate change for reproduction in these birds, insight into arthropod phenology is essential. We investigated weather-related and seasonal patterns in abundance of surface-active arthropods during four years in the tundra of NW Taimyr, Siberia. The resulting statistical models were used to hindcast arthropod abundance on the basis of a 33-year weather dataset collected in the same area. Daily insect abundance was correlated closely with date, temperature, and, in some years, with wind and precipitation. An additional correlation with the number of degree-days accumulated after 1 June suggests that the pool of potential arthropod recruits is depleted in the course of the summer. The amplitude of short-term, weather-induced variation was as large as that of the seasonal variation. The hindcasted dates of peak arthropod abundance advanced during the study period, occurring seven days earlier in 2003 than in 1973. The timing of the period during which birds have a reasonable probability of finding enough food to grow has changed as well, with the highest probabilities now occurring at earlier dates. At the same time, the overall length of the period with probabilities of finding enough food has remained unchanged. The result is an advancement of the optimal breeding date for breeding birds. To take advantage of the new optimal breeding time, Arctic shorebirds and passerines must advance the start of breeding, and this change could affect the entire migratory schedule. Because our analyses are based on a single site, we cannot conclude that this is a general pattern for the entire Arctic. To investigate the generality of this pattern, our approach should be applied at other sites too.

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Castege, I., Lalanne, Y., Gouriou, V., Hemery, G., Girin, M., D'Amico, F., Mouches, C., D'Elbee, J., Soulier, L., Pensu, J., Lafitte, D., and Pautrizel, F. **Estimating actual seabirds mortality at sea and relationship with oil spills: lesson from the "Prestige" oilspill in Aquitaine (France).** *Ardeola* 54(2): 289-307, 2007.

**Notes:** Aims: Estimations were made of seabirds mortality at sea and drift in relationship with oil arrival during the "Prestige" oilspill. Location: South Bay of Biscay (Aquitaine), South-West France. Methods: meteorological data (Meteo France), the amount of hydrocarbons collected along the coast line (CEDRE), number of beached seabirds (UMSOM, DIREN) and their distribution and abundance on wintering areas at sea (MNHN-LAPHY), to assess the joint drift of oiled animals and of hydrocarbons in the south Bay of Biscay (Aquitaine) during the "Prestige" oilspill. For the first time at the time of an oil slick, we experimentally dropped into the open sea (off the French basco-landaise coast) ringed corpses of guillemots *Uria aalge* in order to estimate by capture-recaptures approach the rate of reported bodies (1 over 121) at the coast and thus to appreciate the total mortality of the populations of seabirds (UPPA-MNHN). Results: It is estimated that seabirds mortality was eleven times the amount of beached birds collected on the Aquitaine coasts. That result was in accordance with the decrease in the number of guillemots (the most beached species) observed at sea after the "Prestige" shipwreck. Conclusions: It is demonstrated that the pooling of databases of different natures and origins was necessary to assess the impact of oil spill pollutions, such as those of "Erika" and "Prestige", on the animal populations and more generally for marine biodiversity conservation.

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Ratcliffe, N., Pelembe, T., and White, R. **Resolving the population status of Ascension Frigatebird *Fregata aquila* using a 'virtual ecologist' model.** *Ibis* 150(2): 300-306, 2008.

**Notes:** The Ascension Frigatebird is an island endemic whose conservation status was subject to confusion owing to difficulties in counting and misinterpretation of data. Accurate nest counts for this species are problematic owing to their extremely prolonged breeding seasons, high nest failure rates, turnover of individuals at nest-sites, replacement laying and biennial breeding. We conducted repeated complete censuses of Ascension Frigatebird eggs at the species' sole colony of Boatswainbird Island, and collected data on laying phenology and nest survival rates within sample quadrats, throughout the 2001 and 2002 breeding seasons. We used these data to develop an individual-based model that predicted the number of Frigatebird nests present on each day an actual census occurred assuming an arbitrary 1000 breeding females bred there. We then divided the number of nests counted in these virtual censuses by 1000 to quantify bias, and used this figure to correct real census totals. The model revealed that the population numbered c. 6250 breeding females and c. 9350 mature females in 2001-2, and that numbers have not changed significantly since the late 1950s. Productivity, at 0.34 chicks/pair, was high compared to previous studies of Ascension Frigatebirds and most of those of congeners elsewhere.

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Zino, F., Brown, R., and Bischoff, M. **The separation of *Pterodroma madeira* (Zino's Petrel) from *Pterodroma feae* (Fea's Petrel) (Aves: Procellariidae).** *Ibis* 150(2): 326-334, 2008.

**Notes:** The taxonomic status of petrels from the North East Atlantic has long been a matter of debate. Breeding colonies of petrels occurring on the islands of Madeira, Bugio and Cape Verde were originally thought to be outlying populations of the polytypic species *Pterodroma mollis*. Subsequent taxonomic treatments have varied considerably in their classification of birds from these islands. The petrel populations on Madeira and Bugio represent some of Europe's rarest breeding birds and their exact species designation, and hence relation to conservation mandates, is a question of considerable importance. In this study we use molecular techniques alongside more traditional taxonomic characters to confirm the existence of two species of the genus *Pterodroma* in the Archipelago of Madeira. We also discuss identification of these species in the field and the implications for their conservation management.

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Furness, R.W. **Responses of seabirds to depletion of food fish stocks.** *Journal of Ornithology* 148(Spec. Publ. 2): 247-252, 2007.

**Notes:** Life history theory predicts that seabirds will respond to reduction in food abundance by changes in behaviour or breeding effort, buffering adult survival. Empirical data show some support for this but also sometimes indicate a trade-off in which survival of breeding seabirds may be reduced by food shortage. The sensitivity of seabird adult survival rates may be a feature of the detailed ecology of particular species and may be affected by ecological conditions such as the possibilities for prey switching. Fishery managers may set a lower limit biomass to protect fish stock recruitment, often at about 20% of predicted unfished stock biomass. It is unclear whether this threshold would also protect the needs of seabirds dependent on the fish stock. Time series of seabird breeding success and fish stock biomass may indicate minimum densities of food required. These are orders of magnitude more than the consumption by seabird populations. The critical prey density may also vary tremendously among seabird species and is clearly a function of the detailed ecology of each species. It is possible to predict which species will be most sensitive to reduced food supply. Sensitive species may be sentinels of the "health" of the marine ecosystem. For example, in Shetland and elsewhere in the North Sea, breeding success of kittiwakes *Rissa tridactyla* is particularly sensitive to abundance and quality of sandeels *Ammodytes* spp. However, seabird communities may be affected by a variety of interactions prompted by changes in fisheries; maintaining food fish levels may not alone be sufficient where communities have altered in composition over decades of fishing, as in the North Sea, and where predator-prey impacts induced by changes in fishery management may disrupt seabird communities.

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Crawford, R.J.M. **Food, fishing and seabirds in the Benguela upwelling system.** *Journal of Ornithology* 148(Spec. Publ. 2): 253-260, 2007.

**Notes:** The Benguela upwelling system off south-western Africa supports sardine *Sardinops sagax* and anchovy *Engraulis encrasicolus* that are harvested by purse-seine fisheries and are the main prey of three endemic seabirds: African Penguin

*Spheniscus demersus*, Cape Gannet *Morus capensis* and Cape Cormorant *Phalacrocorax capensis*. There have been large, long-term changes in the abundance and distribution of the fish resources that have influenced seabird populations. After 1956/1957, the numbers of penguins and gannets breeding in Namibia decreased by 90% and 95%, respectively. After 1978/1979, the number of Cape Cormorants breeding in Namibia decreased by 76%. These decreases were significantly related to the biomass of sardine and anchovy in Namibia and are thought to result mainly from a greatly reduced availability of prey. In South Africa, when the sardine collapsed, it was replaced by anchovy. In the Western Cape, the numbers of Cape Gannets and Cape Cormorants were stable after the collapse of the sardine but African Penguins decreased. The sardine resource recovered in the 1980s and 1990s but, at the turn of the century, was displaced to the east, leading to increases and then decreases in the numbers of penguins and gannets in the Western Cape. In the Eastern Cape, there were long-term increases in the numbers of penguins and gannets, until a recent decrease in penguins. In South Africa, the models used to advise allowable catches for sardine and anchovy are being modified to incorporate a model of African Penguins and functional relationships linking penguins and fish stocks. Consideration is also being given to precluding fishing in areas around seabird breeding colonies.

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Matias, R. and Catry, P. **The diet of feral cats at New Island, Falkland Islands, and impact on breeding seabirds.** *Polar Biology* 31(5): 609-616, 2008.

**Notes:** We studied the diet of feral cats (*Felis catus*) on New Island, Falkland Islands, through the analysis of 373 scats collected during the austral summers of 2004/2005 and 2005/2006. The most frequent prey were three introduced mammals (house mice *Mus musculus*, ship rats *Rattus rattus* and rabbits *Sylvilagus* sp.) and the thin-billed prion *Pachyptila belcheri* (each season present on ca. 21% of the analysed scats). These represent the first systematic data on feral cat diet for the Falklands. A simple bioenergetics model suggests that cats could be eating in the region of 1,500-11,000 prions per season, representing < 1% of the local adult and subadult population. Predation on other sea-birds nesting on New Island (several penguin species, albatrosses and cormorants) was unimportant, with the possible exception of white-chinned petrels *Procellaria aequinoctialis*, which nest locally in very small numbers. For each prion eaten, cats were estimated to have killed 1.1-1.9 ship rats during the summer season, and probably more in autumn and winter. Knowing that ship rats are prion predators, it is conceivable that, on the whole, cats are having a positive impact on the prion population, a scenario predicted by general theoretical models. Thus, considering the available information, we would not recommend the implementation of any eradication programme on New Island that would target cats in isolation. Nevertheless, it would be prudent to consider some local action targeting cats and rats around the small New Island white-chinned petrel colony.

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Cresswell, K.A., Wiedenmann, J., and Mangel, M. **Can macaroni penguins keep up with climate- and fishing-induced changes in krill?** *Polar Biology* 31(5): 641-649, 2008.

**Notes:** Macaroni penguins have evolved to cope with the highly variable conditions of the Southern Ocean. However, changes in prey supply and patchiness potentially associated with changes in climate and krill fishing activity may be occurring too rapidly for the penguins to adapt. We use a stochastic dynamic programming model to examine how changes in both the mean and patchiness of krill supply may affect the foraging decisions, and therefore breeding success, of female macaroni penguins at South Georgia. We predict that rapid changes in the mean supply of prey will have more of an effect on the condition of the female and chick than changes in prey patchiness, and that changes in foraging behavior compensate for changes in prey up to a threshold point, beyond which breeding success is likely impacted. In particular, we predict that the location of the threshold is affected by whether or not the penguins are adapted to the prey environment in which they are foraging, with the female and chick receiving on average 20% less of their daily energetic requirement if the female is not foraging optimally.

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Pichegru, L., Ryan, P.G., Van der Lingen, C.D., Coetsee, J., Ropert-Coudert, Y., and Gremillet, D. **Foraging behaviour and energetics of Cape gannets *Morus capensis* feeding on live prey and fishery discards in the Benguela upwelling system.** *Marine Ecology Progress Series* 350: 127-136, 2007.

**Notes:** We compared the foraging ecology of Cape gannets *Morus capensis* attending 2 colonies of equivalent size, yet with contrasting diet and population trends. One colony, on the west coast of South Africa, is decreasing in size and its occupants feed mainly on fishery wastes, whereas the other colony, on the south coast of South Africa, is growing and its occupants feed

exclusively on natural prey (pelagic fish). In October and November 2005, we examined the diet, at-sea behaviour, and energy requirements of breeding gannets using direct observations, miniaturised GPS loggers, and time-depth recorders attached to foraging adults. Concurrent hydroacoustic surveys allowed us to assess the distribution and abundance of their preferred prey (the sardine *Sardinops sagax* and anchovy *Engraulis encrasicolus*). Birds from the declining west coast colony foraged in areas containing very low abundances of pelagic fish. They fed primarily on low-energy fishery discards. They increased their foraging effort and exploited a greater area than birds from the growing colony, which took advantage of abundant pelagic fish stocks in their foraging range. A marked eastward shift of pelagic fish initiated in the late 1990s has resulted in the shortage of natural prey to Cape gannets on the west coast, strongly suggesting that the local population trend is driven by food availability during the breeding season. A bioenergetic model showed that enhanced availability of low-energy fishery discards does not seem to compensate for the absence of natural prey. Added to the predation pressure by the Cape fur seal *Arctocephalus pusillus* and the great white pelican *Pelecanus onocrotalus*, those threats weigh heavily on a vulnerable seabird population.

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Frederiksen, M., Edwards, M., Mavor, R.A., and Wanless, S. **Regional and annual variation in black-legged kittiwake breeding productivity is related to sea surface temperature.** *Marine Ecology Progress Series* 350: 137-143, 2007.

**Notes:** Spatiotemporal variation in seabird demographic parameters is often pronounced and may be an important source of information on the state of marine ecosystems. Black-legged kittiwakes *Rissa tridactyla* in Britain and Ireland show strong regional structure in breeding productivity, and both temporal and spatial variation are probably related to abundance of the principal prey of breeding kittiwakes, the lesser sandeel *Ammodytes marinus*. Annual regional estimates of sandeel abundance do not exist, prohibiting direct tests of this hypothesis. We examined relationships between kittiwake breeding productivity and 2 potential proxies of sandeel abundance, winter sea surface temperature (SST) and abundance of *Calanus* copepods, within and among 6 regions in Britain and Ireland from 1986 to 2004. Means and trends in winter SST differed among regions, with higher means and less pronounced increasing trends in western (Atlantic) regions than in eastern (North Sea) regions. A negative relationship between breeding productivity and winter SST in the previous year was found within 2 regions (East Scotland and Orkney), as well as in a cross-regional analysis. Results were inconclusive for *Calanus* abundance, with a positive relationship in East Scotland and negative in Orkney. These results demonstrate that although a single environmental driver (SST) is related to both within- and between-region variation in a key demographic parameter, regional heterogeneity in SST trends as well as the importance of other factors may lead to highly variable responses. Understanding this heterogeneity is critical for predicting long-term effects of climate change or other anthropogenic drivers on marine ecosystems.

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Springer, A.M., Byrd, G.V., and Iverson, S.J. **Hot oceanography: planktivorous seabirds reveal ecosystem responses to warming of the Bering Sea.** *Marine Ecology Progress Series* 352: 289-297, 2007.

**Notes:** The Bering Sea has experienced dramatic warming in this century that has altered elements of the ecosystem, including the structure and productivity of the zooplankton community on the continental shelf, and the extent to which waters and associated plankton of oceanic origin have intruded onto the shelf. We documented temporal and spatial scales of these changes by monitoring diets of least auklets *Aethia pusilla* on the Pribilof Islands. Least auklets are planktivores that specialize on the large calanoid copepods *Neocalanus* spp. from the basin and *Calanus marshallae* from the shelf. Diets were estimated in the summers of 1996 to 2006 by enumerating prey in regurgitated meals brought to chicks by adults, and by fatty acid analyses of live biopsy samples of adipose tissue from adult birds in 2003 and 2004, which provided additional insight. In the unusually warm 2000s, *Neocalanus* spp. apparently were excluded from regions of the outer shelf, where they typically occur in cooler years, and, concurrently, *C. marshallae* was depressed over a large region of the shelf because of chronic failures of spring cohorts to survive. Both changes were associated with anomalously high water temperatures over the middle shelf. The information provided by least auklets greatly improves our understanding of the consequences of environmental change and supplies clues about how communities and ecosystem processes respond to physical forcing. Continued warming of the magnitude seen in recent years could become a cause for concern for auklets and other planktivores in the eastern Bering Sea if it alters prey availability in ways detrimental to their populations.

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