



1ST WORLD SEABIRD CONFERENCE Seabirds: Linking the Global Oceans

Abstracts of Invited Presentations

The 1st World Seabird Conference has the distinct pleasure of presenting over 700 presentations during the conference September 7 to 11, 2010 in Victoria, Canada. These presentations include over 120 Invited Sessions, over 120 Contributed Sessions, and over 380 Posters. A series of Legacy Workshops, other Workshops and a Legacy Plenary round out the conference program. This document presents the full abstracts for the Invited Session.

Victoria Conference Centre
Victoria, Canada • September 7-11, 2010



V1-1 We 0900-0920 Salon B

Peter Dann

The effects of ocean temperature in south-eastern Australia on the survival of Little Penguins

“Ocean temperature has been shown to be related to various demographic parameters in a number of seabird species. For instance, the timing and success of breeding of Little Penguins (*Eudyptula minor*) has been shown to be correlated with sea-surface temperatures of the autumn six months prior to breeding commencing. In this study we have modelled survival for juvenile and adult Little Penguins in terms of ocean temperatures using a 40-year demographic dataset of breeding penguins in south-eastern Australia. Increased first-year survival was associated with warmer sea-surface temperatures in the summer and autumn of the previous year and the autumn of the current year. In some contrast, adult survival was correlated positively with current autumn and winter sea-surface temperatures, and to a lesser extent, negatively, with summer temperatures of the current year. The potential causal links between ocean temperatures and these demographic variables are discussed together with the implications of predicted climate change for survival trends until the end of the 21st century.”

Leesa Sidhu; Lynda Chambers; Ted Catchpole

V1-2 We 0920-0940 Salon B

Stéphanie Jenouvrier

Predicting seabird population responses to climate change: linking demographic models and IPCC climate projections

“In the face of global climate change, there is a growing demand for accurate forecasts of its ecological impacts. A large number of studies link climatic variables to seabird population numbers. Very few studies however directly link climate projections to demographic processes. Even fewer include uncertainties in demographic parameters and in climate projections, as well as environmental stochasticity. First, I will outline different approaches linking demographic models and climate projections to predict population responses to climate change. Then I will detail the approach used for the emperor penguin *Aptenodytes forsteri*. Emperor penguins are extremely sensitive to change in sea ice because they use sea ice as a breeding, foraging and molting habitat. Sea ice extent (SIE) is projected to shrink as concentrations of atmospheric greenhouse gases increase. We used a stochastic population model that combines a unique long-term data set (1962- 2005) from a colony in Terre Adélie and projections of SIE from General Circulation Models of Earth's climate included in the Intergovernmental Panel on Climate Change assessment report. We showed that the increased frequency of

low SIE will reduce the population viability and that the quasi-extinction probability of the population is at least 36% by 2100.”

Hal Caswell; Christophe Barbraud; Marika Holland; Julienne Stroeve; Henri Weimerkirch

V1-3 We 0940-1000 Salon B

Morten Frederiksen

Climate effects on seabird demography and population dynamics in the NE Atlantic

“During the last ten years, many seabird populations in the NE Atlantic have experienced widespread breeding failures and population declines. These problems are almost certainly linked to lack of suitable food. Long-term studies at several colonies in the UK and Norway have allowed robust statistical assessment of links between seabird demography and climatic fluctuations and trends. The majority of studies have found negative associations between sea temperature and one or more demographic parameters. Declines in the abundance of important prey (lipid-rich pelagic fish) have often been implicated as the proximate mechanism. Circumstantial evidence points to one underlying explanation for the problems observed for seabirds and fish in the boreal NE Atlantic: a large decline in abundance and northward shift in distribution of the most important grazing zooplankton, the copepod *Calanus finmarchicus*. This species is known to be highly sensitive to sea temperatures, and in warming waters it is replaced by the congeneric *C. helgolandicus*, which is less abundant, smaller and less lipid-rich, and therefore less suitable as fish food. Changing sea temperatures in the NE Atlantic are linked to both natural oscillations in the dominant circulation pattern (the Atlantic Subpolar Gyre) and a gradual warming trend.”

Tycho Anker-Nilssen; Sarah Wanless

V1-4 We 1000-1020 Salon B

Tony Gaston

Arctic marine birds and climate change: some predictions

“The avifauna of cold marine ecosystems is dominated by diving birds, in the Arctic, particularly the family Alcidae. Smaller members of this family (auklets, little auk) depend on temporally predictable aggregations of zooplankton for reproduction, while larger members (murre, puffins) are circumscribed in their distributions by their swimming speed in relation to those of predators and prey. Evidence from several sites suggests that the ability of alcids to adjust their timing of breeding to changes in the timing of prey availability is limited and that consequent declines in reproduction may be an important symptom of climate



change. The direct effect of water temperature on the swimming speeds of fish prey and predators and the constraint that these place on the distributions of large alclids makes it possible to predict future distributions of several common and widespread species according to different climate scenarios. These two effects (timing mismatch, temperature effect on predation efficiency) are presented as examples of potentially transient and likely permanent effects of climate change.”

V1-5 We 1020-1040 Salon B

Alexander Kitaysky

Early ice retreat has opposite effects on planktivorous and piscivorous top-predators in the shelf regions of sub-Arctic

“Our long-term studies focus on testing relationships between climate and food web dynamics at several trophic levels in two regions with seasonal ice cover. During 1987-2009, we monitored reproductive success of piscivorous and planktivorous seabirds breeding in the northern Sea of Okhotsk (Talan I.). During 1999-2009, we used endocrine tools to quantify nutritional stress in planktivorous and piscivorous seabirds breeding in the Bering Sea shelf ecosystem. Low reproductive success and high nutritional stress are indicative of difficulty obtaining sufficient prey to meet energy demands during reproduction. We found consistent opposite relationships between climate variability and nutritional limitations in piscivorous vs. planktivorous seabirds breeding in both regions. Planktivorous species showed lower levels of nutritional limitations in years with late ice retreat, which are hypothesized to favor an early phytoplankton bloom and high production of shelf zooplankton (large copepods and euphausiids). Conversely, piscivorous species had lower levels of nutritional limitations in “warm” years with an early ice retreat and a late phytoplankton bloom - conditions hypothesized to be favorable for forage fish production. We conclude that, in the continental shelf ecosystems with seasonal ice-cover, the opposite effects of early ice retreat on planktivorous and piscivorous seabirds are a common phenomenon.”

Elena Golubova

V1-6 We 1100-1120 Salon B

Enriqueta Velarde

Gulf of California Seabirds’ responses and adaptations to changing oceanographic conditions and forage fish community

“We analyzed breeding and feeding responses of three seabird species nesting in the Midriff Islands, Gulf of California, to changes in oceanographic parameters and forage fish availability between 1983 and 2008. We used breeding and

diet parameters, and oceanographic parameters (sea surface temperature, Southern Oscillation Index) to investigate the potential of this information to predict fishing effort outcome. We analyzed seabird species life history strategies in relation to food availability and attempted to predict long term population changes under different periodicities of ecosystem variability. Seabird diet composition reflected relative abundance of forage fish species. The models predicted total sardine catch with an accuracy of 54% and catch per unit effort (CPUE) with an accuracy of 73%. With a longer time series it became clear that the most accurate information to predict sardine CPUE was the proportion of sardine in the Elegant Tern diet. A path analysis using Heermann’s Gull body condition and breeding parameters, and food availability, showed strong chained relationships between variables: extrinsic variables, such as food availability, strongly driven by oceanographic conditions, affects parental body condition (29%) and survival of eggs into hatchlings (34%) and fledglings (19%), intrinsic variables, such as parental age, explained 44% of the observed variation in the fledging success. Heermann’s Gulls’ longevity seems to be an evolutionary response to fluctuating environmental conditions, characteristic of many marine ecosystems. The species survival and breeding rates suggest a strong resiliency to these fluctuations, but indicate a limit if the frequency of ENSO events increases to two per decade.”

Daniel Anderson; Exequiel Ezcurra

V1-7 We 1120-1140 Salon B

Christophe Barbraud

Southern Ocean seabirds, climate change and fisheries

“Estimating the impact of climate change on seabird populations remains a challenge. Fisheries and other factors may act simultaneously with climate on population dynamics, and for many species demographic information is incomplete. Population survey data, capture-mark-recapture, population modeling, and the demographic invariant method were used to investigate the effects of fisheries on the demography of 10 Southern Ocean seabird species, controlling for the effects of climate variability. We illustrate our approach by using case studies for which tracking and diet data were available to estimate the degree of overlap between seabirds and fisheries, and review quantitative studies on the impact of fisheries on population dynamics of Southern Ocean seabirds. Contrary to climate variables which mainly affected breeding parameters, fishing efforts were mainly negatively related to survival parameters. Few species seem to benefit from fisheries activities, and this always resulted in a positive effect on breeding success. Few studies have investigated the effect of fisheries on juvenile survival or recruitment, but these suggest a negative effect, indicating a higher vulnerability of younger individuals to bycatch. Although population growth rate of



seabird populations is less sensitive to variations in juvenile survival or recruitment, chronic mortality in younger age classes due to fisheries may negatively affect population sizes. Population models suggest that for some species, additional mortality due to bycatch may constitute a limiting factor to population growth, or a factor negatively affecting population growth. For some species no effect of bycatch was found on demographic parameters despite reported accidental mortality in fisheries.”

Virginie Rolland; Stéphanie Jenouvrier; Marie Nevoux; Karine Delord; Henri Weimerskirch

V1-8 We 1140-1200 Salon B

Per Fauchald

Seabirds in the Barents Sea ecosystem, what can we expect under climate change?

“Ocean warming is expected to affect seabirds indirectly by changing the phenology, geographic distribution and abundance of important prey species. Polar marine ecosystems with seasonal ice cover are particularly sensitive because small temperature differences can have large effects on sea ice extension. The Barents Sea ecosystem is governed by seasonal ice cover in the north and inflowing warm Atlantic water in the south. In this study we investigate the spatio-temporal interactions between seabirds and prey in this highly dynamic system. We use data from multi-purpose ecosystem surveys, and investigate the distributional pattern and interactions on an ecosystem, community and local patch scale. We use data from two different seasons and multiple years. Based on these analyses and climate projections, we present alternative scenarios for the development of the seabird community in the Barents Sea system under climate change.”

Karine Delord; Charly Bost; Richard Phillips

V1-9 We 1200-1220 Salon B

Richard Veit

Climate-related impacts on seabirds of the Northwest Atlantic Ocean

“We explore changes that have taken place in the range and distribution of seabirds in the Northwest Atlantic Ocean, especially during the past 50 years, and ask which of these changes may be plausibly linked to changing oceanic climate. A major complication to this endeavor is disentangling changes that have occurred due to commercial fishing activities, which have been substantial in the Northwest Atlantic. There were few noticeable declines, except for Black-legged Kittiwakes and Roseate Terns, but several increases, primarily among diving species. Northern Gannets have increased substantially in abundance, and four species of

alcids have increased and extended their winter ranges southward. Double-crested Cormorants continue their increase and range expansion that has been evident since the early 20th century. Gull numbers have increased in New England and decreased in Newfoundland. Cory’s Shearwaters have extended their wintering range northward. These changes are associated with variation in the North Atlantic Oscillation, although we do not claim this to be the only explanation as much of the increase in auk numbers may be attributable to the regional removal of gillnets associated with a decadal closure of Newfoundland cod fishery. Partitioning and as well as better understanding the cumulative effects of ocean climate change and anthropogenic influences remains a pressing research priority.”

William Montevecchi

V1-10 We 1220-1240 Salon B

Nacho Vilchis

Analysis of long-term trophic level shifts in a tropical seabird community

“Understanding mechanisms driving past ecosystem changes are of paramount importance for the interpretation of contemporary environmental change and ecosystem response. With this mindset, we set out to gauge effects of the 1976-77 regime shift of the Pacific Ocean in a tropical and pelagic community of apex predators. Using study skins of historical specimens from museum collections, we retrospectively (1960-2006) measured stable carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotopes for a suite of ecologically and phylogenetically diverse seabirds from the eastern Pacific warm pool. In this region, seabirds generally forage by depending on subsurface predators to drive prey to the surface or by associating with oceanographic features that increase productivity or aggregate prey in space or time. We found no community wide changes in response to the 1976-77 regime shift. Instead we found evidence suggesting a trophic shift and or change in foraging area for Sooty Terns and a long-term decrease in feather $\delta^{13}\text{C}$ for the eastern Pacific warm pool seabird community. This long-term decrease in feather $\delta^{13}\text{C}$ can be accounted for by the Suess effect and not a decline in primary productivity of the system. We hypothesize that a deepening trend in thermocline depth in the eastern Pacific warm pool is affecting Sooty Terns more so than other species in the subsurface predator-dependent guild which depend less on smaller subsurface predators like skipjack tuna.”

Lisa Balance



V1-11 We 1400-1420 Salon B

Henri Weimerskirch

Climate change effect on Wandering Albatrosses distribution and life history traits

“Over the past 20 years our understanding of the ecology of oceanic seabirds has been revolutionised by progress in telemetry. Here we trace the development of studies of the large-scale movements of seabirds tracked by Argos satellite transmitters (PTT), GPS and GLS (Geolocating Systems). We show how the appearance of new techniques has aided in the advance of our knowledge, and has also raised new questions. In the earlier years, large Argos transmitters only allowed us to track large species, such as albatrosses and penguins, and to describe their wide-range movements during short periods of the breeding season. With the progressive reduction in size of transmitters, smaller species were tracked for longer periods. The miniaturisation of GPS technology has allowed finer-scale studies, still during the breeding season. With the further miniaturisation of solar panelled PTTs and the development of very small GLS, long term deployments became possible and allowed the study of the movements of the non-breeding part of populations, such as juveniles, immatures, birds in sabbatical year, and winter migrations. Today it is possible to have a complete view of the life-cycle movements of many species of large- and medium-sized oceanic seabirds, and to better understand their relationship with the marine environment and human activities.”

Kjell Einar Erikstad; Mette Skern-Mauritzen; Edda Johannesen; Geir Helge Systad

V1-12 We 1420-1440 Salon B

George Hunt

Climate variability and the responses of kittiwakes and murrens breeding at the Pribilof Islands: what have we learned over 30 years?

“Climate-related impacts on seabirds occur over a wide range of temporal scales, from that of individual storm events, to the timing of seasonal transitions, to large-scale impacts on marine ecosystems and their ability to support prey resources in the vicinity of a colony. In this paper, we present examples of climate-related phenomena that have affected seabirds breeding at the Pribilof Islands. There, the timing of chick loss in black-legged kittiwake (*Rissa tridactyla*) nests with two chicks is related to the occurrence of storms, while the timing of nesting is related to winter conditions (ice cover, sea-surface temperature) and delayed transitions to summer conditions (late-melting snow banks affect the availability of cliff-face nesting sites). Climate variability can influence prey availability through changes in prey recruitment, distribution, or interactions with competitors for shared resources. Decadal-scale changes in the composition and or abundance of prey species affects the ability of parents to complete egg-

laying, successfully incubate eggs to hatching, and to fledge young, once hatched. Additionally, variations in the work required to raise young may affect the stress levels of adults and their ability to survive the post-breeding period and to return to breed in subsequent years. Thus, not only may direct climate impacts affect seabirds, but also indirect impacts on food supplies may affect not only breeding success, but also adult survival that, in turn, strongly impacts demography.”

Stephani Zador; Alexander Kitaysky; G. Vernon Byrd

V1-13 We 1440-1500 Salon B

James Mills

Effect of climate fluctuations on food availability and reproductive performance of the planktivorous Red-billed Gull

“Using 46 years of data we compare temporal variations in the dynamics of the red-billed gull (*Larus novaehollandiae scopulinus*) at Kaikoura, New Zealand to changes in climate, oceanography and the availability of the planktonic euphausiid *Nyctiphanes australis* (krill). An increase in krill availability increased the likelihood of breeding and recruitment of young adults, caused earlier laying and resulted in an increase in the condition of adults, egg volume, clutch size and fledging success. The hydrography off Kaikoura is complex and several factors have an impact on the productivity of krill populations. Approximately 61% of the variation in krill availability to breeding birds (Oct-Dec) is explained by variation in chlorophyll a concentration in the surface water in July during the krill's egg laying phase. The continental shelf off Kaikoura is relatively narrow and vulnerable to wholesale incursions of warm subtropical water from the north. Strong advection can displace the water column replacing it with warmer, low nutrient water. Smaller incursions can result in warm water overlaying the colder water preventing the upward migration of krill, making them unavailable to the gulls. Inflow of colder water from the south accounts for 56% of the variability of krill. Krill availability is high during the positive phase of the SOI during La Niña-like conditions when NE winds are more frequent. These winds are implicated in upwelling off Kaikoura. A positive correlation between krill availability and NE winds during Oct-Nov indicates that upwelling in late spring is a major determinant of krill availability”

John Yarrall; Janet Bradford-Grieve; Michael Uddstrom; James Renwick; Juha Merila



V1-14 We 1500-1520 Salon B

Yutaka Watanuki

Responses of three species of seabirds breeding at Teuri Island, northern Japan Sea, to local climate fluctuation

“To understand the impact of climate change on marine ecosystem, it is useful to study responses of top predators. Seabirds are suitable for this purpose. Diet and breeding biology of Rhinoceros Auklets *Cerorhinca monocerata* (RHAU), Japanese Cormorants *Phalacrocorax filamentosus* (JCOM) and Black-tailed Gulls *Larus crassirostris* (BTGL) have been monitored in 1984-2009 at Teuri Island, except 1986-1991, in northern Japan Sea off Hokkaido where no strong upwelling is observed but Tsushima Current influences. RHAU and BTGL fed on pelagic fish and krill in the spring but pelagic fish in the summer. JCOM fed on bottom fish in the spring and pelagic and bottom fish in the summer. During these 20 years, spring air temperature and SST increased slightly and Tsushima Current became stronger, but no apparent trend in the seabird timing of breeding and productivity were observed. Some of interannual changes in diet and productivity, however, were explained by the fluctuation in local climate. RHAU and JCOM bred earlier in years with less snow, high spring air temperature and SST, while BTGL did not. All species exhibited higher productivity in years when they bred earlier. RHAU and JCOM shower higher chick productivity when the former fed more on anchovy *Engraulis japonicus* and Tsushima Current was stronger and the later fed more on sandlance *Ammodytes personatus* rather than bottom fish. These variable responses to local climate fluctuations indicate strong species-specific constraints; nesting habitats and prey in spring and summer.”

Motohiro Ito

V1-15 We 1540-1600 Salon B

David Gremillet

Little Auks buffer the impact of current Arctic climate change

“Climatic models predict a multi-degree warming of the North Atlantic in the European sector of the Arctic during the 21st century, and this warming trend is already significant across the region. One major research priority is therefore to understand the impact of current change upon marine ecosystems. Little auks (*Alle alle*) are the most numerous seabirds in the North Atlantic, comprising at least 40 million individuals. They feed mainly on copepods and are essential components of pelagic food webs, as well as potential bioindicators of the impact of climate change. We tested their capacity to buffer the impact of current warming using parallel measurements at three breeding colonies exposed to contrasting environmental conditions across the Greenland Sea. At sea, we assessed sea-surface temperatures and their

consequences for the zooplankton communities targeted by little auks. Deployments of time-depth-recorders, direct observations, dietary studies and estimation of energy consumption using doubly-labeled water allowed us to evaluate the foraging response of birds to varying prey availability and its impact on their energy balance. Further, monitoring of breeding parameters (chick growth and reproductive success) and estimation of adult survival rates via a mark-recapture study were used to determine the fitness consequences of observed foraging plasticity. Our results strongly suggest that behavioral plasticity allowed little auks to buffer against the wide range of environmental conditions experienced in the Greenland Sea during 2005-2007. We found that diet and foraging behavior are the most powerful response variables to be monitored in little auks facing climate change.”

Jorg Welcker; Nina Karnovsky; Wojciech Walkusz; Margaret Hall; Jerome Fort; John Speakman; Ann Harding

V1-16 We 1600-1620 Salon B

William Sydeman

Ocean climate change and phenology: effects on trophic synchrony and consequences to fish and seabirds in the North-Central California Current

“The marine climate of the California Current has changed in many ways (e.g., warming, increased stratification) consistent with expectations under global warming. One of the consequences of these physical changes appears to be increasing trophic asynchrony which has, in some years, destabilized predator-prey interactions. It is hypothesized that increased climate variability, as a consequence of climate change, will cause changes in the timing of key seasonal events. However, it is not well known how these changes will impact predator-prey relationships. Several mechanistic hypotheses have been put forth to explain changes in fish production in relation to phenological variability of prey, including Cushing’s (1990; *Adv Mar Biol* 26:249-293) ‘match-mismatch’ hypothesis, yet there have been few tests of these ideas relative to ongoing ocean climate change. We have conducted comprehensive retrospective analyses of the nexus between marine climate, phenology, and trophic synchrony in the northern-central California Current, focusing on krill and juvenile rockfish. We found key climatic determinants of predator timing of breeding and reproductive success (seabirds), and growth (rockfish) which were related primarily to winter atmospheric-oceanographic coupling. We also found spatial, and to a lesser extent temporal, ‘mismatches’ in krill-krill predator interactions, which is apparently related to changes in surface winds, ocean circulation, and plankton transport.”

Bryan Black; Steven Bograd; Jeff Dorman; Kyra Mills; John Field; Steve Ralston; Zack Powell; Jarrod Santora; Isaac Schroeder; SarahAnn Thompson; Frank Schwing

**V1-17 We 1620-1640 Salon B****Wayne Trivelpiece****Penguins in peril: an old ecological hypothesis replaces a current paradigm and links climate change to penguin population declines in the Western Antarctic Peninsula**

“The Western Antarctic Peninsula (WAP) encompasses some of the richest waters and most abundant wildlife populations on earth, some of which were nearly extirpated by the late 1900s. The WAP is also warming faster than elsewhere in Antarctica, and possibly on earth, with 5-6° C increases in mean winter temperatures and associated decreases in winter sea-ice extent and duration. These changing conditions have profoundly affected the ecosystem. A current paradigm guiding ecological interpretations of change in the WAP, the “Sea-Ice Hypothesis”, suggests that less winter sea ice has directly led to population declines in “ice-loving” Adélie penguins, while “ice-avoiding” chinstrap penguins have increased. However, 30 years of field studies in the WAP and recent surveys throughout the Scotia Sea refute this hypothesis; both Adélie and chinstrap penguin populations have declined by >50% throughout this region. Furthermore, since these penguins were never harvested by man, changes in their populations track historical changes to this ecosystem. Here we present evidence supporting an older, more robust, hypothesis that explains both increases and decreases in penguin populations as a result of changes in the abundance of their main prey, Antarctic krill. Linking trends in penguin abundance with trends in krill biomass can explain why these penguin populations increased after fur seals and baleen whales were nearly extirpated and are currently decreasing in response to climate change.”

**Jefferson Hinke; Aileen Miller; Christian Reiss;
Susan Trivelpiece; George Watters**

V2-1 We 0900-0920 Salon C**Tim Essington Accounting for dependencies of seabirds on forage fish in fisheries management**

“Forage fish are some of the most important fish in the sea, both for their economic value, and for their role as prey for a myriad of marine fish, mammals, seabirds and other marine life. Currently forage species account for nearly 40% of global wild marine fisheries catch, and pressure is expected to intensify. Concurrently, evidence of strong, dependence of marine predators on forage species has accumulated. In some cases, foraging grounds of predators overlap substantially with forage fisheries. Conflicts between fisheries and natural predators for forage fish may be particularly strong in coastal upwelling ecosystems, where forage fish productivity and distribution are extremely sensitive to atmospheric and oceanic processes. Various seabirds in these ecosystems are

dependent on one or more of the resident forage fish species (such as anchovies and sardines). Studies have documented that a decrease in the forage fish abundance can result in increased mortality and decreased reproduction, fledging, and breeding success of seabirds. The Lenfest Forage Fish Task Force is addressing the need for ecosystem-based management which accounts for the unique ecological role and life histories of forage fish. We will present several examples of seabird dependencies on forage fish, and their implications for more effective fisheries management. In particular, we will focus on examples from upwelling ecosystems including the Benguela, Humboldt, and California current systems.”

Ellen Pikitch; Christine Santora; Konstantine Rountos

V2-2 We 0920-0940 Salon C**Mårten Hjernerquist****Population fluctuation of seabirds and fish in the Baltic Sea**

“Many marine environments are over-exploited, and the Baltic Sea in Northern Europe is no exception. Changes in fish populations can affect the entire ecosystem and organisms at all trophic levels. Marine top-predators such as seabirds are influenced by the abundance and quality of their prey fish. In the Baltic Sea, an increased abundance of Sprat has been argued to be negative to seabirds providing one of the best field evidence for the “junk-food” hypothesis. This because increased competition among Sprats supposedly decreases the energy content of each individual fish. Hence, more Sprats lead to more food but of less quality. In this study, the role of quality and quantity of Sprat on three seabird species (Common Guillemots, Razorbills and Lesser Black-backed Gulls) in the Baltic Sea is tested using long term population data. The results support the notion that the abundance of prey fish is of utter importance to piscivore species. Contrary to other studies on seabirds in the Baltic Sea, population data do not support the “junk-food” hypothesis and the seabird populations follows the fluctuations in Sprat abundance. In the Baltic Sea, more Sprat simply seems to mean more food.”

Björn Hjernerquist

V2-3 We 0940-1000 Salon C**Michelle Paleczny****Are global marine fisheries starving seabirds?**

“Industrial fisheries began to operate globally in the 1950's, concentrating in the same areas and targeting many of the same species as seabirds. The resulting competition has contributed to numerous seabird declines around the world. Globally, seabird abundance is declining, yet the component of this decline that can be attributed to competition with



fisheries is unknown. We use global data on abundance, foraging distribution, and diet of seabirds, in addition to spatially explicit annual fisheries catch of seabird prey items since 1950 to examine the relationship between seabird abundance and fisheries extraction of their prey from foraging areas. This study will provide new information on the effects of global marine fisheries which is essential to ecosystem based management of fisheries.”

Vasiliki Karpouzi; Patrick O'Hara; Reg Watson; Daniel Pauly

V2-4 We 1000-1020 Salon C

John Piatt

Predator response functions and the management of forage fisheries

“Some long-term studies of marine predators, mainly seabirds and seals, have revealed relationships between prey density and indices of predator performance. In other cases no relationship can be detected. We collated information from several marine ecosystems of the world to search for functional relationships and model their form. Where functional relationships were observed, they generally exhibited non-linearity, often with thresholds. This is caused in part by the behavioural plasticity of predators that allows them to harvest sufficient food above some threshold of prey density. Below the threshold, predators have difficulty obtaining sufficient food and this is reflected by rapid changes in demographic or foraging parameters. In our analyses, thresholds were identified using standard models and T-GAM (Threshold Generalized Additive Models). In cases where functional relationships were not observed, the predators involved generally had a high capacity for buffering against fluctuations in food abundance. In other cases, data were insufficient to model responses, for example, when there was not enough contrast in prey density. We believe that thresholds are a fundamental feature of predator-prey relationships that can be used to quantify the minimum forage fish biomass needed to sustain marine predators. They are needed to determine precautionary reference points above which prey abundance should be maintained by fisheries managers, as mandated in an Ecosystem Approach to Fisheries (EAF) currently adopted by many fisheries organizations.”

Ian Boyd; Robert Crawford; Philippe Cury; Robert Furness; Elisa Goya; Jean-Paul Roux; Sylvain Bonhommeau

V2-5 We 1020-1040 Salon C

Jason Link

The importance of including predation mortality in the evaluation and management of forage fishes

“Forage fish such as herring and mackerel are affected by a

broad range of predators including piscivorous fishes, marine mammals, and seabirds. Accounting for predation mortality is an important consideration in ecosystem-based fisheries management and is especially important when setting management targets for forage fish populations. A suite of applications utilizing various fisheries models have demonstrated that predation mortality is: 1) ontogenetically variable, 2) temporally variable, 3) ergo not typically fixed at 0.2 as is commonly assumed, and 4) for forage species, generally higher than assumed in traditional single species stock assessments. Here we demonstrate that biological reference points (fishing mortality rates) generated by explicitly incorporating predation mortality into population dynamic models are generally more conservative than those produced using traditional fisheries assessment methods. Even if predation mortality is not directly included in such models, our results suggest assessments for forage fisheries should be more conservative. Because biological reference points are the benchmark against which fisheries management decisions are made, they should reflect the ecological realities faced by each species to the fullest extent possible. Adhering to the more conservative biological reference points produced by explicitly incorporating predation mortality is an easily implemented facet of ecosystem-based fisheries management.”

Megan Tyrrell; Hassan Moustahfid

V3-1 We 0900-0920 Lecture Theatre

Tom Good

Marine debris entanglement of seabirds: global patterns, impacts, and solutions

“Marine debris affects seabirds via ingestion of anthropogenic materials (e.g., plastics, pellets, fish hooks, etc.) and entanglement in derelict fishing gear (recreational or commercial fishing nets, lines, etc.) and other entangling plastic debris lost or abandoned in the marine environment. A 2009 report of the United Nations Food and Agriculture Organization and Environment Programme reported that approximately 640,000 tons of discarded fishing gear enters the oceans yearly, accounting for nearly 10% of the world's total of marine debris. Since the 1950s, most of the world's fishing industries replaced nets composed of natural fiber with those made from synthetic material, resulting in lost or abandoned fishing gear remaining in the marine environment for decades. Derelict fishing gear has been implicated in the entanglement and death of marine birds since the 1970s, and entanglement and ingestion impacts were reviewed in the 1990s. Since then, there has been an increase in gear retrieval programs and explicit studies on the fate and biological impacts of derelict gear, including impacts on marine birds. We reviewed published and unpublished reports of seabird entanglement and mortality to summarize geographical, taxonomic, and fishery patterns worldwide. Monofilament



line is the most common entangling gear, with monofilament gillnets causing the greatest mortality. Over 80 species of marine birds have been documented entangled; however the demographic effects of this mortality source are not well understood. United Nations resolutions now require reducing derelict fishing gear and marine debris in general, and clean up efforts underway worldwide should reduce associated risk for all seabirds.” **Amanda Phillips**

V3-2 We 0920-0940 Lecture Theatre

David Hyrenbach

Plastic ingestion by North Pacific seabirds: progress review and future directions

“Over 50 species of North Pacific seabirds have been documented to ingest plastic marine debris, with mounting evidence of higher incidence and larger loads over time. The widespread nature of this pollution warrants a review of progress to date and a discussion of the challenges facing this evolving research field. To this end, we compiled published and unpublished reports of seabird ingestion of marine debris, and critically evaluated the literature to assess progress in terms of: (1) study objectives and approach, (2) experimental design, and (3) reporting of results. We performed a meta-analysis of the resulting large database (> 200 species records and 10,000 specimens) spanning from 1969 to the present, to investigate the importance of biogeographic, taxonomic, and life-history patterns as determinants of plastic ingestion. These analyses revealed increases in the incidence and loads of plastic, especially for surface-foraging species. Even though the taxonomic scope of the studies has narrowed over time to include fewer species, the sample sizes have increased to include specimens from different sources (bycatch, beach cast, collections) and stages of the life-cycle (breeding adults, non-breeding adults, chicks). We discuss these critical considerations for developing standardized metrics of plastic ingestion, and for the use of seabirds as biological sensors of marine debris in the global ocean.”

Hannah Nevins; Michelle Hester; Erica Donnelly

V3-3 We 0940-1000 Lecture Theatre

Paul Scofield

Your rubbish affects us too: a review of plastic ingestion in the South Ocean

“Published research has shown an increasing trend in the frequency of plastic ingestion in seabird populations worldwide. In this paper I review studies of the incidence and impacts of plastic ingestion on Southern Ocean seabirds and, using a meta-analysis, identify that foraging method and whether a species undergoes migration to the Northern Hemisphere are the two most important factors influencing whether a particular species will have high levels of plastic in

the gizzard. Here I use data from 8 years of necropsy on Sooty Shearwaters (*Puffinus griseus*) killed in New Zealand fishing operations to demonstrate that the origin of the majority of plastic ingested by this species is most probably the northern hemisphere. In contrast I will also present unpublished data from the Northern Royal Albatross, a species that does not migrate to the Northern Hemisphere that suggests that incidence of plastic ingestion in exclusively Southern Ocean species is also increasing. Evidence for the harmful effects of bio-accumulation of the toxic compounds leached from the ingested plastics, with potential detrimental effects on fecundity rates and egg breakage rates has been suggested for northern Hemisphere seabirds. Evidence for similar effects is currently lacking for Southern Hemisphere species and more work on this important area is needed.”

V3-4 We 1000-1020 Lecture Theatre

Jan A. van Franeker

Seabirds as monitors of marine litter

“The ultimate fate and environmental impact of marine plastic debris is a major policy concern. Priorities for, and efficacy of measures taken, need to be addressed through reliable assessments of regional variations and rates of change. Bio-monitoring integrates pollution levels over space and time and links these to ecological impact, which in turn generates strong public and political awareness of the urgency to deal with the problem. Seabirds that regularly ingest plastic, like many tubenoses, are suitable bio-monitors. In the North Sea, regional differences and trends in marine litter are monitored by the abundance of plastics in stomachs of beached Fulmars (*Fulmarus glacialis*). Procedures for dissections, stomach analyses and data processing have been standardized as one of the OSPAR Ecological Quality Objectives (EcoQO’s) for the North Sea. A wider European application is considered in the EC Marine Strategy Framework Directive, which develops standards for ‘Good Environmental Status’. In the EcoQO approach, a policy target for ‘acceptable environmental quality’ has been set at the level where less than 10% of beached Fulmars has more than 0.1g of plastic in the stomach. Currently 40% to 60% of Fulmars in the North Sea exceeds that critical level. The fulmar can be an adequate monitoring species over much of the northern Atlantic and Pacific. For other areas, feasibility studies are needed using other seabird species but similarly standardized methods.”

Save the North Sea Fulmar Study Group

V3-5 We 1020-1040 Lecture Theatre

Hannahrose Nevins

Evidence for increasing plastic ingestion in Northern Fulmars in the Pacific

“We quantified the incidence of plastic ingestion in Northern



Fulmar (*Fulmarus glacialis*) collected opportunistically by fisheries observers (Alaska) or by beach surveyors during unusual mortality events (California) during 2003-2009. We compared the incidence and type of ingested plastic (industrial or post-consumer fragments) from fulmars collected taken as bycatch in Alaska fisheries in 2007-2008 (n = 173) and in central California during a 2007 Mystery Spill (n = 106). We then compared these samples to past studies and AK in 2005 (n = 198) in central CA in 2003 (n = 190). Our results indicate that the relative amount of plastics in both CA and AK has increased in both areas in recent years; from 71% to 85% in CA (2003 to 2007), and from 62% to 72% in AK (2005 to 2007-08). These findings indicate that marine debris pollution is pervasive in both relatively unpopulated (AK) and in heavily inhabited (CA) areas. This study highlights the value of using fulmar stomach contents as a bio-indicator of plastic marine debris in the North Pacific, similar to in the EU environmental metric developed for the North Sea.”

Erica Donnelly; Michelle Hester; David Hyrenbach

V3-7 We 1120-1140 Lecture Theatre

Holly Gray

Incidence, variety, and mass of plastics ingested by Laysan and Black-footed Albatrosses recovered as by-catch in the North Pacific Ocean

“Laysan (*Phoebastria immutabilis*) and Black-footed Albatrosses (*P. nigripes*) ingest plastic debris, as evidenced by plastic in the digestive contents of their chicks, however there is little documentation of ingested plastics carried in foraging adults. We quantified plastics among the digestive contents of 18 Laysan Albatrosses and 29 Black-footed Albatrosses collected as by-catch in the North Pacific Ocean. Ingested plastic was present in 30 of the 47 birds examined, with Laysan Albatrosses exhibiting a greater incidence of plastic ingestion (83.3% n=18) than Black-footed Albatrosses (51.7% n=29) ($X^2=4.8$, $df=1$, $P=0.03$). Of the varieties of ingested plastic recovered, plastic fragments contributed the greatest mean mass in both species. Between species, Laysan Albatross specimens contained a higher mean mass of plastic fragments, and Black-footed Albatross specimens contained a higher mean mass of plastic line. Though the overall mean mass of ingested plastic in both species ($0.46g \pm 1.45$) was lower than previously noted among albatross chicks, the high incidence of ingested plastic reported here suggests that long-term effects, e.g. absorption of contaminants from plastics, may be of concern throughout the population. Furthermore, signs of regurgitation, coupled with limited digestive contents, indicate further research is required to determine if specimens obtained through fisheries by-catch result in underestimates of plastic burdens.”

Gwendolyn Lattin; Charles Moore

V3-8 We 1140-1200 Lecture Theatre

Lindsay Young

How colony-based differences in foraging distribution lead to increased plastic ingestion in Laysan Albatross

“The highly vagile Laysan albatross which forages throughout the North Pacific, are well known for their tendency to ingest plastic. Here we examine whether Laysan albatross nesting on Kure Atoll and Oahu Island, 2,150 km apart, ingest different amounts of plastic and whether this is a result of differences in their at-sea distribution. Twenty two geolocators were deployed on breeding adults for up to two years. Boluses were also collected from chicks at each site. Chicks from Kure Atoll were fed almost ten times the amount of plastic compared to chicks from Oahu despite boluses from both colonies having similar amounts of natural food. Tracking data indicated that adults from either colony did not overlap in their core distributions during the early half of the breeding period and that adults from Kure had a greater overlap with the putative range of the Western Garbage Patch corroborating the higher plastic loads at this colony. At-sea distributions also varied throughout the year suggesting that Laysan albatrosses either adjusted their foraging behavior according to constraints on time away from the nest or to variation in resources. However, in the non-breeding season, distributional overlap was greater indicating that the energy required to reach the foraging grounds was less important than the total energy available. These results demonstrate how regional and seasonal differences in foraging of a pelagic seabird can lead to vastly different levels of plastic ingestion.”

Cynthia Vanderlip; David Duffy; Scott Shaffer

V3-9 We 1200-1220 Lecture Theatre

Jennifer Provencher

Plastic ingestion by two seabird species in the Eastern Canadian Arctic

“Plastic debris has become ubiquitous in the marine environment and seabirds may ingest debris which can have deleterious effects on their health. More than 200 seabird species have been reported to ingest plastics worldwide, with isolated and remote areas not immune to this global problem, including the Canadian Arctic Archipelago. We examined the stomach contents of two seabird species breeding in the eastern Canadian Arctic for ingested plastic, an alcid, the thick-billed murre (*Uria lomvia*) and a procellariiforme, the northern fulmar (*Fulmarus glacialis*). 84% of the fulmars collected at mid and high Arctic colonies contained plastic debris in their gastrointestinal tract and 11% of the murre collected at low, mid and high Arctic sites contained plastic debris, a species with no previous reports of ingested plastics in the north Atlantic. Although both species showed higher



occurrence of plastic debris than previously reported few murrelets contained more than 1 piece of plastic, while 28% of the fulmars collected had plastic loads greater than 0.1 grams, the Ecological Quality Objective goal set for fulmars in the North Sea. This study sets a baseline for ingested plastics by seabirds in the Canadian Arctic but more work is needed to understand plastic ingestion patterns in these two species. Marine plastic debris is becoming a problem in distant and remote locations away from industrialized areas, and we can use seabirds as indicators of plastic debris worldwide where little other plastic debris assessment work is being done.”

Tony Gaston; Mark Mallory; Patrick O'Hara; Grant Gilchrist

V3-10 We 1220-1240 Lecture Theatre

Gwendolyn Lattin

Plastic ingestion by planktivorous fishes in the North Pacific Central Gyre

“Marine debris has accumulated in the North Pacific Central Gyre (NPCG). The effects of marine debris on larger marine organisms have been documented through reported cases of entanglement and ingestion; however, little is known about the effects of this debris on lower trophic level marine organisms. This study is the first of its kind to document ingestion and quantify the amount of plastic found in the gut of common planktivorous fish in the NPCG. 11 neuston samples were collected in February 2008 by manta trawl in the NPCG. Approximately 35% of the 670 fish studied were found to have ingested plastic, with an average of 2.1 pieces per fish. This study confirms that fish in the NPCG are ingesting plastics, additional studies are needed to determine the effects of mechanical damage or transfer of toxicants sorbed to the ingested plastics on fish health and the transmission of these impacts throughout the food web and to higher trophic level organisms such as sea birds.”

Christiana M. Boerger; Shelly L. Moore; Charles Moore

V3-11 We 1400-1420 Lecture Theatre

Annette Henry

Quantifying Marine Debris in the Eastern Tropical Pacific Ocean

“As part of the 2006 *Stenella* Abundance Research (STAR) survey, two seabird observers were placed aboard each of two NOAA research vessels to collect data on the distribution and abundance of marine debris, concurrently with data on seabirds. The survey area was the eastern tropical Pacific (ETP) and included 12 countries, the high seas, and three major surface currents. NOAA Ship David Starr Jordan surveyed primarily the shelf and nearshore areas while NOAA Ship McArthur II focused on the high seas. Using strip transect methods, a total of 2,177 sightings of marine debris

were made: 1,547 from the Jordan and 630 from the McArthur II. Marine debris sightings were classified into 10 categories: glass; metal; monofilament line, ropes and fishing gear; organic matter; paper or cloth; plastic; rubber; Styrofoam; wood; and “other” which consisted of unidentifiable or multiple items of different categories. More than 95% of the marine debris encountered could be described in four categories: plastic, Styrofoam, wood and other. Plastic was the most common debris item sighted and accounted for more than half of all debris encountered (Jordan: 57.5%; McArthur II: 64.4%). We found that the density of marine debris in the ETP varied spatially and was relatively high in shelf or nearshore waters of most countries as well as in convergence zones such as the Equatorial Front.”

Lisa Ballance; Thomas Moore; Christopher Cutler; Michael Force; Rich Pagen; Sophia Webb

V3-12 We 1420-1440 Lecture Theatre

Andrew Titmus

Habitat associations of seabirds and marine debris in the North East Pacific at multiple spatial scales

“Floating marine debris accumulates in subtropical gyres, regions characterized by surface convergence. While many surface-foraging seabirds ingest plastic at-sea during their vast foraging trips, little is known about when and where these seabirds collect this material. Studying the habitat associations of seabirds and debris is key to interpreting plastic ingestion rates by these oceanic predators. We surveyed concurrent distributions of marine debris and seabirds within the Eastern Garbage Patch, a conspicuous area of plastic accumulation in the Northeastern Pacific Ocean, during two summer cruises. In 2008, we used a cruise from Honolulu, HI to San Francisco, CA to characterize the biogeographic affinity of seabirds and debris. We identified two distinct communities in tropical and subtropical waters. Several Procellariiform seabirds (black-footed albatross; Murphy’s, Hawaiian, Cook’s petrel; Leach’s storm-petrel) overlapped with debris concentrations over large (100s km), yet not at small (10s km) spatial scales. In 2009, we used a cruise from San Diego, CA to 40° N, 140° W and back to Newport, OR to describe the distribution and patchiness of debris in the center and edge of the gyre. Highest abundances of debris occurred within the gyre, dominated by small (<10 cm) plastic fragments, bioavailable for ingestion. Plastic abundance was patchy on multiple spatial scales, from a few to 100s of km, suggesting that a variety of oceanographic mechanisms aggregate this material.”

David Hyrenbach



V4-1 Th 0900-0920 Salon A

Christa Mulder

The Seabird Islands and Introduced Predator (SEAPRE) research coordination network: global comparisons

“Seabird islands across the planet share several characteristics. They support unique plant and animal populations and species that are no longer found on the mainland. Seabird predators have devastated seabird populations and drastically altered vegetation processes and ecosystem function. These predators are now being eradicated on hundreds of islands, but restoration plans usually do not include vegetation, invertebrate communities, or ecosystem processes. The SEAPRE network brought together researchers from across the globe to perform the first world-wide cross-system comparisons and syntheses, establish standard methodologies, identify crucial data that are lacking, and develop a conceptual framework for understanding and predicting impacts of seabirds and predators on island functioning, the consequences of their removal, and requirements for restoration of island functioning. Specifically, we examined the extent to which impacts of seabirds are similar across systems, and the extent to which they are determined by system-specific characteristics such as geographic location and isolation, climate, or seabird species. In this talk we introduce 15 focal island systems; these range from sub-arctic to tropical and from desert to rainforest. We briefly describe their characteristics and history of non-native predator introductions and eradications. Next we explain the approaches taken in comparing information from a highly diverse set of systems. Finally, we introduce the goals of the symposium and explain mechanisms for feedback on the two anticipated products: 1) preliminary recommendations for management or restoration following predator eradication, and 2) a database aimed at providing practical information for managers involved in seabird island restoration.”

Julie Ellis; Wendy Anderson

V4-2 Th 0920-0940 Salon A

Joanna Smith

Where marine ornithology, soil science and botany converge: seabirds as island ecosystem engineers

“Around the world, seabirds occupy oceanic and continental islands during breeding. For ornithologists, these island systems are fascinating places to study breeding biology, foraging ecology and other aspects of marine ornithology. However, from the perspective of soil scientists and botanists, seabird islands represent unique ecosystems transformed by the birds themselves. We studied 15 seabird island systems, in both Northern and Southern Hemispheres, with seabirds principally from the Procellariiformes, Pelecaniformes, and

Charadriiformes. We summarise seabird life history characteristics that influence nutrient inputs, including foraging ecology, guano production and deposition, as well as examine the physical effects that seabirds have on soils and vegetation because of body size and nest types. We conclude that the extent and timing of nutrient inputs and physical disturbance will be strongly dependent on seabird identity. Furthermore, because of the different behaviours exhibited by different seabird species, physical disturbance and nutrient inputs may be decoupled to some extent: some species may provide large nutrient additions with relatively little physical disturbance (e.g., crevice-nesting seabirds), while other may have substantial impacts on soil structure and ground vegetation without concurrent major inputs of nutrients (e.g., some burrowing seabirds). Understanding the impacts of seabirds on island ecology, and the consequences if birds are extirpated, is critical to restoring seabird island ecosystem function.”

Christa Mulder; Julie Ellis

V4-3 Th 0940-1000 Salon A

Mark Rauzon

Impacts of introduced predators on seabirds

“We present a comprehensive review of the effects of introduced predators on seabirds of the world. Atkinson (1989) identified 80 species of mammals that have been introduced to islands. At least 40 of these are actual or potential predators of seabirds. Among the predators are six species of monkeys, six species of mustelids, four species of pig other than feral domestic pigs, three species of rats, canids, including domestic dogs and three species of foxes and at least two species of mongoose. The most widespread species are the commensal rodents that have followed human colonization of the world’s islands. A meta-analysis identified 115 independent rat-seabird interactions on 61 islands involving 75 affected species of seabirds in 10 families. Rodents are mesopredators, having differential impacts on seabirds and island ecosystems depending on the rodents and seabird species present. In contrast are the super-predators kill more seabirds than are eaten in one meal. Cats kill repeatedly as hard-wired hunters, while foxes hoard stocks of prey for winter. Tramp ants are also emerging as seabird predators, especially after released by rat eradications. Often a suite of predators impact seabirds and determining which species is harming seabirds the most, and which should be targeted for eradication has been aided by recent developments using stable isotopes measured from predator tissue. Novel techniques will be necessary as eradications grow in size and complexity. We emphasize the value of eradicating invasive predators from island food webs as a means of stopping their impacts on island species and ecosystems.”

David Towns; Vernon Byrd; Franck Courchamp; Holly Jones; Mark Rauzon; James Russell; Chris Wilcox

**V4-4 Th 1000-1020 Salon A****Susanne Schmidt****Global analysis of biogeochemistry and plant communities of seabird islands**

“Seabird islands are characterized by physical disturbance and nutrient inputs at the extreme high end of those experienced by natural ecosystems. Seabird-induced biogeochemical conditions and disturbance regimes result in distinct vegetation, which provide suitable nesting and roosting habitat for seabirds. We analysed soil and vegetation characteristics of seabird and non-bird islands across biomes to test for generalities. Such knowledge underpins understanding of the processes that drive the ecology of seabird islands, and guides restoration efforts on islands where seabirds have been eradicated and current vegetation is unsuitable. Plant communities on seabird islands can have a high proportion of taxa typically associated with nutrient enrichment and disturbance, but also taxa unique to these islands. Invasive plant species threaten seabird islands to a greater extent as evidenced by a greater number of non-native plant species at the plot level than comparable islands without birds. Across island ecosystems, nitrogen saturation of the vegetation was reached at 600-1000 nests ha⁻¹, but stabilized or declined above those densities. Leaf nitrogen levels of up to 6% in some forbs are some of the highest recorded for terrestrial plants. In contrast, leaf phosphorus contents were not affected by seabird density in the studied islands. We discuss these findings in context of the diverse seabird islands used in our global analysis and how this knowledge could guide restoration.”

Christa P Mulder; Julie Ellis; Peter Bellingham; Ewen Cameron; Don Croll; Holly Jones; Kayoko Kameda; Gundula Kolb; Christoph Kueffer; Glen Mittelhauser; John Orrock; Cecilia Palmborg; Eric Vidal; Alexander Wait; David Wardle; Louie Yang; Hilary Young

V4-5 Th 1020-1040 Salon A**Wendy Anderson****Seabird Impacts on Island Food Webs**

“Seabirds nesting on islands generate resources for resident plants and animals. Inputs such as guano, seabird carcasses and fish scraps can subsidize invertebrate and vertebrate consumers, and thus alter population abundance and community interactions. In addition, consumers on islands with introduced predators of seabirds experience multiple impacts from those predators, including reduction of the seabird-derived resources and direct predation pressure by the introduced predators. We will synthesize emergent trends from seabird islands in the Baltic Sea, Mediterranean Sea, Gulf of California and New Zealand. These systems represent variability in climatic regions, nesting seabird species biology

and presence of introduced seabird predators. In all of these systems, most consumer groups sampled responded positively to the presence of seabirds as a resource provider. The exceptions to that pattern were often associated with the disturbance impacts of seabirds on soils and vegetation, which alter the physical habitat for the species that have decreased abundance. Also, in some cases, trophic cascades arise from the enhanced secondary productivity stimulated by seabird inputs. Islands without seabirds or with diminished seabird populations due to introduced predators tend to have lower abundances of consumers. Eradicating predators, though, can lead to unintended shifts in community structure and interactions. For instance on islands with cats and rats, the eradication of cats can lead to an increase in rats, which then limits the ability of seabirds and native consumers to recover. Given the importance of native consumers in maintaining healthy ecosystems on islands, these consumer species should be monitored during restoration efforts.”

Gundula Kolb; Hillary Young; James Russell

V4-6 Th 1100-1120 Salon A**Donald Drake****Direct impacts of seabird predators on island biota other than seabirds**

“Islands favored by seabirds typically lack predatory mammals. It follows that the rest of the biota on seabird islands is also unaccustomed to these predators. Hence, the introduction of seabird predators such as cats, foxes, pigs, rats, and mice affects not only the seabirds, but also many naive, vulnerable, island taxa. We review and provide examples of the direct effects the main seabird predators have on island arthropods, mollusks, amphibians, reptiles, land birds, mammals, and plants. Direct negative effects are predation, herbivory, and physical disturbance, while direct positive effects include acting as prey or reproductive mutualists for island taxa. We then apply two principal components analyses to compare overall similarities among predators based on their direct negative impacts: one analysis to compare similarities in predator effects on seabirds, and another to compare their effects on all other biota. Results suggest that while some predators, such as rats and cats, are relatively comparable in their effects on seabirds, they differ significantly in their effects on other biota. For other predators, the reverse is true. And some species, such as pigs, have unique impacts and share few similarities with other predators. We conclude with recommendations for research and management of predator impacts on seabird islands, with special emphasis on consequences for non-seabird taxa.”

Thomas Bodey; James Russell; David Towns; Manuel Nogales; Lise Ruffino



V4-7 Th 1120-1140 Salon A

Holly Jones

A review of the world's seabird restoration projects

“Within the past several decades, restoration methods have been developed to restore seabird populations in locales where they were reduced or extirpated. Chick translocation and/or acoustic vocalization playbacks and/or decoys are now used widely to lure breeding seabirds to restoration sites. This is the first worldwide review of seabird restoration projects that use these methods. We evaluate the factors affecting success or failure and recommend future directions for management. We identified 123 restoration projects that were implemented to protect 49 seabird species in 92 locales in 14 countries since restoration methods were pioneered in 1973. Seabird restoration can achieve conservation goals for threatened and endangered species. It can also help to restore ecological health as large seabird colonies function to cycle marine nutrients to terrestrial ecosystems and create habitats for commensal species. Restoration is especially appropriate where the original causes of decline are no longer working to suppress colony growth.”

Stephen Kress

V4-8 Th 1140-1200 Salon A

David Towns

Community involvement in seabird island restoration

“Community involvement in island restoration was reviewed for 24 projects on seabird islands in 8 countries. The project formed three categories: those aimed at providing information, with minimal citizen participation (public engagement); those with high levels of citizen involvement, including devolution of responsibility to local communities (stakeholder participation); and those where citizens themselves have initiated the projects (stakeholder instigation). Unlike mainland restoration, seabird island projects often involved the eradication or control of predators (usually introduced mammals); they were often in remote locations; the habitats were sometimes sensitive to high levels of public traffic; their management often required high levels of technical and institutional support; and, especially in developing nations, their implementation was often initiated by outside organisations such as NGOs. However, like other reviews of restoration projects on the mainland, those on seabird islands usually suffered from a vague understanding of the aspirations of agencies and local communities, informal project design, and as a result, difficulties with assessing relationships between agencies and stakeholders. A more analytical approach to assessing the effectiveness of various models of participation is required, while recognising that goals and approaches will need to reflect the local political and social climate.”

V4-9 Th 1200-1220 Salon A

Julie Ellis

Seabird island restoration guidelines: an ecosystem-based approach

“The presence of introduced seabird predators often results in very large changes in seabird island communities via reducing or eliminating seabirds and other species, and by reducing nutrient inputs and disturbance regime that seabirds impose on islands. Marine nutrients brought in by seabirds can subsidize native and endemic animal populations frequently found on remote islands. Predators are being successfully removed from hundreds of islands, but restoration plans usually do not include vegetation and ecosystem processes. Results from our global cross-system analyses indicate that there are often complex ecological interactions on seabird islands that have important implications for island restoration. For example, in systems with multiple seabird predators, eradication of one predator may cause populations of others to explode. Thus, it is important to carefully identify all native and introduced predators and their impacts in order to understand how removing one may affect the others. Similarly, seabirds consistently increase soil N and P and create conditions that facilitate invasion of non-native plant species; increases in invasive plants can reduce the suitability of seabird nesting habitat. Restricting access to seabird islands, and/or restoring native plants prior to re-introduction of seabirds, will reduce the likelihood of invasion by non-native plant species. In this talk we present and solicit input on guidelines for restoration of seabird islands based on our global comparisons of seabird island ecology.”

Christa P Mulder

V5-1 Th 1440-1500 Salon A

Neil Dawe

The Conservation Ark has sailed but it missed the elephant in the room.

“Many recent and significant studies and reports give a disheartening picture of what humanity appears to be forcing upon the life support systems of the ocean and the entire planet. At the same time, one has to wonder how this can be when we have more environmental laws and ocean regulations; more marine protected areas; more scientific, ecological, and conservation research and information; more technological advances; more ecosystem restoration projects and endangered species recovery plans; more public environmental awareness; and more people working to conserve ecosystems and their (marine) biodiversity than ever before. As Gus Speth has pointed out, “Our environmental organizations have grown in strength and sophistication, but the environment has continued to go downhill, to the point that the prospect of a ruined planet is now very real. How



could this have happened?” Here, I consider current general declines in the biodiversity of the planet and offer one explanation as to why, despite concerted efforts by dedicated conservationists, ecologists, and biologists around the world to reduce these declines, many populations continue their downward spiral. Specifically, I contend that the majority of our efforts have been focused on the myriad symptoms of our environmental problems rather than the root cause: our perennial demand for economic growth and its fundamental conflict with biodiversity conservation in the sea and on land. I also consider how we might begin to address the root cause in order to stop the precipitous declines in global biodiversity because there is a solution: the steady state economy.”

V5-2 Th 1500-1520 Salon A

Antony Diamond

Seabirds and economies: from subsistence egging through incidental take and collateral damage

“Objectives: to review the global extent of interactions between seabirds and human economies, and how the directions and degrees of those interactions may change over time. Peoples throughout the world have relied on seabirds and their products throughout human history; it is not clear at what point exploitation shifted from subsistence to a market economy, and this probably happened at different times in different places. There are few such subsistence relationships remaining between people and seabirds; most direct exploitation now is market-based and consequently requires strong regulation to be sustainable. Most seabird mortality attributable to humans currently is in the form of “incidental take” - the civilians' version of “collateral damage” - in which birds die as an indirect effect of human activities directed towards ends other than bird mortality. This kind of mortality is much harder to regulate, simply because it is not deliberate; regulatory systems are struggling increasingly to find ways to do so. These attempts are largely doomed so long as political and consumer support of unsustainable fisheries continues, as it does world-wide. Incidental take of seabirds in fisheries - unlike, for example, that from oiling or other habitat change - has a direct cost to the fishing economy which is rarely included in benefit/cost analyses employed in setting regulations.”

V5-3 Th 1540-1600 Salon A

Caroline Fox

Seabirds and Economy in British Columbia: The NGO Perspective

“Seabirds have long suffered from the damaging effects of the global economy. Climate change, oil spills and conflict with fisheries are all examples of the inherent conflict between economic growth and biodiversity, including seabirds. On the

North and Central coasts of British Columbia, recently proposed energy projects present large ecological risks that overlay ecosystems already altered due to centuries of exploitation. Combined with a relatively limited amount of information relating to seabirds in these areas, adequate management and protection of seabirds and their habitat is increasingly uncertain. Using specific examples, we offer our perspective on seabirds, economic growth and the role of NGOs in these waters.”

V5-4 Th 1600-1620 Salon A

Falk Huettmann

Murrelets and economy: history, evidence and a required change

“Marbled and Kittlitz’s Murrelets lived for thousands of years in the Pacific Northwest. But during the last 60 years they have received dramatic and well documented habitat and population losses. Impacts on “individual bird quality” are not even addressed well, e.g. fragmented group structure and behavior. In parallel, the western world saw a huge increase in GDP and coastal development. Murrelets make for a prime example how the human economy grows on the cost of an inherent wildlife economy, and how such a school of economy virtually ignores the value of land, and specifically, the irreplaceability of Old-Growth forests and glacier habitat. Any school of economy that promotes the free substitutability of (timber) products, and which marginalizes external costs such as atmospheric pollution with carbon harms species such as Murrelets. This is because Murrelets are found downstream in coastal estuaries, relying on specific temperatures and healthy watershed processes linked to ancient landscapes. Their nesting and feeding habitat presents a finite commodity. Despite bigger and ongoing research efforts, an apparently wrongly focused research and management priority over the last 30 years has not halted this trend in relevant terms. Stakeholders from Asia and elsewhere have not been accounted for. Here, I am showing such connections, and promote to re-focus the Murrelet science and management onto the real underlying problems, and less on the symptoms. In addition, I am promoting to include an Ecological and Macro-Economic view in the way how modern Adaptive Management for these seabirds can be improved.”

V5-5 Th 1620-1640 Salon A

Mark Bellingham

Restoring seabird nesting colonies: the role of indigenous landowners and local communities

“The New Zealand bio-region has a high diversity of seabird species, yet most have been extirpated from the larger islands of New Zealand. Until recently most of the seabird conservation work in New Zealand has been carried out by the Conservation Department and its predecessor the Wildlife



Service. But over the past 25 years indigenous landowners and local communities have been increasingly involved and initiating colony restoration projects. This paper outlines a number of case studies where indigenous landowners and local communities have protected and restored seabird nesting colonies on the mainland North and South Islands, Chatham Islands and smaller offshore islands. Since 1990 Central Government conservation funding has suffered a serious decline and this is continuing. Yet the public concern for the protection and conservation of seabird nesting colonies has increased. This has led to landowners and communities taking a greater role in the management of seabird nesting colonies, where they may be able to provide a more consistent and long-term conservation solution.”

V5-6 Th 1640-1700 Salon A

Valeria Ruoppolo

Wildlife and oil in the Antarctic - a recipe for cold disaster

“The recent spate of incidents involving vessels in Antarctica has highlighted the potential for chemical spills into the Antarctic environment. An increasing number of tourist vessels, often without ice-strengthened hulls built for use in other parts of the world, are penetrating farther and longer into Antarctic waters, and whose focus for destination are wildlife concentrations. This is a recipe for a catastrophic spill event with high numbers of oiled wildlife in a remote part of the world where there are major logistical constraints on the provision of equipment and personnel to respond. Here we review the history of events that led or could lead to discharges, the current legislation and contingency plans in place by Antarctic Treaty signatories’, debating preparedness and expertise for oiled wildlife response in the region.”

Eric Woehler; Kerri Morgan; Curtiss Clumpner; Veronica Frank; Barbara Callahan; Jay Holcomb

V6-1 Th 0900-0920 Salon C

Linda Wilson

Surveying and predicting important foraging areas for terns in support of MPA identification

“Pre-1970, almost all seabird work focused on studies on land, primarily due to the difficulties of following birds at sea. The subsequent use of recording devices on free-living seabirds led to startling insights into bird performance, particularly with regard to depth use. Post-1980, rapid advances in solid-state technology led to a plethora of new devices being increasingly used to examine the physiology, behaviour and ecology of free-living birds. This work describes the genesis and development of bird-attached recording systems and examines how this has radically changed the way we perceive how these animals operate in their demanding environment.”

V6-2 Th 0920-0940 Salon C

Nadav Nur

Seabird hotspots in the California Current System: implications for marine spatial planning

“We developed predictive models of seabird distribution to identify areas that support foraging aggregations (“hotspots”) to inform marine spatial planning and designation of marine protected areas in the California Current System (CCS). We hypothesized that seabirds aggregate in predictable areas determined by bathymetric and oceanographic features. We modeled 16 species using at-sea observations collected between 1997 and 2008 in an area extending from Vancouver Island to the US/Mexico border and up to 600 km offshore. Single-species predictive models included bathymetric variables (e.g., depth; proximity to continental shelf-break) and remotely sensed oceanographic covariates (e.g., chlorophyll-a). Bathymetric variables were often strong predictors; oceanographic variables were less important. Model predictions were applied to the CCS for each season in each of 11 years. Single-species predictions were combined to identify potential hotspots using three criteria: (1) overall abundance, (2) importance of “core areas”, and (3) predicted persistence. Predicted hotspots were often aligned with currently protected areas, but we also identified potential hotspots in Northern California/Southern Oregon and off Vancouver Island that may warrant additional protection. Modeling seabird aggregations provides a powerful tool to identify marine hotspots and, when combined with information on specific threats and economic constraints, can assist marine spatial planning at a broad scale.”

Jaime Jahncke; Mark Herzog; Julie Howar; K. David Hyrenbach; David Ainley; John Wiens; Lisa Ballance; Kenneth Morgan; Jen Zamon; Diana Stralberg

V6-3 Th 0940-1000 Salon C

Kees (C.J.) Camphuysen

The differentiation between offshore sea areas based on recorded seabird behaviour during ship-based transects or with GPS loggers

“Large amounts of data have been collected to assess distribution patterns of seabirds around the world. Three sources of data are highlighted: ship-based surveys, aerial surveys, and analysis of spatial patterns based on logger data. The identification of sea areas of importance for seabirds is a challenge, because it is often unclear what certain sea areas are used for by the birds that occur there. Between species, there are differences in habitat choice, foraging techniques and feeding range, and in tendencies to roost at sea or to utilize resting places closer to or even on land. Because the designation of important sea areas for seabirds should bear relevance to the ecological importance of these regions,



simple presence/absence information is not sufficiently accurate and could be misleading. Recently protocols to systematically record seabird behavior at sea during ship-based surveys and novel tracking technology that facilitate spatio-temporal quantification of space use and differentiation of (aerial) behavioral aspects will be evaluated in the context of IBA designations. We present some shortcomings of traditional techniques, but more particularly possibilities of new instruments and protocols. These advanced approaches in data collecting and spatial analysis will reveal important ecological information that can enhance our ecological understanding of offshore seabird distribution patterns which can be applied to the designation of IBA and seabird conservation.”

Judy Shamoun-Baranes; Willem Bouten

V6-4 Th 1000-1020 Salon C

Bill Montevecchi

“Tracking seabirds in the Northwest Atlantic to identify important marine habitats, assess risks and implement conservation strategies”

“Research employing miniaturized bird-borne tracking and logging devices are generating novel insights into avian movement and utilization of the marine environment. We integrate bird-borne device studies (geolocators, time-depth recorders, satellite and GPS tags) with colony and vessel-based research to investigate the foraging and migratory ecology and ocean habitat use of free-ranging Northern Gannets, Common and Thick-billed Murres in the Northwest Atlantic. The spatial and temporal movements of individuals provided information that enhanced vessel and colony-based studies and allowed for assessments of processes and mechanisms that determine the activities, distributions and aggregations of birds at sea. We document species, colony and individually specific movement patterns and areas of use by murres and gannets and relate these to oceanographic and prey conditions. Breeding murres and gannets aggregated at forage fish hotspots and showed individual consistency in successive foraging trips. Outside the breeding season, individual birds exhibited consistency in migratory timing and movement patterns across years. These findings are used to assess human-induced risks (associated with fishing, hydrocarbon extraction, shipping and hunting) that seabirds encounter when foraging, migrating and residing on wintering areas. We use this information to identify key marine habitat areas to better understand and more effectively protect important marine ecosystem processes.”

April Hedd; Laura McFarlane Tranquilla; Chantelle Burke; Paul Regular; Stefan Garthe; David Fifield; Emily Wilson; Gail Davoren; Anthony Gaston; Paul Smith; Gregory Robertson; Richard Phillips

V6-5 Th 1020-1040 Salon C

Matthieu Le Corre

Tracking seabirds to identify potential high-seas Marine Protected Areas in the western Indian Ocean

“As numerous parts of the oceans are now overexploited by fisheries, there is a growing interest in the implementation of Marine Protected Areas in the open oceans, where fishing activities would be regulated. The question is now, where to put these high-seas MPAs? Remote sensing and satellite imaging are powerful tools to identify productivity hotspots but these hotspots are not necessarily adequate to implement oceanic MPAs because the species targeted by fisheries are generally at the top of the food chains and not at the bottom. The foraging movements and concentrations of top predators like large fish, marine mammals and seabirds on the other hand are powerful indicators of key areas, especially if these predators are associated with targeted fish species. Among these predators, seabirds are especially interesting because their foraging movements can be tracked easily and with an increasing precision using archival tags and satellite telemetry. In this talk we will present a long term regional programme designed to track simultaneously a wide number of far ranging tropical seabirds of the Indian Ocean. Although data are still being collected, we will present the first data obtained on 7 species tracked at 5 major seabird places of the western tropical Indian Ocean (Europa, Seychelles, Aldabra, Tromelin and Réunion Island)”

Henris Weimerskirch; David Pinaud; Francis Marsac; Teresa Catry; Jamie Ramos; Patrick Pinet; James Russell; Nirmal Shah; Michelle Kappes; Sébastien Jaquemet

V6-6 Th 1100-1120 Salon C

Jacob Gonzalez-Solis

Global migration dynamics of transequatorial shearwaters

“In each of the two major oceans of the world, the Atlantic and the Pacific, millions of shearwater migrate across the equator twice a year. Some species breed in the northern, and “winter” in the southern hemisphere, while others conduct the opposite migration, but all pursue for an endless summer. Understanding the global dynamics of these movements can help us to better assess major driving factors, multispecific hot-spots and the risks faced by shearwaters during their journeys. Using geolocation data, we analysed the trans-hemispheric migration of ten shearwater species, including those breeding in both hemispheres and the two major ocean basins: Cory's (*Calonectris borealis*), Scopoli's (*C.diomedea*), Cape Verde (*C.edwardsii*), Streaked (*C.leucomelas*), Manx (*Puffinus puffinus*), Great (*P.gravis*), Flesh-footed (*P.carneipes*), Pink-footed (*P.creatopus*), Short-tailed (*P.tenuirostris*) and Sooty (*P.griseus*) shearwaters. Concurrent



data on marine habitat traits were obtained from the NASA. Spatiotemporal overlap among species revealed a few major large-scale hotspots in both oceans. In the Atlantic, most species followed relatively narrow corridors showing a figure of eight migration associated with the northern and southern oceanic gyres. In the Pacific, however, most species migrated between hemispheres within a western, or a broad eastern corridor. We discuss the consequences for management and conservation of shearwaters in each ocean.”

Angel Felicísimo; Yann Tremblay; Tim Reid; Mark Carey; Peter Hodum; Akinori Takahashi; Jesus Muñoz; Ingvar Sigurðsson; David Thompson; Peter Ryan; Richard Cuthbert; April Hedd; William Montevecchi; Phil Trathan; Richard Phillips; Scott Shaffer

V6-7 Th 1120-1140 Salon C

Lorien Pichegru

Marine no-take zone benefits endangered penguin

“No-take zones may protect populations of targeted marine species and restore the integrity of marine ecosystems, but it is unclear whether they benefit top predators that rely on mobile pelagic fish. In South Africa, foraging effort of breeding African penguins decreased by 30 % within 3 months of closing a 20-km zone to the competing purse-seine fisheries around their largest colony. After the fishing ban, most of the penguins from the experimental island had shifted their feeding effort inside the closed area. Birds breeding at a colony which remained open to fishing 50 km away increased their foraging effort during the same period. This demonstrates the immediate benefit of a relatively small no-take zone for a marine top predator relying on pelagic prey. There is currently much debate about the efficacy of MPAs as a tool to conserve for pelagic predators, and our study provides the first empirical evidence that marine top predators could benefit from no-take zones. Selecting such small protected areas may be an important first conservation step, minimizing stakeholder conflicts and easing compliance, while ensuring benefit for the ecosystems within these habitats. Despite their preliminary nature, our results strongly encourage this strategy, and support the creation of further marine protected areas for oceanic top predators.”

David Grémillet; Robert Crawford; Peter Ryan

V6-8 Th 1140-1200 Salon C

Carlos Zavalaga

Identifying feeding hot spots of three species of boobies from Peru and Galapagos: the use of dataloggers for the implementation of MPA.

“GPS in conjunction with time-depth recorders were used to identify feeding zones of Peruvian (*Sula variegata*) and Blue-

footed boobies (*S. nebouxii*) in northern Peru, and Nazca boobies on Isla Española, Galapagos. Feeding areas were overlaid to concurrent remote sensing data of oceanographic features using Geographic Information Systems to examine the habitat use. Tracks and location of diving areas indicate that boobies forage at specific areas that are not necessarily associated to abiotic variables (e.g. bathymetric features, high concentration of chlorophyll-a). Other ecological factors such as competition for food with sympatric species, or commensalism with subsurface predators may also explain the spatial distribution of boobies. Likewise, the three species of boobies spend a high proportion of the time for foraging outside the boundaries of Marine Protected Areas or exclusion zones. Booby feeding areas also extensively overlap with fishing zones, but the extent of interactions with fisheries is still unknown. In December 2009, the Peruvian government officially approved the creation of a New National Marine Reserve that incorporates 22 islands and 11 guano points into the National Protected Area System. The incorporation of these sites increases the protected areas by approximately one million hectares. Thus, new information on seabird movements and foraging areas are necessary to implement an effective MPA.”

Steven Emslie; David Anderson; Giacomo Dell’Omo

V6-9 Th 1200-1220 Salon C

Josh Adams

Connectivity and summertime use of West Coast U.S. National Marine Sanctuaries by migratory Sooty Shearwaters (*Puffinus griseus*)

“Nonbreeding Sooty Shearwaters are the most abundant seabird in the California Current Ecosystem (CCE) during summer and are excellent indicators of ecosystem functioning in part because of their extreme mobility unconstrained by central-place foraging from colonies. During 2008–09, we used satellite telemetry (61526 bird hrs, 57 birds) to evaluate summertime (May–September) distribution and movement patterns from 3 discrete locations throughout the CCE: Columbia River Plume, WA/OR; Monterey Bay, CA; and Santa Barbara Channel, CA. Shearwaters ranged from SE Alaska to Southern Baja California, Mexico, and spent 83% of their time within the US EEZ. Within the EEZ, shearwaters spent 25% of their time within the 5 National Marine Sanctuaries (NMS). Monterey Bay NMS and Channel Islands NMS were most heavily used (69 and 18% of the time, respectively). Shearwaters spent 57% of their time over shelf (<200m), 35% of time over slope (201–1000m), and 8% of time over continental rise (>1000m). We evaluated overlap among individuals’ utilization distributions and related “hotspot” area-use to a recently-developed satellite-based chlorophyll persistence index. Finally, we used shearwaters and remotely-sensed data to evaluate connectivity and regional scaling of hotspots both within and beyond NMS



boundaries. This information is critical for assessing trends in shearwater numbers in the CCE, developing special management zones within Sanctuaries, and selecting locations for new Sanctuaries.”

**David Hyrenbach; Robert Suryan; James Harvey;
Andrew DeVogelaere**

V6-10 Th 1220-1240 Salon C

David Ainley

Modelling of top predators to define MPA boundaries in the Ross Sea, Antarctica

“CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources) is currently designating a network of marine protected areas (MPAs) across the Southern Ocean. Halpern et al.’s (2008, Science) recent analysis indicated the Ross Sea to be Earth’s least anthropogenically affected stretch of ocean. Likely it is the last having a full suite of top-predators and therefore has a columnar rather than the pyramidal trophic structure now found in marine waters elsewhere. To define provisional MPA boundaries, we used MAXENT to model the distribution of several top-predators: Antarctic minke whales, Antarctic toothfish, crabeater seals, Adélie and emperor penguins, and three species of petrels/albatross. Data were obtained from continuous at-sea surveys, as well as CPUE in a newly-arrived fishery. Co-variates in the modelling included bathymetry, rate of change in bathymetry, proximity to the shelfbreak front, prevalence of Circumpolar Deep Water, chlorophyll and krill abundance. Validation of models for crabeater seals and penguins was accomplished by kernel analysis of satellite tracking. Clearly evident was the primary importance of the enhanced productivity characterizing the Ross Sea continental shelf and the Antarctic shelfbreak front. We propose that MPA boundaries contain the shelf and slope, a small (3.2%) but ecologically significant portion of the Southern Ocean.”

Dennis Jongsomjit; Grant Ballard

V6-11 Th 1400-1420 Salon C

Iván Ramirez

MPAs in Europe, from marine IBAs to SPAs

“The identification of Marine Important Bird Areas is currently at the top of BirdLife International agenda. The identification of these sites began in the 1980s but has experienced a major boost over the past 5 years thanks to intensive data collection in Europe funded by the European Union. The European Union, through its Birds Directive (2009/147/EC), requires that all member states define a coherent network of Special Protected Areas (SPAs) for birds within its territories. This SPA network must be defined to both the territorial waters and the Economic Exclusive Zone (EEZ) of each member state. This is probably the most

powerful legislation affecting Marine IBAs and, as it previously happened with terrestrial IBAs, is currently being targeted by BirdLife partners as the main conservation tool to protect and manage the Marine IBA EU network. This talk will cover the current state of the “Marine IBA Toolkit”, a set of documents written by BirdLife partners in close collaboration with the Secretariat that summarize the methods used for the identification of Marine IBAs in Europe. Information on the total number of Marine IBAs present in Europe, both within the territorial waters and EEZs, as well as the percentage of those currently covered by the Birds Directive will also be presented. A detailed analysis of the problems and threats identified by EU partners to achieve full legal protection of their Marine IBA network will also be shown.”

V6-12 Th 1420-1440 Salon C

Anna Weinstein

Advances in protecting key seabird habitats in the U.S., British Columbia and Mexico

“The northeast Pacific (U.S., Canadian and Mexican waters) is a global seabird breeding and foraging hotspot, supporting over 200 species and 100 million individuals. Some important colonies and foraging destinations are partially or fully protected from many threats under a variety of state and federal legislation and planning initiatives, but most others remain vulnerable. We will provide examples from Alaska, British Columbia, California and Mexico that capture the range of scientific, economic and political challenges associated with securing protections. For example, in California a process is ongoing that is creating a network of no-fishing marine reserves which provide critical direct and de facto protections for seabirds. In British Columbia, numerous large seabird colonies are protected by law, but many lack active management, and foraging extensions from colonies are neither protected nor in many cases well known. A new, tri-national collaboration, drawing on the European experience, is identifying and designating Marine Important Bird Areas (IBAs) from Alaska to Mexico as part of BirdLife International’s global Marine IBA program. We will demonstrate how this process is providing a key new tool for engaging in effective, biologically defensible advocacy and conservation planning at appropriate spatial scales.”

Matthew Kirchoff; Peter Davidson; Eduardo Castro

V7-1 Th 0900-0920 Lecture Theatre

Matthew Parsons The value of long-term seabird population monitoring in the UK

“Since 1986 the UK Seabird Monitoring Programme (SMP) has annually sampled breeding abundance and success of 26 species at a geographically dispersed set of colonies. Adult survival and chick diet of some species are also monitored.



Given limited resources, we recently developed a monitoring strategy that aims to maximise information about seabird populations and what this tells us about the drivers of change and required management. The strategy focuses on six species that represent a range of foraging niches and provide information on the impact of pressures (such as climate change, fisheries, pollution). Rapidly declining species are also subject to investigation to determine reasons for their decline. Much of what we know about the impact of pressures on seabirds has come from detailed research, complementary to and using data from the SMP. We use examples from research conducted in a long-term study on the Isle of May in eastern Scotland by the Centre for Ecology and Hydrology. These demonstrate effects of changes in sea surface temperature, storminess and fishery presence, in *Phalacrocorax aristotelis*, *Uria aalge* and *Rissa tridactyla*. Such insights can only be established from long-term monitoring, where extensive and relatively low-input monitoring can provide valuable information, especially if supported by targeted research. We also emphasise the benefits of continuing to monitor common, non-declining species, as future changes may be currently unpredictable.”

Ian Mitchell; Francis Daunt; Sarah Wanless

V7-2 Th 0920-0940 Lecture Theatre

Tycho Anker-Nilssen

The Norwegian way to seabird monitoring

“Seabird monitoring in Norway and Svalbard has advanced considerably from the early ad hoc efforts of a few dedicated scientists. Today’s SEAPOP programme is a national effort coordinated by Norway’s key institutions and seabird scientists. It includes an extensive annual population monitoring of breeding and wintering seabirds across 20^o of latitude, and an intensive monitoring of reproductive performance, survival rates and diets of a selection of ecotypically different species at 12 key sites along the entire coast. Within three regional sea areas (Barents, Norwegian and North Seas), 75% of the breeding populations have, only since 2000, probably changed beyond internationally recommended target levels. Offshore species are most severely hit in the north, but in the North Sea, inshore surface-feeders are faring worst. The causes are not fully understood, but reduced food-availability is a very important factor. We present examples of how the long-term effort continued within SEAPOP is fulfilling its main objectives; 1) to monitor the status of Norwegian seabird populations and, through multi-disciplinary analyses and modelling of the time-series data, 2) to identify the most important pressures on Norwegian seabird populations, 3) identify and quantify effects of climate variation and perturbations caused by more direct anthropogenic influence (e.g. fisheries), and 4) develop the use of seabirds as cost-efficient, early warning indicators of the marine environment.”

Robert Barrett; Kjell Einar Erikstad; Svein-Håkon Lorentsen; Hallvard Strøm

V7-3 Th 0940-1000 Lecture Theatre

Kerry Woo

Understanding trends in Nunavut Thick-billed Murre populations

“Populations of Thick-billed Murres *Uria lomvia* have been monitored by means of annual or periodic sample counts and population censuses at three colonies in Nunavut, Arctic Canada, since the 1970s. Trends at all three colonies have been broadly congruent, suggesting that population control is regional rather than colony-specific, hence likely to operate in winter. Some, but not all, changes in population trajectory can be accounted for by changes on the wintering grounds. At the most intensively studied colony, at Coats Island, northern Hudson Bay, environmental conditions in the wintering area have had little effect on adult survival, but strongly influenced annual counts, suggesting that trends in counts are determined more by recruitment than by the survival of breeding age birds. We compare inferences that can be made from intermittent colony visits at Digges and Prince Leopold islands with those possible based on annual visits at Coats Island to highlight the kind of value added by more frequent monitoring.”

Paul Smith; Anthony Gaston

V7-4 Th 1000-1020 Lecture Theatre

Eric Woehler

Breeding population trends of Adélie Penguins at Casey over 50 years

“Data on breeding populations of Adélie penguins *Pygoscelis adeliae* from two localities at Casey, East Antarctica, provide information on trends at multi-decadal scales and the impact associated with human disturbance to breeding populations. Data are available from Whitney Point, an Antarctic Specially Protected Area, since 1959/60, and from Shirley Island, adjacent to Casey and subject to human visitation each summer, since 1968. The two populations have exhibited marked differences in breeding success and in population trends, with the penguins inside the protected area increasing in numbers more rapidly and exhibiting higher breeding success than the birds on Shirley Island that are subject to low levels of human disturbance.”

V7-5 Th 1020-1040 Lecture Theatre

P. Dee Boersma

The Magellanic Penguin Project: penguins as ocean sentinels

“We began studying Magellanic penguins (*Spheniscus magellanicus*) at Punta Tombo, Argentina in 1982. Each year



we measure colony attendance, adult body condition, egg and chick dates, chick growth, and reproductive success. We have a large sample of individually-marked, known-aged birds, having marked over 50,000 penguins. Students study additional aspects of penguin ecology and behavior. Their research has led to 5 Argentine and 4 American Ph.D. degrees. Our research on oiled penguins in the 1980s fueled public action to move tanker lanes (1994) and curb illegal bilge dumping. Annual censuses of the breeding population at Punta Tombo showed a 21% decline from 1987 to 2009. Reproductive success is variable among years, from almost one to less than 0.1 chicks fledged per nest. Years of lowest reproductive success have more than 60 mm of rainfall from October to December. Climate change and overfishing affect the abundance and distribution of prey. Penguins swam 60 km farther from the colony to forage in 2003-2006 than in 1997-2000. Reproductive success is lower when penguins have to go farther to forage. Egg laying dates have become later, by about 3 days per decade, since the early 1980s. Tourism at Punta Tombo is growing, with over 100,000 visitors per year, and will impact reproductive success if not properly managed. Magellanic penguins are ocean sentinels. Only long-term data can reveal what they are trying to tell us and how to balance penguins' needs with humans' needs."

V7-6 Th 1100-1120 Lecture Theatre

Phil Capitolo

Brandt's Cormorant breeding population changes in the Gulf of the Farallones, California, USA, in 1979-2006

"Using primarily aerial photography, we examined Brandt's Cormorant *Phalacrocorax penicillatus* breeding population trends in 1979-2006 in the Gulf of the Farallones (GF), central California, where the species largest known colony (South Farallon Islands [SFI]) and greatest breeding concentration occurs. In 1979, colony sizes were relatively large offshore at SFI and nearshore north of San Francisco Bay. By 1985, all GF colonies were greatly reduced, following impacts from the strong 1982-1983 El Niño event. In 1985-1995, while no trend was detected for SFI, nearshore colonies increased by 19% per annum combined, driven mainly by rapid growth in 1994-1995 of newly-formed colonies at Alcatraz and Año Nuevo islands. Nearshore growth likely reflected increased protection, movements of birds from SFI, and changes in prey availability in the GF. After the strong 1998 El Niño event, significant increase occurred at all colonies in 1998-2006 (range 13-29% per annum, 18% overall), associated with high reproductive success especially during strong La Niña conditions in 1999-2000. The 1979-2006 period corresponded mostly with a warm phase of the Pacific Decadal Oscillation (PDO), but also a possible shift to a new cold phase beginning in 1999. In 2006, the GF total breeding population peaked (34,876 birds),

with SFI having returned to its largest known size (~23,500 birds), last recorded in 1974 during the previous cold phase of the PDO. Annual aerial photographic surveys of all major breeding colonies are critical for best documentation of Brandt's Cormorant population trends in California."

Gerard McChesney; Harry Carter; Michael Parker; Lisa Eigner; Richard Golightly

V8-1 Fr 0900-0920 Salon B

John Croxall

Eliminating seabird bycatch: where are we now and where do we need to get to?

"Since CCAMLR took the first steps in the early 1990s to introduce mandatory mitigation measures to reduce seabird bycatch in demersal longline fisheries, a lot has happened to tackle bycatch in longline and trawl fleets around the world. However, many albatross and petrel populations continue to decline due primarily to unsustainable bycatch levels. There remain large gaps in the knowledge required to quantify bycatch levels in many fisheries in EEZs and on the high seas and we still lack a comprehensive suite of effective technical (mitigation) measures to mitigate the problem, particularly in pelagic longline fisheries. While there has been real progress in recent years in the development of 'etop-down' policy to reduce bycatch, for example, the entering into force of the Agreement on the Conservation of Albatross and Petrels (ACAP) and the FAO Best Practice Guidelines Technical Guidelines to Reduce Seabird Incidental Mortality, many States and Regional Fisheries Management Organisations lack the capacity and/or political will to take concrete steps to convert this policy into the practical actions required onboard vessels. The recently released BirdLife/ACAP Mitigation Fact Sheet series highlight the advances we have made and also the many gaps that exist in our ability to define and implement best practice mitigation. Improved practical solutions and unequivocal mitigation advice for fisheries are urgently required, together with better mechanisms for implementation. The lack of these is a serious impediment to halting the decline of many albatross and petrel populations."

V8-2 Fr 0920-0940 Salon B

Rebecca Lewison

The bycatch landscape: making sense of global and local patterns

"Fisheries bycatch of seabirds is a worldwide conservation issue. Despite a growing awareness of seabird bycatch in particular ocean regions, a global picture of the prevalence and intensity of fisheries bycatch has been limited. On the local scale, spatial analyses of bycatch have been hampered by inherent data limitations and the need for novel applications of geospatial and telemetry-based approaches.



Here, I present a global overview of the current state of seabird bycatch, in terms of where bycatch has been documented and the relative intensity of that bycatch. I will also present several spatial applications that inform and improve our ability to understand the distribution and trends of bycatch at both a local and global scale”

V8-3 Fr 0940-1020 Salon B

Bill Montevecchi

The Eastern Canadian gill-net removal experiment: tracking the population responses of seabirds to the ground-fishery closure

“In 1992, the eastern Canadian fishery for northern cod and other ground-fish was closed on the Grand Bank and coastal waters of Newfoundland and Labrador. This moratorium resulted in the immediate and prolonged decadal removal of many 1000s of km of gill-nets known to inflict high levels of seabird mortality. This action in turn provided an unprecedented opportunity to engage an ocean-basin experiment on the after-effects of the removal of fishing gear on the eastern Canadian seabird community. We compared the sources of mortality and population trajectories of the surface-feeders and divers of the breeding seabird community of the Northwest Atlantic before and after the closure of the ground-fishery. Preliminary results indicate that those species most vulnerable to entanglement in fishing gear, the diving species, show population increases consistent with reduction in the mortality of immature and breeding adults. For diving seabirds, release from this potent top-down pressure appears to be over-riding pervasive bottom-up influences expressed through poor condition of forage fishes following a cold water induced regime shift in the early 1990s. This bottom-up food effect is evidenced through declines in the populations of surface-feeding seabirds that are not vulnerable to gill-net mortality. We use these data to model the sources of anthropogenic and climatic mortality that influence the marine bird community of eastern Canada. This research can aid mitigation efforts”

Paul Regular; Alejandro Buren; Chantelle Burke; Dave Fifield; April Hedd; Laura McFarlane Tranquilla; Emily Wilson

V8-4 Fr 1020-1040 Salon B

Rebecca Lent

Interactions between seabirds and fisheries: a global perspective

“Seabirds, particularly albatrosses and petrels, are taken as bycatch in longline fisheries worldwide. Although actual estimates can be lacking or imprecise, estimates of seabirds killed annually in fisheries worldwide run in the hundreds of thousands. For some species, interactions with fisheries are

among the most serious of threats to their long-term conservation. While an individual fishing vessel may catch a seabird only occasionally, the scale of global fishing may threaten a species’ very existence. A decade ago, global longline fisheries were estimated at approximately 1.4 billion hooks annually, the equivalent of 3.8 million hooks each day. Today, this number may be higher as longline fisheries have expanded worldwide, both in terms of vessels and overall effort. Because seabirds’ movements cross geographic boundaries and those of distant water fishing operations, any one country’s efforts to reduce seabird bycatch alone will not solve the problem. Fortunately, the world’s fishing nations have become increasingly aware of this issue and are responding in more and more coordinated ways. In particular, Regional Fisheries Management Organizations (RFMOs) whose longline fisheries overlap with seabird distribution are working together to address the problem. In June, the United States co-hosted a workshop of the five tuna RFMOs to address all bycatch in longline fisheries. Seabird bycatch was a primary issue at the workshop, not only for the successes that have been achieved to date, but for the steps that the RFMOs identified as needed for improving the efficiency and effectiveness of their efforts to reduce seabird bycatch in the future.”

V8-5 Fr 1100-1120 Salon B

Mark Tasker

Working together to tackle bycatch in the work of the Agreement on the Conservation of Albatrosses and Petrels

“The Agreement on the Conservation of Albatrosses and Petrels (ACAP) is an intergovernmental conservation mechanism established in 2004 to address the dire state of the world’s albatrosses and larger petrels. Bycatch in fisheries operations is one of the greatest pressures on their populations. The agreement is working on several levels to tackle bycatch. It has a grants scheme whereby funds are invested in determining bycatch levels in priority fisheries and in developing promising approaches to bycatch mitigation. The Agreement has also reviewed published information on bycatch and its mitigation in demersal and pelagic longline, and in trawl fisheries. This information has been used by Parties to the Agreement in their efforts to reduce bycatch and to develop specific plans of action in their Exclusive Economic Zones. Challenges in both domestic and high seas fisheries include obtaining sufficient information on bycatch rates and gaining support for implementation of bycatch mitigation measures. Much work remains to be done to verify the efficacy of mitigation measures. ACAP has worked collectively to provide technical assistance and to influence decisions in the Regional Fisheries Management Organisations that govern fisheries on the global High Seas. ACAP cannot work alone and has therefore operated in



Partnership with other organisations and governments that are not Party to the Agreement, most notably BirdLife International and the USA. This paper will review some of the approaches being taken to reduce seabird bycatch, and will identify key issues that need to be addressed for the effective implementation of bycatch mitigation measures.”

Barry Baker; Marco Favero; Warren Papworth

V8-6 Fr 1120-1140 Salon B

David Agnew

Fishing the future: an exploration of the possible trends in fishing activity and their implications for seabirds

“The world wild fish catch is currently dominated by large scale industrial vessels, predominantly using trawling, purse seining and pelagic longlines. Whether the face of fishing in 30 years time will look the same as today will depend on a number of causal factors and their trends over time. These will include, but may not be limited to - the oil price and the availability of alternative fuels; consumer demand for fish from clean fisheries; the long-term sustainability of existing fish stocks; climate-induced shifts in the distribution of ecosystems and productive fisheries; and the growth of small-scale fisheries. Almost all fishing methods have the potential to impact birds, to different degrees, and bird populations themselves are also likely to suffer from fishing and non-fishing related anthropogenic change. This paper will explore some of these issues, drawing on the increasing number of predictive analyses of future change in the marine ecosystem, and identify areas where work needs to be done to continue to minimise threats to birds.”

Ben Sullivan

V8-8 Fr 1200-1220 Salon B

Orea Anderson

Global seabird bycatch in longline fisheries: a review

“Longline bycatch is the main cause of adverse conservation status in many seabird species, and yet no comprehensive global assessment currently exists. We review the extent of seabird bycatch in all longline fisheries for which there are sufficient data. Despite the inadequacies and assumptions therein, we estimate that at least 160,000 (and potentially in excess of 320,000) seabirds are killed annually. Most at risk are the Procellariiformes, with current levels of bycatch mortality unsustainable in some species and populations. We identify potential reductions in seabird bycatch in several key fisheries over the last decade. These reflect both reductions in fishing effort (especially in estimated illegal, unregulated and unreported fishing in the Southern Ocean), but also more

effective use of mitigation measures onboard; notably in demersal fisheries (e.g. CCAMLR). Despite this progress, bycatch problems in other fisheries have emerged. Current concerns include fisheries with previously unidentified bycatch problems (e.g. the Spanish demersal fishery off Gran Sol) and fisheries where the persistent lack of data prevent a true assessment of the scale of the impact (e.g. Nordic demersal fisheries). Future reviews regarding the nature and magnitude of seabird bycatch can only achieve greater precision when minimum data collection, reporting and analysis protocols are implemented across all fleets and relevant regional fishery management organizations. Meanwhile, the problem of seabird bycatch could be reduced to negligible proportions in all demersal and most pelagic longline fisheries by enforceable regulations that incorporate suitable, cost-effective best-practice mitigation devices and techniques.”

Cleo Small; Andy Black; John Croxall; Ben Sullivan; Oliver Yates

V8-9 Fr 1220-1240 Salon B

Ramunas Zydulis

Seabird bycatch in gillnet fisheries worldwide

“Gillnet fisheries is one of the most widespread forms of fishing, commonly taking place in nearshore waters. Seabirds come into contact with gillnet fisheries in many parts of the world, and likely hundreds of thousands of birds die in fishing nets annually. Seabirds differ in their susceptibility to entanglement in gillnets, the most frequent victims being species that dive and especially pursue their prey underwater. Distribution of species and their ecological characteristics determine that seabird bycatch in gillnets is mostly confined to temperate and high latitudes, especially so in the Northern Hemisphere. While identifying potential bycatch issue is relatively easy, studying and managing seabird mortality in gillnet fisheries is challenging. Gillnetting is often a form of artisanal fisheries involving large number of fishermen, and these fisheries are typically poorly monitored and managed. Even when seabird bycatch is recognized, mitigation solutions are never simple. Whereas certain gear modifications may offer solutions to decrease seabird entanglement, the most effective management method remains spatial and temporal regulation of fishing effort and promoting alternative fishing techniques.”

V8-10 Fr 1400-1420 Salon B

Ed Melvin

Shrink and defend: streamer lines for pelagic longline fisheries

“Although pelagic longline tuna fisheries managed by international agreements constitute one of the greatest



conservation threats to seabirds of the southern oceans, best mitigation practices for these fisheries, including the best streamer lines design, are the subject of considerable debate. We compared the performance of a “light” streamer line with short streamers to a “hybrid” streamer line that mixes long streamers with short streamers using seabird attack rates in the Japanese joint venture tuna fishery in the South Africa EEZ. We also determine the sink rates of weighted (60 g placed 70 cm from the hook) and unweighted branchlines (status quo) to inform the distance astern that birds have access to baited hooks. Most primary attacks were made by white-chinned petrels and most of those occurred beyond 100 m astern, the target aerial extent of tori lines. A third of primary attacks led to secondary attacks by albatrosses. Virtually all albatross attacks occurred within 100 m. Fewer birds attacked baits inside 100 m when hybrid lines were used, but mean rates were not statistically significant for either foraging guild. Unweighted branchlines sank beyond the reach of diving seabirds (10 m) more than 3 times (307 m) the target aerial extent while weighted branchlines sank to 10 m at just under 100 m. These data strongly suggest that in order to defend baits from bird depredation in pelagic longline fisheries using streamer lines, the distance at which baits sink to 10 m must be reduced to within an achievable streamer line aerial extent.”

Troy Guy

V8-11 Fr 1420-1440 Salon B

Richard Phillips

Longline fisheries and the decline of the wandering albatross at South Georgia

“Although declines in many albatrosses and large petrel have been attributed to incidental mortality, it is often difficult to ascribe this to particular fisheries. Wandering albatrosses at South Georgia showed a decline of 1.8% p.a. from all-island surveys in 1984 and 2004; at the main site, Bird Island, annual monitoring indicated a halving of the population since the 1960s (1% p.a. to the late 1990s; 4% p.a. thereafter). In comparison, the other two main populations (in the Indian Ocean) have shown some recent recovery after earlier declines. Here we present detailed data on population trends, demography, distribution, fisheries overlap, and ringing recoveries, to try to diagnose the underlying causes of the South Georgia situation. Land-based threats to wandering albatrosses at South Georgia are negligible, and breeding success has been high and increasing since the late 1970s. Survival of adults decreased by 1-2%, and of juveniles has approximately halved since the mid-late 1990s. Tracking data indicate that adults from South Georgia have probably the widest nonbreeding distribution of any albatross, hence greatly overlap with conspecifics from island groups in the Indian and Pacific Oceans. Analysis of fisheries overlap, corroborated by evidence from ringing recoveries and

observed bycatch rates, suggests that the most likely cause of the decline is the interaction of breeding and nonbreeding adults, and of juveniles, with fishing vessels in the SW Atlantic.”

Geoff Tuck; Andrew Wood; John Croxall

V8-12 Fr 1440-1500 Salon B

Sophie Bertrand

Fishers and seabirds competing for the same prey off Peru

“In Peru, the main fish resource, anchovy, is ‘shared’ by marine mammals, seabirds and an industrial fishery (~1500 purse seiners extracting 5 to 10 million tons.y-1). The global competition for the resource between top predators has long been suspected as seabird populations declined markedly since the fishery began in the 1950’. Still, the effects of fishery removals on seabirds’ populations may differ greatly according to their spatial pattern, becoming critical if concentrated within the foraging range of the breeding colonies. To assess if no-take areas around the breeding colony could be beneficial to Peruvian seabirds populations, we need to understand how fishers and seabirds exactly interact while foraging on the same anchovy concentrations. For that purpose, we examine concomitant data sets: (1) GPS tracking data collected on Peruvian boobies and guanay cormorant (2007, 2008 and 2009 breeding seasons; >250 bird trips), (2) Vessel Monitoring System data which provide a high resolution and exhaustive observation of the fleet displacements, (3) anchovy landings for the areas of interest and (4) anchovy distribution from a dedicated acoustic survey. We show that according to the pattern of anchovy distribution and the level of competition with the fishery, seabirds may adjust distinct foraging parameters (e.g. distance to colony versus time at sea). Moreover, while fishers and seabirds may share the same ‘anchovy spots’ at the beginning of the fishing season, they tend to dissociate then. We discuss on the processes of local enhancement, local depletion and exploitative competition that may drive those observed patterns.”

Yann Tremblay; Giannina Passuni; Jaime Silva; Henri Weimerskirch

V8-13 Fr 1500-1520 Salon B

Valentina Lauria

Modelling the effects of climate and fishing on seabirds: an application of Ecopath with Ecosim models

“Marine ecosystems are exposed to a wide range of anthropogenic impacts, most notably climate change and fishing. The North-east Atlantic ecosystem has undergone a



period of extensive change over the last 20 years, primarily in response to changes in oceanography driven by climatic fluctuations leading to dramatic changes in plankton communities. These changes have implications for upper trophic levels including mid trophic fish and marine apex predators such as seabirds. How climate change and fishing impacts affect higher trophic levels depends up on the structure and function of ecosystem regulation. Specifically, understanding the relative importance of top-down and bottom-up effects will be critical for predicting impacts on top predators. To investigate climate and fishing effects on trophic interactions in the Celtic Sea we used a trophic dynamic model: Ecopath with Ecosim (EwE). We aim to understand how long-term fluctuations in fish populations driven by environment and fishery related change, affect seabird populations. In the model Ecopath provides an instantaneous static mass balanced description of the resources in an ecosystem and their interactions in terms of energy flow, while Ecosim is a time dynamic simulation module for exploring past and future impacts of fishing and environmental disturbance. Long-term datasets were used to explore the past while changes in fishery effort and climate variation scenarios were simulated in order to predict future impacts on seabird populations. EwE represents a powerful tool for a fully integrative analysis of ecosystem exploitation and can be used for policy exploration of ecosystem-based fisheries management.”

**John Pinnegar; Steve Mackinson; Martin Edwards;
Martin Attrill; Andy Brown; Stephen Votier**

V8-14 Fr 1540-1600 Salon B

Nicole Sonntag

Bird bycatch in gillnets in the Baltic Sea: assessment of the vulnerability and conflict potential towards drowning mortality as tools for conservation management

“The accidental catch and drowning of birds in gillnets is documented from marine areas worldwide and is considered to have a major impact on bird populations. The quantification of bycatch mortality and the assessment of its effect on population level, however, are rather difficult. For the southern Baltic Sea in northeastern Europe, a vulnerability index based on relative bird abundances was developed, indicating maximum susceptibility of birds towards drowning mortality. Secondly, a spatial overlap approach was developed to indicate the potential conflict for diving birds in relation to gillnet fisheries, based on comprehensive data of diving bird abundances and fishing activities. Vulnerability and potential conflict exhibited spatial and temporal variation within the study area and were highest during winter and spring in coastal areas and on shallow offshore grounds. The approach provides a valuable tool for conservation management purposes: the analysis of potential conflict indicates priority

areas and priority periods, for which the development of conservation measures is of paramount importance, while the vulnerability index indicates important areas in terms of diving bird abundance irrespective of fisheries. Accordingly, a suite of measures, like temporal and spatial restrictions, can be derived. Given the lack of other adequate data on bycatch and mortality rates, the approach enables the development of solid options for conservation management and can provide a baseline for the development of an environmentally sound fishing practice in marine areas worldwide.”

**Henriette Dries; Heino Fock; Jochen Bellebaum;
Stefan Garthe**

V8-15 Fr 1600-1620 Salon B

Kees (C.J.) Camphuysen

On the brink of collapse: prospects for a seabird population relying on fisheries in the light of a new European policy for sustainable fisheries

“Gull populations in The Netherlands increased during the 20th century and anthropogenic factors have played a significant role in these trends. First persecution came to a halt, followed by bird conservation measures so that new colonies could be established and increase in size. Later, new food supplies became available, including numerous open rubbish tips and an enormous amount of discards in commercial fisheries. These factors, more safety and food, stimulated an exponential increase of notably Herring Gulls *Larus argentatus* and Lesser Black-backed Gulls *Larus fuscus*. Studies of the breeding ecology and foraging strategies have been conducted during this period of expansion and growth. Meanwhile, rubbish tips have been covered up, eliminating access by foraging gulls, and the Herring Gull population crashed soon thereafter. Currently tendencies to modernize beamtrawl fisheries will now reduce the excessive production of discards in the region. High fuel prices, reduced catches, fleet reductions, and modernizations onboard commercial trawlers have all contributed to a persistent decline in food availability for Lesser Black-backed Gulls, while LBBG colonies are currently larger than ever before. The presentation will emphasize the importance of commercial fisheries for large gulls, on dominance hierarchies in flocks of trawler-following gulls, on the effect that food reductions (may) have on the demography (survival, recruitment, cannibalism) and the foraging ecology (diet, foraging trips) of the birds, and forecast what might happen with a “surplus” of birds in the Southern North Sea in the near future when reductions in fisheries related food sources will become even more severe.”

Arnold Gronert



V8-16 Fr 1620-1640 Salon B

Robert Crawford

The importance of both abundance and distribution of prey in accounting for food requirements of predators in an ecosystem approach to fisheries - examples from southern Africa

“An ecosystem approach to fisheries was encouraged by the World Summit on Sustainable Development (2002). In terms of the Reykjavik Declaration (2001), it includes incorporation of predator-prey relationships. FAO’s Code of Conduct for Responsible Fisheries (1995) stresses the need to account for dependent species in the management of exploited fish stocks. In the Benguela ecosystem off southern Africa, severe decreases of seabirds followed both large decreases in biomass and altered distributions of forage fish species. In Namibia, a collapse of sardine *Sardinops sagax* led to subsequent decreases of 95% of Cape gannets *Morus capensis*, 90% of African penguins *Spheniscus demersus* and 76% of Cape cormorants *Phalacrocorax capensis*. Off South Africa, shifts in the locations of anchovy *Engraulis encrasicolus* and sardine caused a mismatch in the distributions of the breeding localities and prey of seabirds and a loss over five years of 50% of the world’s African penguin population. In the latter instance, forage fish biomass remained at a high level and large catches continued to be allocated. However, most fish was displaced beyond the range of fishing boats. This led fishers to make large catches in the vicinity of seabird colonies, where penguins were heavily outcompeted for food. These examples indicate that in accounting for the food requirements of central-place foragers, is it important not only to ensure adequate escapement of prey but also to avoid local depletions of prey.”

V9-1 Fr 0900-0920 Salon C

Stéphanie Jenouvrier

Contrasting seabird population responses to climate change: winners and losers?

“Long term times series of population and vital rates of three Antarctic seabirds breeding in Terre Adélie, reveal an abrupt change in the ecosystem in the late 70s-early 80s, also called regime shift. During this regime shift, the emperor penguin population decreased by 50% and has remained stable since then, while the petrel populations did not show such abrupt decline. These changes in population dynamics and vital rates were related to change in sea ice conditions (i.e. sea ice concentration and extent, SIC/SIE). In Antarctica, seabird species are sensitive to change in SIC/SIE because sea ice affects their food resource and/or their habitat. Population responses to sea ice variations are different among species according to their life history. For example, penguins are

more sensitive to decrease in SIC/SIE than petrels. Emperor penguins breed almost annually and penguin adult survival decreases during years with low SIC/SIE. In contrast, petrels skip reproduction during years with low SIE/SIC rather than compromising their survival and future opportunities to reproduce. Coupling demographic models and climate projections permits to project the response of Antarctic seabirds to future sea ice changes. Using such approach for the emperor penguin, we show that the median population size is projected to decline from approximately 6000 to 400 breeding pairs by 2100, if sea ice declines at the rates projected by IPCC models. This population response contrasts with the results obtained for the petrel populations. Is there more hope in the flight of petrels than in the march of penguins?”

V9-2 Fr 0920-0940 Salon C

William Kendall

Designing robust demographic studies of seabird populations

“Demographic studies of seabirds involve marking individuals and tracking them as reliably as possible across time and space. This effort is often intense and expensive, and therefore great attention should be given to design (collecting sufficient data of the proper type), to maximize the information extracted from the study. Biases or reduced precision are induced by factors such as imperfect detection, heterogeneity in vital rates or detection probabilities among individuals, transitions to unobservable locations or life stages, uncertainty about life stage, marker loss, marking an unrepresentative subset of the population, or causing stress in captured individuals. Impacts of these factors are minimized through attention to design, and statistical modeling. Knowledge of species behavior and habitat use aids in choosing a representative sample to mark. Double-marking individuals permits adjustment for marker loss. Collection of covariates that predict heterogeneity minimizes its impact. Multiple capture periods per season or telemetry / archival tags facilitate estimation of transitions to unobservable states, and temporary marks permit multiple detections of an individual within a season with only one physical capture. Where breeding birds are studied in plots, a buffer area within which marked birds are sought avoids mistaking breeders nesting outside the plot for skipped breeders. Statistical methods and software exist to implement these approaches.”

Sarah Converse; Paul Doherty, Jr.; Maura Naughton; Morten Frederiksen; James Hines



V9-3 Fr 0940-1000 Salon C

Norman Ratcliffe

The demography of un-banded macaroni penquins revealed using an automated gateway system

“We studied survival and recruitment of Macaroni Penguins at a small and declining colony on Bird Island, South Georgia. Birds were marked with PIT tags from 2002 onwards and were “recaptured” using an automated gateway system. Survival and recruitment were estimated using a multi-state capture mark recapture model, in which birds between fledging and first-return to the colony were in an unobservable state. Recapture rates were high (0.999) in years that the gateway worked, even if only for 2 weeks, but were low (0.161) in the year when it failed completely and hand readers were used. Survival averaged 0.887 and showed significant time-dependence, exceeding 0.90 in 2002 and 2006. First year survival averaged 0.181, and also varied with time, exceeding 0.50 in the first year, c. 0.20 in the following 3 years and zero in the final two. Cumulative return probability was 0.197 at one year old, 0.81 at 2 years, 0.91 at three and all birds had returned by four years. Breeding success averaged 0.52. A population model based on these parameters over-estimated the rate of decline at the study colony, probably owing to immigration from a large nearby colony. Unlike the study colony, the large colony has increased since 2000: we suggest that our estimate of first year survival is biased low owing to permanent emigration to that site.”

Phil Trathan

V9-4 Fr 1000-1020 Salon C

Peter Dillingham

Potential biological removal of albatrosses and petrels with minimal demographic information

“Seabirds such as albatrosses and petrels are frequently caught in longline and trawl fisheries, but limited demographic data for many species creates management challenges. A method for estimating the potential biological removal (the PBR method) for birds requires knowledge of adult survival, age at first breeding, a conservation goal, and the lower limit of a 60% confidence interval for the population size. For seabirds, usually only the number of breeding pairs is known. This requires estimating the population size from the number of breeding pairs when important demographic variables, such as breeding success, juvenile survival, and the proportion of the adult population that engages in breeding, are unknown. In order to do this, a simple population model was built where some demographic parameters were known while others were constrained by considering plausible asymptotic estimates of the growth rate.

While the median posterior population estimates are sensitive to the assumed population growth rate, the 20th percentile estimates are not. This allows the calculation of a modified PBR that is based on the number of breeding pairs instead of the population size. For threatened albatross species, this suggests that human-caused mortalities should not exceed 1.5% of the number of breeding pairs, while for threatened petrel species, mortalities should be kept below 1% of the number of breeding pairs.”

David Fletcher

V9-5 Fr 1020-1040 Salon C

Sarah Converse

Bayesian multi-state modeling of Yellow-Nosed Albatross demography

“Multi-state models have proven useful for modeling the demographics of seabird populations. Survival can be estimated in an unbiased fashion using multi-state models with unobservable states, despite the skipped breeding exhibited by many seabird species. In addition, transitions amongst breeding states (e.g., pre-breeders, breeders, and skipped breeders) may themselves be of biological interest. We demonstrate the tremendous flexibility of the Bayesian analysis software WinBUGS for building and analyzing multi-state models. We apply such a model to the yellow-nosed albatross population of Gough Island, and present estimates of survival, breeding probability, and recruitment.”

John Cooper; Richard Cuthbert; Peter Ryan

V9-6 Fr 1100-1120 Salon C

Jaime Ramos

Unraveling seabird demographic traits in tropical seabirds

“Our current knowledge of seabird life history traits is mostly based on north-temperate or polar systems. This study examines productivity of Roseate Terns (*Sterna dougallii*), Lesser Noddies (*Anous tenuirostris*), Brown Noddies (*Anous stolidus*) and White-tailed Tropicbirds (*Phaethon lepturus*) during 22, 19, 10 and 8 years, respectively, on Aride Island (Seychelles, Equatorial Western Indian Ocean), in relation to oceanographic variation. We examined adult survival for Roseate Terns and White-tailed Tropicbirds and survival during the early years of life for Roseate Terns. Productivity for all seabird species rarely exceeded 0.7 chicks/pair, apparently due to lower marine productivity coupled with strong seasonal and annual variation, and was lower than that of temperate species of the same families. Adult survival of both Roseate Terns and White-tailed Tropicbirds was similar or even lower than that of temperate counterparts. A multistate model estimated Roseate Tern survival over the



first 2 years at 62%, which is 18-40% higher than that of temperate populations of Roseate Terns. This suggests that a high survival rate of young birds may be crucial to understand demographic traits of tropical seabird species. Roseate Terns and White-tailed Tropicbirds returned to their natal colonies with 1-3 years old, in an advanced maturation stage, which may enable them to acquire full breeding capacity earlier than their temperate seabird species.”

David Monticelli; Teresa Catry

V9-7 Fr 1120-1140 Salon C

Katie Dugger

Episodic variation in survival and philopatry of breeding Adélie Penguins

“For many long-lived birds with low reproductive success and high survival, breeding philopatry is believed to be high. In the well-studied Adélie penguin (*Pygoscelis adeliae*), movements of breeding adults among colonies within a metapopulation in association with unusual environmental conditions, provides interesting insights into this species population dynamics. We used multi-state mark-recapture models to investigate survival and dispersal of breeding birds within 4 colonies in the Ross Sea, Antarctica, during 12 breeding seasons (1996 ñ 2007). Colony size varied by orders of magnitude (from 140,000 - 4000 pairs), allowing investigation of survival and dispersal rates in relation to both environmental conditions and colony size. Survival was lowest for the smallest colony and similar for the medium and large colonies, despite increased foraging effort required to breed at the largest colony. Movement rates of breeding birds were generally low (<1%), except during years of difficult environmental conditions; then, movements increased, especially away from the smallest colony (3.5%). Decreased survival at the smallest colony could reflect differences in migration chronology and winter habitat use compared to the other colonies, or may reflect increased permanent emigration to colonies outside our metapopulation. Contrary to previous thought, breeding penguins are not always philopatric and infrequent, stressful conditions can increase dispersal rates.”

David Ainley; Phil Lyver; Kerry Barton; Grant Ballard

V9-8 Fr 1140-1200 Salon C

Tony Gaston

Population trends and demographic drivers in a declining population of Ancient Murrelets

“The development of CMR analysis techniques has provided us with powerful tools to track changes in the adult survival of marine birds and investigate possible causes. Although much attention has been paid to the drivers of adult survival, especially climatic variables, less emphasis has been placed

on linking survival rates to population changes. In a 14-year study of Ancient Murrelets at East Limestone Island, Haida Gwaii, we found that the annual survival of breeding adults remained fairly constant, whereas survival of pre-breeding birds declined during a period when reproductive success also declined. These changes were tracked through a variety of biological indicators. They were associated with a 50% decrease in breeding population size. A nearby colony increased during the same period, pointing to local causes of reduced recruitment. It seems likely that colony decline was caused by disturbance and predation by introduced raccoons on East Limestone Island, leading to avoidance by potential recruits after initial prospecting, rather than by adult survival per se. We discuss ways in which recruits may have reacted to the presence of predators and some effects on indicators of colony health.”

Sebastien Descamps

V9-9 Fr 1200-1220 Salon C

Jeff Spendelov

Estimating adult breeding dispersal/fidelity at different geographic scales to evaluate restoration efforts for Roseate Terns

“Prior estimates of adult dispersal/fidelity rates of the endangered Northwest Atlantic Ocean metapopulation of Roseate Terns (*Sterna dougallii*) were derived from mark-recapture/resighting data from four sites 45-250 (mostly >100) km apart that supported the largest breeding colonies in the 1980s-1990s. Restoration efforts since then have established two more sites within Buzzards Bay, Massachusetts (BBMA), but local populations also have declined at two of the initial study sites. We update previous work to show how analyses of adult movement rates designed to test several hypotheses at different geographic scales can aid in evaluating the success of restoration efforts. Nocturnal predation of eggs/chicks from 1996-2005 at a colony site in Connecticut was associated with a decrease in local apparent survival due mainly to increased breeding dispersal to a larger colony in New York. Hazing adults (to prevent them from becoming oiled during spill clean-up procedures) at one BBMA site in 2003 resulted in the colonization of a third BBMA site. While intercolony movement rates treating the BBMA sites as a single unit are similar to rates estimated previously, higher within-BBMA movement rates suggest that successful restoration at the third site is still an ongoing process.”

James Hines; James Nichols; Ian Nisbet; Carolyn Mostello; Grace Cormons; Helen Hays; Jeremy Hatch



V9-10 Fr 1220-1240 Salon C

Jose Lahoz-Monfort

Climatic influences upon multispecies synchrony in adult seabird survival at the Isle of May, Scotland

“We present a method for studying the role of environmental covariates in generating synchrony and asynchrony in demographic parameters, illustrated here by three sympatric seabird species. The method can provide insight into how species that share one area respond similarly or differently to changes in their environment, and help to disentangle the sources of these differences. We studied three colonially-nesting auk species that share resources during the breeding season at the Isle of May (56°11'N, 2°34'W) in Scotland. Mark-resight information was collected since 1984 for Atlantic puffins *Fratercula arctica*, common guillemots *Uria aalge* and razorbills *Alca torda* marked as breeding adults. We explore the relationship between synchrony in survival and a range of environmental covariates, modelling the data for the three species together and using random effect terms to separate the contributions of these climatic factors into synchronous and asynchronous components of the between-year variance in adult survival. We show that the same covariates can act simultaneously as synchronising and asynchronising agents, possibly through different indirect causation paths, some of them influencing the three species in the same way, others impacting them differently. The estimated indices of synchrony will help to generate further hypotheses about similarities/dissimilarities in these species' ecology, such as the potential overlap of wintering areas. The method is readily applicable to other species, ecosystems and demographic parameters.”

Byron Morgan; Michael Harris; Sarah Wanless; Stephen Freeman

V9-11 Fr 1400-1420 Salon C

Tone Reiertsen

Temporal variation in common guillemot populations; linking demography to environmental factors

“The Common Guillemot (*Uria aalge*) is a long-lived species with delayed maturation and a low reproductive output. The Norwegian population (ca. 15 000 pairs in 2006) has declined by >95% since the 1960s and is classified as critically endangered in the Norwegian Red List. Its extremely “slow” life history makes their population especially vulnerable to environmental changes. Their main prey is often short-lived pelagic fish species with high but variable recruitment rates and it is to be expected that they may regularly face food shortages. In this study we have analysed population trends and demographic traits in Common Guillemots at Hornøya in

the SE Barents Sea, in relation to sea surface temperature and their main food prey species (Herring, *Clupea harengus*, Capelin, *Mallotus villosus* and 0-group Arctic Cod *Gadus morhua*). Since the early 1980s the population on Hornøya has fluctuated greatly, and in 1986/1987 the population declined by 80%, but in contrast to other Norwegian populations it has increased steadily since, reaching pre-collapse levels in 2009. This gives a unique opportunity to determine the sensitivity of the population to environmental factors and which demographic traits contribute most to the population trends. We have developed a stochastic demographic model of the population and do retrospective analyses to show that the variance in recruitment of young birds and immigration rather than adult survival have contributed most to the population growth rate since 1987. Furthermore, we have used demographic models and different environmental scenarios to predict the population trends into the future.”

Rob Barrett; Kjell Erikstad

V9-12 Fr 1420-1440 Salon C

Michael Harris

Explaining a crash in the numbers of Atlantic puffins *Fratercula arctica*

“Some populations of Atlantic puffins *Fratercula arctica* in the northeast Atlantic are experiencing difficulties. Numbers at the Isle of May, the largest colony in the North Sea, increased from 3,000 pairs in 1975 to 69,000 pairs in 2003 but in 2008 there were 42,000 pairs. An analysis of retraps of chicks and adults ringed in the 1970s estimated survival from ringing to age 5 as 0.752 and annual survival from the 5th year as 0.953. Using observed mean values of demographic parameters, a deterministic matrix projection model predicted population growth of 11.7%/year, close to the observed 10.9%/year. A study of colour-ringed adults showed that annual survival was > 0.90, except in 1989/91 when it was c.0.80, and in 2006/08 when it was c.0.70. A simulation model with empirical annual fecundity and adult survival and the earlier constant survival for pre-breeding age classes predicted population growth from 1973 to 2003 but not the low 2008 count. A good fit was achieved by setting survival of all pre-breeding age classes 2003-2008 at 0.7. Field observations supported poor immature survival in recent years. It thus appears that the crash in breeding numbers was caused by a combination of two years of poor adult survival and a period of reduced survival of pre-breeders.”

Morten Frederiksen

**V10-1 Fr 0900-0920 Lecture Theatre****Tammy Steeves****Assessing the taxonomic validity of an enigmatic subgenus, the 'cookilaria' petrels**

“Small *Pterodroma* petrels comprising the subgenus *Cookilaria* (currently, 6 species) are widely distributed within the subtropical and tropical Pacific Ocean yet are some of the least studied seabirds. For example, our understanding of their evolutionary relationships is poor and debated: species of *Cookilaria* share morphological and plumage characteristics with several species of subgenus *Proaestrelata* (5 species, all breeding in the Pacific) and it is presently unclear if either taxa is monophyletic. To test the monophyly of *Cookilaria* and *Proaestrelata* we are applying phylogenetic methods to mitochondrial and nuclear sequence data from a global sample of taxa from within the proposed subgenera. Sample species include all six *Cookilaria* (*P. brevipes*, *P. cookii*, *P. defilippiana*, *P. leucoptera*, *P. longirostris*, *P. pycrofti*) and all five *Proaestrelata* (*P. axillaris*, *P. cervicalis*, *P. hypoleuca*, *P. inexpectata*, *P. nigripennis*) species. Preliminary phylogenetic analyses based on a subset of these species screened for sequence variation in four nuclear introns (β -fibint7, IRF2, PAXIP1, CSDE1) suggest that *Cookilaria* and *Proaestrelata*, as proposed by Imber (1985), may indeed be monophyletic. In addition to resolving taxonomic affinities, these phylogenetic trees are enabling phylogeographic studies investigating the roles of extrinsic and intrinsic factors in the diversification of the 'cookilaria' petrels, both above and below the species level.”

**Pieter Pelser; Matthew McKown; Benoit Gangloff;
Vincent Bretagnolle; Matthew Rayner**

V10-2 Fr 0920-0940 Lecture Theatre**Anthony Bicknell****Assessing population structure and dispersal in Leach's storm-petrels *Oceanodroma leucorhoa* in the North Atlantic using molecular techniques: implications for the EU population**

“Procellariiformes are long-lived and nest in a few densely aggregated places making them particularly vulnerable to the deleterious effects of global change, yet despite being one of the most threatened avian taxa in the world, we still know little about their dispersal behaviour. A large colony of 45,000 pairs of Leach's storm-petrel (*Oceanodroma leucorhoa*) breeds on St Kilda, Scotland, representing 94% of the EU population, yet this population is under threat from large numbers of Great Skuas (*Stercorarius skua*) breeding on the same island. However, very large colonies of Leach's storm-petrel (>6 million birds) exist in Newfoundland and if birds are able to move between these locations, immigration to St Kilda may offset the effects of skua predation. Therefore

dispersal may be critical for the long-term persistence of colonies of this species. Here we use a combination of genetic markers and stable isotopes to determine the extent of movement between Leach's storm-petrel colonies in the North Atlantic. These data have important implications for understanding dispersal and meta-population dynamics of this species, as well as for implementing appropriate conservation strategies for a threatened internationally important colony.”

Mairi Knight; Dave Bilton; Jim Reid; Stephen Votier

V10-3 Fr 0940-1000 Lecture Theatre**Petra Deane****What traits predispose band-rumped storm petrels to the repeated, independent evolution of geographically sympatric seasonal foraging types?”**

“Evidence for the repeated evolution of hot-season and cool-season “foraging types” across colonies of band-rumped storm petrel (*Oceanodroma castro*) has garnered much interest from seabird ecologists and evolutionary biologists, alike. Within certain archipelagos, seasonal populations are temporally segregated by breeding time and have distinct morphological adaptations associated with different foraging strategies. Hot- and cool-season populations have also been shown to be each other's closest relative, implying that this ecological divergence into distinct seasonal types has taken place several times independently, and each time in the absence of strong geographical barriers to gene flow. Here, we present data on the genetic characteristics of a unique year-round breeding population in the Cape Verde archipelago, and a morphological comparison of birds breeding in June with those breeding in November. In this system genetic differentiation between the seasons is low, and morphological variation both within and between seasons is high. Interpreting these patterns in the phylogenetic context of band-rumped populations range-wide, we suggest that both genetic isolation by breeding time and selection on standing variation within ancestral populations are candidate mechanisms to explain the repeated, independent evolution of conserved seasonal foraging types in this species.”

**Mark Bolton; Jacob Gonzalez-Solis; Elena Gomez-Diaz;
Victoria Friesen**

V10-4 Fr 1000-1020 Lecture Theatre**Bruce Robertson****Oceanites, Fregetta or Pealeornis? Phylogenetic affinities of the rediscovered New Zealand storm-petrel**

“The observation of birds similar to the extinct New Zealand storm-petrel *Oceanites maorianus* in New Zealand's Hauraki Gulf in 2003 raised the possibility that the species had been



rediscovered after 150 years. *O. maorianus* has and continues to be surrounded by taxonomic uncertainty, being variously classified as a distinct genus, a distinct species or merely a plumage variant of Wilson's storm-petrel (*O. oceanicus*). In the 2005/2006 austral summer four *O. maorianus*-like birds were captured allowing phylogenetic comparison with the three museum specimens of *O. maorianus* collected over 150 years ago. Using 132 bp of cytochrome b sequence amplified from the 150+ year old museum specimens, we found that the extant and museum *O. maorianus* were the same taxon (0.78% sequence divergence) with both differing from all other storm-petrel taxa (Oceanitinae 6-15%; Hydrobatinae 19-35%). Using 574 bp, we examined the phylogenetic affinities of *O. maorianus* to the Oceanitinae and Hydrobatinae storm-petrels. Bayesian and maximum likelihood analyses consistently placed *O. maorianus* and *Fregetta* spp. together within the Oceanitinae family. The genetic distance between *O. maorianus* and *Fregetta* spp. (10-12%) further supports close alignment of these genera and confirms the distinction to species level of Oceanites (13-14%) and *O. maorianus*, thereby confirming that it is a distinct species and not a plumage variant of *O. oceanicus*. Hybridisation with closely related genera was ruled out by examining the nuclear beta-fibrinogen gene. Our analysis indicates that the extinct New Zealand storm-petrel has been rediscovered and now can be assigned a conservation priority commensurate with its Critically Endangered status."

Brent Stephenson; Neil Gemmell; Sharyn Goldstien

V10-5 Fr 1020-1040 Lecture Theatre

Theresa Burg

Evolutionary Biogeography of Southern Ocean Seabirds

"Seabirds are highly vagile and capable of travelling large distances especially during the non-breeding season. Despite the potential for dispersal, studies on seabirds in the Southern Ocean around Antarctica found moderate to high levels of population structure. Many species of albatrosses, petrels and penguins breeding on sub-Antarctic and southern sub-tropical islands show similar patterns and timing of population divergence. Gene flow among islands appears to be restricted by a variety of factors including at-sea distribution and polar fronts rather than geographic distance alone. Using standard population genetic approaches to estimate divergence times, divergence dates between populations/subspecies correspond to interglacial periods during the mid-Pleistocene."

Graham Pasternak

V10-6 Fr 1100-1120 Lecture Theatre

Norine Yeung

Systematics and phylogeography of the White Tern (*Gygis alba*)

"A thorough understanding of systematic relationships, taxonomy and population connectivity is crucial for accurate biodiversity assessments, conservation, and evolutionary biology. The Pacific White Tern (*Gygis alba*) is a pantropical seabird and based mainly on geographic range and morphological variation, there are three nominal species recognized. To assess the systematic relationships, test current taxonomic hypotheses, and study population genetics within this genus, I used two mitochondrial and six nuclear markers to assess differences among nominal Pacific White Tern subspecies and populations. Furthermore, the origin(s) of a recently established population on Oahu was examined using molecular data. These data do not support the designation of phylogenetically distinct species or subspecies within the Pacific Ocean. Microsatellite analyses reveal moderate levels of gene flow among geographically distinct populations, indicating that these groups consist of two genetically admixed populations. The two genetic populations within the Pacific Ocean overlap considerably in the Northwestern Hawaiian Islands, Marshall Islands and Marquesas Islands. Main sources of migrants to other Pacific populations are from the Northwestern Hawaiian Islands and Tuamotu Archipelago. The significant, yet small amount of morphological and mitochondrial variation found among the two South Pacific groups, *G. a. microrhyncha* and *G. a. pacifica*, indicates some level of restricted gene flow, but does not warrant recognition of distinct species or subspecies. Lastly, the main source of founding migrants to the recently established Oahu colony is from the Northwestern Hawaiian Islands, with a few individuals coming from other populations."

V10-7 Fr 1120-1140 Lecture Theatre

Mareile Techow

Sex and the City: why females of a socially monogamous seabird aren't always faithful

"A key question in studying mating systems is to understand why socially monogamous females choose to mate with extra-pair males. A possible explanation which is gaining increasing support is 'genetic compatibility'. Albatrosses are classic examples of K-selected species in which a reproductive skew is unexpected yet a small portion of breeding pairs is responsible for fledging the majority of chicks. A factor explaining inter-individual differences may be inherent difference in parental quality. We test whether female Wandering Albatrosses *Diomedea exulans* with poor reproductive histories seek extra-pair copulations with more successful males and whether diversity in the major



histocompatibility complex (MHC) correlates with past reproductive success and therefore influences mate choice. Wandering Albatrosses breeding on Marion Island have been ringed since the 1980s and reproductive histories of many adults are known. Blood was collected from ca 130 breeding pairs and their chicks for three consecutive seasons. Levels of extra-pair paternity and overall genetic variability were investigated using 11 microsatellite loci and a ca 600 bp fragment of a MHC Class II B gene. Preliminary analysis indicates that ca 20% of chicks was sired by an extra-pair male. As is typical for many seabirds, overall genetic diversity is low. Given the relatively high level of extra-pair mating in this monogamous species, females may be indirectly benefiting by improving their reproductive success.”

Genevieve Jones; Peter Ryan

V10-8 Fr 1140-1200 Lecture Theatre

Scott Taylor

Is seabird speciation driven by ocean currents and sexual selection in the Eastern Tropical Pacific?

“Compared to many avian groups, seabirds encounter few obvious physical barriers to gene flow throughout their range. Seabirds are, however, a diverse group and present an interesting context in which to examine patterns of population differentiation and models of speciation: their distributions and dispersal potential could violate models of speciation without gene flow. Utilizing a 540 base pair segment of the mitochondrial control region, 18 microsatellite loci, and 2 z-linked loci we examined intraspecific gene flow and population structure, hybridization, and interspecific gene flow, and attempted to elucidate the evolutionary history of blue-footed (*Sula nebouxii*) and Peruvian (*S. variegata*) boobies in the eastern tropical Pacific Ocean. These sister species exhibit the biogeographic signature of speciation with gene flow across an extreme environmental gradient, and blue-footed boobies experience strong sexual selection: both factors could limit gene flow between the species. We found evidence of high gene flow and low population differentiation in both species, low levels of hybridization, and little evidence of interspecific gene flow. Our results suggest that both species are unique among the Sulidae with respect to their dispersal tendencies, and that pre and post mating barriers to hybridization are well established. Further analyses will shed light on their evolutionary history and address the speciation with gene flow hypothesis.”

**Carlos Zavalaga; David Anderson; Laura Maclagan;
Guillermo Luna-Jorquera; Alejandro Simeone;
Vicki Friesen**

V10-9 Fr 1200-1220 Lecture Theatre

Elena Gomez-Diaz

Ectoparasites as tools for seabird evolution, ecology and conservation

“Parasite evolution depends to a great extent on host evolution and should in many cases share a common evolutionary history. But due to intrinsic characteristics of parasites (e.g., smaller population sizes and shorter generation times), studies that focus on these organisms may provide a better resolution of the common history than studies on the host itself. However, the utility of parasites as host proxies will depend on the host-parasite system and the study scale of the analysis (phylogenetic, phylogeographic or demographic). Seabirds host a plethora of parasitic organisms and these include a great number of arthropod ectoparasites with contrasting life history traits and host specificities. Most seabirds show low levels of genetic structure, thus genetic information from their parasites can complement genetic data from the seabird hosts. Here, I will present our work on *Calonectris* shearwaters and their ectoparasites (lice, fleas, and ticks) as a study model to investigate these co-evolutionary phenomena. Initial analyses of mitochondrial variation provided contrasting information on the genetic structure of the different parasite species when compared with that of the host. We discuss these results in the light of on-going genetic analyses using microsatellite genetic markers as well as the potential application of these results for seabird genetics and conservation.”

Jacob González-Solís; Karen McCoy

V10-10 Fr 1220-1240 Lecture Theatre

James Morris-Pocock

The complex history of isolation and gene flow in Brown and Red-footed Boobies

“To test whether both physical and ecological barriers to gene flow drive population differentiation in tropical seabirds, we surveyed genetic variation at ten microsatellite loci, three nuclear intron loci, and the mitochondrial control region in 242 brown (*Sula leucogaster*) and 271 red-footed boobies (*S. sula*). Global population genetic structure was high in both brown and red-footed boobies and historic gene flow between major ocean basins apparently has been restricted by major physical barriers to gene flow such as the Isthmus of Panama. In contrast, population structure and evolutionary history of populations within ocean basins differed markedly between the two species. In brown boobies, we found high levels of population genetic differentiation and limited gene among colonies. The evolutionary history of brown boobies appears to have predominantly consisted of allopatric isolation and divergence on a colony-scale. Although red-footed booby colonies were also genetically differentiated within ocean basins, coalescent analyses indicate that populations have



either diverged in the face of ongoing gene flow, or diverged without gene flow but have recently come into secondary contact. We suggest that the contrasting patterns of gene flow within ocean basins may be explained by the different habitat preferences of brown and red-footed boobies.”

**Tammy Steeves; Felipe Estela; David Anderson;
Vicki Friesen**

WITHDRAWN V10-11 Fr 1400-1420

Hayley Lawrence Lecture Theatre

Conservation genetics of New Zealand’s rarest seabird, Hokopapa o tch Tchaik, Whakapapa o te Taiko

“The Chatham Island Taiko (*Tchaik*, *Pterodroma magentae*) is one of the world’s most endangered seabirds and a taonga (treasured) bird of the people of Rekohu (Wharekauri / Chatham Island). Genetic techniques were used to investigate aspects of Taiko biology and relationships in order to aid Taiko conservation. Mitochondrial DNA markers were sequenced in almost the entire known Taiko population. The level of genetic variation revealed in Taiko was unexpectedly high. Sequencing of ancient DNA from subfossil Taiko bones showed a large proportion of the genetic diversity of the extinct Taiko populations was retained in the remnant population. However, genetic variation in Taiko chicks was low, thus genetic diversity in the population could be lost in just a few generations. DNA sexing revealed that the many non-breeding Taiko were almost all male, which signified a potential Allee effect (i.e. that a reduced density of potential mates is decreasing population productivity). Further understanding of the Taiko mating system and behaviour was obtained by parentage, sibship and pairwise relatedness analyses of genotypes at eight microsatellite DNA loci. Conservation efforts are now attempting to maximise genetic diversity in the population. It is also important that Taiko are found so they can be protected from introduced predators. Results indicated that there are likely to be more Taiko breeding in undiscovered areas. Analysis of philopatry using genetic markers can assist conservation by the identification of areas to search for these undiscovered individuals. Genetics has also aided the Taiko Trust’s initiative to establish a new breeding colony to help secure the Taiko’s future.”

Graeme Taylor, Craig Millar, David Lambert

V10-12 Fr 1420-1440 Lecture Theatre

Frank Hailer

Genetic and morphological structuring of brown booby populations across land and open ocean habitats

“The brown booby (*Sula leucogaster*) is a tropical seabird known to forage further inshore than many sympatric seabird

species, and considerable levels of philopatry have been demonstrated from banding studies. We studied genetic and morphological variation in brown boobies from nesting sites across the Caribbean, eastern and central Pacific Ocean. Our findings demonstrate a strong structuring into main geographic groups, reflected at neutral genetic loci as well as in plumage characteristics. Further, we provide evidence for a fine-scale structuring within regions. This is consistent with life history traits of the species and suggests that local populations need to be managed separately.”

**Elizabeth Schreiber; Joshua Miller; R. Terry Chesser;
Robert Fleischer**

V11-1 Sa 0900-0920 Salon B

Hunt & Wilson

Introduction: History of ideas and technology

V11-2 Sa 0920-0940 Salon B

Yvon Le Maho

Colony studies: The importance of technological innovations on long term monitoring of individuals and populations in colonial species

“We pioneered the use of RadioFrequencyIdentification (RFID) and automatic weighing in wildlife in 1991. This new technology allowed us to investigate how body stores of micro-tagged king penguins returning from sea determine their breeding success, giving us an indication of climate-induced changes in food availability at sea. For this, a part of the colony was enclosed with a single passageway equipped with an electronic scale. However, RFID was first limited in allowing identification only over short distances, but antennas could not be installed throughout a colony. Instead, birds were flipper banded to monitor individual breeding status, yet a decrease in the number of birds was then observed over subsequent years. To eliminate any effect of banding or enclosures, we developed a new RFID set-up in 1998 with underground antennas on usual passageways of the birds. We discovered flipper bands affected negatively breeding success and survival up to a decade after banding. Using revaluated demographic parameters, we were able to show that adult fitness components were negatively affected by warm events. In parallel, to further improve the automatic weighing, we designed a new setup for Adélie penguins to solve the issue of multiple birds standing on the weighing platform at once. Now, to measure both the breeding status of emperor penguins and the distribution of individuals within a king penguin colony, we are developing a new approach using radio controlled robots with mobile RFID antennas.”

**Benjamin Friess; Claire Saraux; Michel Gauthier-Clerc;
Celine le Bohec**



V11-3 Sa 0940-1000 Salon B

Nina Karnovsky

Colony studies: From lavage to lipids: innovations and limitations in estimating diets

“Linking variability in oceanographic conditions with measurements we make on seabirds (reproductive success, chick growth rates, recruitment, survival, at-sea distributions, stress levels, energetic expenditures, body condition, phenology, etc.) requires an understanding of the type, amount and quality of prey that seabirds consume. Traditionally, estimating diets has been done through classification and enumeration of stomach contents of seabirds collected at sea, as well as chick meals, pellets and guano collected at the colony. These techniques can reveal the type and number of prey, but are often biased in that they reflect only the meal recently taken, indigestible remains and often only the prey taken for chicks. Recent developments of biochemical assays of seabird tissues (stable isotope and fatty acid signature analysis) have provided insight into how diets shift over varying time scales in the past (e.g. diets during winter when seabirds are often inaccessible), feeding locations (e.g. benthic versus pelagic) and have elucidated differences between adult and chick diets. However, these biochemical approaches are limited in their ability to assess prey type and the quantity of prey consumed when diverse prey from similar trophic levels or with the same fatty acids are ingested. Careful application of traditional techniques in conjunction with these newer biochemical methods has advanced our understanding of the ways in which seabirds can indicate inter seasonal, annual, decadal and regime shifts in oceanographic conditions. Furthermore they have expanded our understanding of the spatial scales over which seabirds forage providing answers to questions about migratory pathways and natal origins.”

Keith Hobson; Sara Iverson

V11-4 Sa 1000-1020 Salon B

Alexander Kitaysky

Colony studies: Exploring mechanistic links between nutritional stress and population processes in seabirds

“Consequences of food shortages for population dynamics of long-lived seabirds are not well understood. Longevity of seabirds may buffer their populations from relatively long-term declines in foraging resources, yet several reports suggest that some populations are prone to rapid declines. In this paper we discuss two recent advances in studying consequences of nutritional stress that might help us to predict seabird population responses to food shortages. A field endocrinology approach allows us to quantify nutritional stress by measuring concentrations of the stress hormone

corticosterone in the blood of individuals. Empirical studies suggested that severity of nutritional stress, defined by the magnitude and duration of glucocorticoid elevation, determines reproductive performance and survival of adults. However, responses to similar levels of nutritional stress differed between declining and increasing populations indicating that demographic structure plays an important role. Recent work has linked chronic elevation of glucocorticoids with cellular aging as measured by telomere shortening. Thus, a molecular determination of biological age of individuals, based on telomere length and rates of their shortening in response to stress, might provide a way to link colony-specific responses to nutritional stress and demography. Taken together, these measures could allow us to predict seabird population responses to climate variability and change.”

Mark Haussmann

V11-5 Sa 1020-1040 Salon B

Rory Wilson

Colony studies: The development of logging devices that reveal the behavioural ecology of seabirds

“All five of the UK’s breeding tern species (Arctic *Sterna paradisaea*, common *Sterna hirundo*, little *Sternula albifrons*, roseate *Sterna dougallii* and Sandwich *Sterna sandvicensis*) are listed in Annex I of the European Union Birds Directive as rare or vulnerable. Consequently, these species require the designation of both terrestrial and marine Special Protection Areas (SPAs). The Joint Nature Conservation Committee is currently undertaking survey and analysis to identify marine areas around the UK that are important for terns in the breeding season, and which may be suitable for designation as SPAs. In order to predict the locations of important marine areas for Arctic, common, roseate and Sandwich terns we are generating habitat suitability models to identify those environmental variables that best explain the variation in their at-sea distributions. For little terns, which forage close inshore, shore-based observational data are being analysed to determine the extent of important foraging areas in the coastal areas adjacent to the colonies. This paper will summarise the habitat requirements of these central place foragers, describe the habitat models, and outline the variety of conventional and novel survey techniques (line transect samples from boat/aircraft; ‘visual tracking’ of individual terns from fast moving boats) that we deploy around the study colonies. Results from the first two (of a planned three) seasons of data collection and analysis will be presented.”

Julie Black; Kerstin Kober; Susan O'Brien; Chris Bingham; Ilka Win; Andy Webb; James Reid

**V11-6 Sa 1100-1120 Salon B****David Ainley****Pelagic studies: Advances in the at-sea studies of seabirds**

“Understanding the ecology of seabirds means understanding their role in marine ecosystems, enabling prediction of population responses to biophysical changes in the marine environment. The ‘classical’ age of at-sea investigation of seabirds occurred during the 1970-90s, a time when extensive data usually from “platforms of opportunity” were collected. Much was learned about seabird associations with specific water masses, in addition to close associations with gyres, eddies and frontal zones from large- to meso- to local-scales. These correlations of population variability with physical features helped researchers to formulate questions about processes at different temporal and spatial scales that might drive the patterns. Advancing these subjects was the standardization of data collection and data analyses, in conjunction with the advent of remotely sensed information on ocean productivity as well as the inclusion of seabirds as bona fide components of research cruises. Most recently, the development of predictive quantitative models integrating seabird occurrence patterns to ocean productivity and its proxies have guided the discipline. With the most recent advances in technology, we are poised to understand the biophysical mechanisms by which changes occur in seabird populations; in order to do this, seabirds and their co-occurring species need to be fully integrated into designed multidisciplinary oceanographic ecosystem investigations, particularly at the meso-scale. Taking an ecosystem-view of seabirds, rather than a species-centric view, will be important in light of large-scale ecosystem changes already underway and we propose several avenues of research to provide new insights into this “seabirds as a part of marine ecosystems” view.”

Eric Woehler; Christine Ribic; Lisa Balance**V11-7 Sa 1120-1140 Salon B****John Piatt****Pelagic studies: Advances in the methods for quantifying the distribution and abundance of seabird prey**

“The invention of sonar and its application to measuring the abundance of plankton and fish underwater opened up a new world for biologists in the late 1900s. Prior to its use, we could only measure biomass below the surface using net sampling, which was time-consuming, allowed only for point sampling, and was prone to serious bias in estimating biomass or its distribution. With hydro-acoustic technology, we could continuously send pulses of sound into the water column and not only record a 2- or 3- dimensional record of echoes from

organisms below, but also estimate their individual size, the spatial extent of schools and larger aggregations, and create a continuous record of distribution to compare with seabird distributions at the surface. In turn, this created new opportunities to examine seabird-prey relationships that would otherwise have been impossible to study, including spatial scaling of both predators and prey (patch size), tracking efficiency of seabirds (aggregative response), prey density thresholds, and interference competition for prey patches. It also greatly enhanced our understanding of how oceanographic features such as thermoclines, fronts, eddies, and upwelling can concentrate prey at different depths in the water column. Finally, with scientific-grade sounders, it has been possible to translate echoes into precise measures of biomass (e.g., in g/m³) allowing us to compare and contrast the prey density fields in different ocean habitats (e.g., coastal, shelf, shelf-edge), among different seas and oceans, and assess the needs of competing predators, including marine mammals and predatory fish.”

George Hunt, Jr.; Kelly Benoit-Bird**V11-8 Sa 1140-1200 Salon B****Henri Weimerskirch****Pelagic studies: Advances in the methods for determining the movement of breeding and non-breeding oceanic seabirds**

“The southern hemisphere westerlies are the strongest time-mean oceanic winds in the world. Over the past 50 years, a shift of the southern annular mode (SAM) into a positive phase and westerlies have shifted poleward and increased in intensity possibly in relation to ozone depletion and warming from rising concentrations of atmospheric carbon dioxide. Allbatrosses movements are strongly influenced by wind and southern westerlies are the main support for the dynamic soaring flight of albatrosses and their ability to reduce flight costs. Therefore we expect that changes in winds conditions could have influence albatross movements and their life history traits. Here we show that over the past 20 years, in the southern Indian Ocean, the windiest part of the southern ocean, breeding wandering albatrosses, have increased their flight speed and shifted their foraging range poleward, in conjunction with increased wind speed and southward shift of westerlies. Male and female are affected differently, because of their different distributional pattern. As a consequence, the duration of foraging trips has decreased, and birds have improved their body condition and breeding success. These results suggest that the predicted further intensification and poleward shift of westerlies may affect future distribution of species relying on wind condition, and illustrate an unexpected, but potentially important indirect consequences of climate change on seabird distribution.”

Sophie de Grissac; Maite Louzao; Karine Delord



V11-9 Sa 1200-1220 Salon B

Vicki Freisen

Technological advances in the understanding of seabird evolution and population dynamics

“Information on current and historical population dynamics of seabirds is important both for understanding their evolution and for successful conservation. Analyses of morphology provided many insights into seabird evolution and population dynamics, but these studies were complicated by convergent evolution, stabilizing selection and environmental effects. Banding studies generate indispensable data on movements, but require extensive effort and are virtually impossible for secretive species. The advent of protein electrophoresis and restriction analysis of mitochondrial DNA provided initial glimpses into the genetic relationships among species and conspecific populations, but were limited by low variability, and sample collection and storage restrictions. Recent revolutions in molecular genetics, including sequencing and efficient mutation-detection methods, are providing direct information on genetic variation within and among populations and species, with few limitations to data collection. Furthermore, theoretical advances such as coalescent theory, and developments in computer technology are providing powerful tools to unlock secrets about species’ historical and contemporary numbers, distributions and movements. Combination of these recent developments with banding, morphological and ecological data promise to provide especially useful insights into seabird ecology and evolution, and to aid their conservation.”

V11-10Sa 1220-1240 Salon B

David Hyrenbach

Advances in seabird conservation: towards Ecosystem-Based Management

“Marine conservation is advancing rapidly, spurred by technological developments for biodiversity monitoring (e.g., wildlife tracking, remote sensing) and conceptual advances for determining where / when to make the most effective conservation investments (e.g., population structure, demographics). Yet, the worsening conservation status of oceanic birds and the decline in the ocean’s ability to support the food webs they depend upon require novel approaches. Because marine ecosystems are spatially-explicit environments, management must address the underlying physical and biological heterogeneity in time and space, as well as the dynamic nature of key life-history processes and human impacts. Thus, we contend that a critical goal for seabird conservation should be to develop spatially explicit targets. To this end, we outline five key principles guiding the development of these conservation targets, and illustrate their conceptual foundations and practical application: (1) evaluating mismatches between management and ecological

processes, (3) accommodating scale-dependent temporal and spatial variability, (3) preserving webs of ecological interactions, (4) acknowledging the heterogeneity of human activities, and (5) embracing place-based management. An improved dynamic understanding of critical habitats and human impacts will facilitate the integration of seabird conservation needs into the developing marine spatial planning paradigm for territorial waters and the high-seas.”

Matthieu Le Corre; Josh Adams; Maite Louzao; Alison Rieser

V12-1 Sa 0900-0920 Lecture Theatre

Sue Lewis

Phenotypic plasticity in breeding phenology in the Wandering Albatross: effects of age, experience and past reproductive success

“Phenotypic plasticity is a principal means whereby populations can adjust to climate change. Individual variation in plasticity for fitness-related traits in response to environmental change has been documented in some wild vertebrates but the mechanisms responsible for this variation and its consequences for population and evolutionary dynamics remain poorly understood. We investigated plasticity in breeding phenology in wandering albatrosses over 3 decades in a population experiencing a dramatic decline. Average egg laying dates have advanced over the last three decades. However, individual females varied significantly in their rate of advance. We examined the effects of age, breeding experience and previous breeding success on this change in phenology. Phenology was most advanced among middle-aged birds and delayed in the youngest and oldest age classes. Contrary to expectations birds showing relatively high past breeding success were less plastic and tended to lay later on average relative to the population as a whole. Despite this, they had improved current breeding success. Our results underline the importance of understanding the causes and fitness consequences of individual variation and suggest that the relationship between quality and plasticity may not be as straightforward as has been proposed. The presence of among- and within-individual variation in phenology and breeding success has profound implications for predicting the effects of climate change on natural populations.”

Richard Phillips; Daniel Nussey; Andrew Wood; John Croxall

**V12-2 Sa 0920-0940 Lecture Theatre****Deborah Pardo****Age and environmental related variations in survival and reproduction in a Black Browed Albatross population**

“The current global changes are now acknowledged by the majority of the scientific community and a main goal is to predict their ecological and societal consequences. The inter-individual variability observed within populations complicates the understanding of the impact of those changes on populations. Indeed, some categories of individuals seem to be more affected than others by the same environmental fluctuations. Here we investigate how senescence is responsible for this inter-individual heterogeneity. Using a long-term dataset on a population of the black-browed albatross (*Thalassarche melanophrys*) studied since 1979 at Kerguelen, Southern Indian Ocean, we attempt to determine the age-specific patterns in survival and reproduction. We then examine the age-specific response between these vital rates and climatic factors. The inter-individual heterogeneity in demographic parameters is studied with environmental climatic covariates on both the breeding and the wintering zones using multi-event models. Based on previous studies on long-lived seabirds, we expect the older individuals to have lower vital rates due to senescence. Senescent birds are likely to present two different responses to climate relative to prime aged birds: either being more susceptible to climate variability, or being more resistant thanks to their experience.”

Henri Weimerskirch; Christophe Barbraud**V12-3 Sa 0940-1000 Lecture Theatre****Thomas Reed****Demographic and evolutionary consequences of phenotypic plasticity in a changing world**

“Marine environments are highly variable across time and space, and the ability of seabirds to adaptively adjust behavior, development, and allocation of resources to competing demands (i.e., phenotypic plasticity) allows them to respond to natural and anthropogenic environmental changes. Yet our understanding of the causes and consequences of plasticity variation and the limits to individual plasticity within and across populations remains rudimentary. I present results from collaborative research on plasticity in *Uria aalge* populations in Scotland and California, where individual-level data on behavior and breeding success have been collected for decades. Patterns of individual plasticity and selective pressures on reaction norms (functions describing how traits change across environmental states) were characterized for each system, allowing inferences to be made about potential fitness consequences of environmental change. I then describe an individual-based

modeling analysis, where these basic principles are cast in a generalized framework applicable to any species. The effects of phenotypic changes on population viability were explored under a range of scenarios. Results show that the demographic consequences of plasticity depend on the pattern of environmental variability and the reliability of cues, both of which might change through time. Ecological and evolutionary changes in reaction norms will be key factors affecting future persistence of seabird populations.”

V12-4 Sa 1000-1020 Lecture Theatre**Antony Diamond****Phenotypic responses to environmental change in a seabird community**

“Objectives: Use of seabirds as indicators of environmental change requires measurable responses to those changes, i.e. phenotypic plasticity; but how should this be measured? Methods: I use variance of standard measures of breeding phenology and success, chick growth rates, adult condition, fledging mass, and diet, in the four commonest species in the seabird community of Machias Seal Island (Bay of Fundy/Gulf of Maine) 1995-2009, as measures of phenotypic plasticity. Principal Results: More inter-annual variance was found in Arctic and Common Terns *Sterna paradisaea* and *S. hirundo* than in auks, and more in Atlantic Puffins *Fratercula arctica* than in Razorbills *Alca torda*. The extreme response - colony abandonment - occurred only in terns, in response partly to food-web changes and partly to increased predation. Some components of plasticity are predictable from life-history characteristics (nest site, proximity to edge of range), while others are not. Reduced availability of the keystone prey species (juvenile Atlantic Herring *Clupea harengus*) affected breeding biology (timing, success, chick growth) in similar ways in the terns and puffin, with Razorbills most resistant to a food shortage that contributed to abandonment of the colony by terns (which historical records show to be an “extreme event” recorded only once in the previous 140 years). Colony abandonment is proposed as one extreme of a gradient of possible phenotypic responses to environmental change.”

V12-5 Sa 1020-1040 Lecture Theatre**Francis Daunt****Phenotypic plasticity in winter foraging time: carry-over effects on breeding performance in the European Shag**

“In winter, adult seabirds must not only survive but attain sufficient condition to commence breeding activities in early spring. Such carry-over effects between seasons are of fundamental importance to population ecology, yet are poorly understood. Variation among individuals in pre-breeding



condition is likely to result from intrinsic abilities to obtain sufficient food across a range of winter conditions. Phenotypic plasticity is the primary mechanism whereby individuals adjust to environmental fluctuations. A number of studies on wild populations have demonstrated individual variation in phenotypic plasticity, with the general prediction being that increased plasticity will be favoured by selection in a fluctuating environment. In this study, we deployed miniature activity loggers on adult European shags *Phalacrocorax aristotelis* breeding on the Isle of May, south-east Scotland, over six winters and monitored their subsequent breeding phenology and success. The loggers recorded daily foraging time, and we tested the prediction that individuals showing higher plasticity in foraging time to late winter conditions would breed earlier and more successfully. In addition, much of the data consisted of repeat deployments on the same individual across adjacent winters. This deployment strategy provided a rare opportunity to examine whether individuals are consistent in their plastic responses, an issue of fundamental importance to population and evolutionary ecology.”

Richard Phillips; Sarah Wanless

V12-6 Sa 1100-1120 Lecture Theatre
Amélie Lescroel

Behavioral plasticity of Adélie Penguins in response to varying sea-ice conditions

“The ability of individual seabirds to adjust their behavior in response to the conditions they experience is an example of phenotypic plasticity, which likely has important consequences on seabird population’s capability to cope with environmental change. To date, however, empirical studies of between individual variation in behavioral reaction norms are lacking. Here, we propose to examine the relationship between a behavioral trait, foraging efficiency, and an environmental variable, sea-ice concentration, in the Adélie penguin *Pygoscelis adeliae*. Based on a 13-yr, individual-based longitudinal data set on foraging parameters of pit-tagged individuals, we tested for and described individual plasticity in foraging efficiency using random regression models. Adélie penguins show substantial phenotypic plasticity in foraging efficiency, suggesting that at least part of the population can cope with a wide range of sea ice concentration levels. However, further analyses would be needed for predicting the population’s response to ongoing climate change.”

Grant Ballard; David Ainley

V13-1 Sa 1120-1140 Lecture Theatre

Olivier Chastel

Environment, stress and phenology in polar seabirds

“Breeding at the right time is crucial for reproductive success. Although environmental conditions (SST, sea ice extent, resources availability) greatly influence the timing of breeding in seabirds, the proximate mechanisms remain less well understood. In birds, stressors such as food shortage stimulate the release of stress hormone (corticosterone), triggering physiological and behavioural responses that aid immediate survival but inhibit reproduction. Relating this to the timing of breeding, we predict that elevated corticosterone levels would delay the timing of breeding through the disruption of the reproductive axis (ex: luteinizing hormone (LH)). We found that pre-laying corticosterone levels were a good predictor of egg-laying date in Snow Petrels and that high corticosterone levels constrained LH release in Black-Legged Kittiwakes. Furthermore, female kittiwakes with experimentally decreased corticosterone levels laid their eggs 4 days earlier than control ones. To our knowledge, this is the first experimental evidence showing that decreased stress levels result in an advancement of the timing of egg-laying and an enhancement of breeding success in a free-living organism. In seabirds, stress hormones appear therefore to play a major role in mediating interactions between environmental conditions, reproductive physiology and the onset of breeding.”

Aurélien Goutte; Børge Moe; Claus Bech; Geir Gabrielsen; Céline Clément-Chastel

V13-2 Sa 1140-1200 Lecture Theatre

Jan Ove Bustnes

Ecological impacts of persistent organic pollutants in top predator seabirds under different stress regimes

“Seabirds are subject to increasing anthropogenic stress resulting from fisheries, climate change and pollution. Fisheries and climate change may have strong negative impact on feeding conditions for many seabird populations, which might enhance the potential effects of other stressors on fitness, for example persistent organic pollutants (POPs). This presentation will review some recent studies on gulls and skuas from Polar Regions that show how moderate levels of POPs may be associated with adverse ecological effects under different stress regimes, including poor feeding conditions, harsh climates and high parasite burdens. An important issue will be how different life-history traits (various reproductive variables and survival) of seabirds might be affected by pollution under different stress.”



V13-3 Sa 1200-1220 Lecture Theatre
Thierry Boulinier

Circulation of infectious agents and nutritional stress in seabirds: insights with the system involving seabird tick *Ixodes uriae* and Lyme disease agent *Borrelia burgdorferi* s.l.

“Understanding what factors affect the large scale circulation of infectious disease agents has become a topic of broad interest. Seabirds have the ability to disperse agents over broad scales, but they can also suffer from being exposed to parasites, and it is likely that nutritional stress affects their interactions with parasites. Detailed field studies considering interactions among nutritional stress, parasite circulation and population ecology processes are thus needed. Here, we present recent progresses made using the system involving the seabird tick *Ixodes uriae* and Lyme disease bacteria *Borrelia burgdorferi* sensu lato. The analyses combine information from a large scale survey using endocrinological and immunological approaches (conducted on several species at the scale of the North Pacific), with information from long term studies tracking the physiological status of breeding individuals. The sero-epidemiological work allowed us to assess which individuals had mounted a specific immune response following exposure to the bacteria transmitted by the tick vector. Field endocrinology carried on the blood of undisturbed individuals provided a way to quantify their level of stress hormone corticosterone, which can be related to changes in food availability. The results highlight the need for further detailed work on this kind of issues, which involve processes occurring at a hierarchy of temporal and spatial scales.”

Alexander Kitaysky

V13-4 Sa 1220-1240 Lecture Theatre
Stacey Robinson

Parasitism, mercury contamination and stable isotopes in cormorants

“Contaminants and parasitism have been positively related in free-ranging birds. One proposed explanation is that contaminants reduce host immunity resulting in a greater susceptibility to parasitism. However, alternative explanations should be addressed to further inform and test hypotheses about relationships between contaminants and parasitism. We investigated whether total mercury and *Contracaecum* spp. were related in double-crested cormorants *Phalacrocorax auritus* and whether there was support for contaminants and infective stages of parasites being co-ingested. For breeding cormorants, males had 1.5 times more total mercury in breast muscle than did females and > 2 times more *Contracaecum* spp. (nematodes). Different males were responsible for the two sex biases hence separate explanations for each pattern were required. Males tended to forage on more pelagic prey and at a slightly lower trophic level than did females, as

determined by stable C and N isotope signatures, respectively. Sex biases in parasitism but not mercury concentration could be explained by sex differences in use of foraging habitats. We found similar results in a second sample of cormorants from another lake ecosystem; therefore, we rule out the likelihood that original patterns were due to chance. We suggest that sex differences in exposure be addressed whenever testing contaminant-parasite linkages.”

Mark Forbes; Craig Hebert

V13-5 Sa 1400-1420 Lecture Theatre
Sophie Bourgeon

Geographic variation in persistent organic pollutants in an avian top predator, the great skua: influence on feather corticosterone, body condition and biomarkers of health

“Persistent organic pollutants (POPs) have been shown to cause adverse effects on a vast array of biomarkers in avian species further affecting population dynamics. Namely, POPs can alter the stress response, defined as a suite of behavioural and physiological responses to environmental perturbations, and impair immune function. Also, recent studies have proposed oxidative stress as another indicator of exposure to diverse stressors. Nevertheless, there is a lack of studies assessing the potential damaging effects of POPs on oxidative stress. Besides, POPs can have different ecological effects at different latitudes and they can also affect individuals differently based on their quality and/or sex. In this context, our study aimed at comparing physiological parameters collected in three breeding colonies of great skuas (*Stercorarius skua*) distributed from temperate regions to the high Arctic. More precisely, we assessed the potential causal relationships between POPs (organochlorine and perfluorinated compounds) and feather corticosterone (the main stress hormone in birds), body condition, immunoglobulin levels and, oxidative stress. The current study, at the interface between ecology and physiology, proposes to identify physiological proxies that can provide information about the mechanisms of toxicity of POPs on breeding birds' health status. The results are further discussed in relation to breeding success and other life-history traits.”

Aaron Fisk; Robert W. Furness; Hallvard Strøm; Ævar Petersen; Geir Wing Gabrielsen; Jan Ove Bustnes

V13-6 Sa 1420-1440 Lecture Theatre
Grant Gilchrist

Metal concentrations and biomarker responses in eider ducks in the Canadian Arctic

“We determined concentrations of cadmium, mercury and selenium and assessed biomarker responses in king and common eiders at three locations in the Canadian arctic.



Renal cadmium concentrations in king eiders from the eastern Canadian arctic were among the highest ever recorded in any species of sea duck (geometric mean: 155 microg/g) while they were lower in king and common eiders at other sites (geometric means: 68-117 microg/g). Hepatic mercury concentrations were low in king and common eiders at three locations (geometric means: 1.3-3.8 microg/g) while mean hepatic selenium levels ranged from 10-36 microg/g. Both spleen mass ($p=0.02$) and the number of nematodes found in gastrointestinal tracts ($p=0.02$) were positively correlated with hepatic mercury levels. This prompted us to examine immune function. Neither antibody response nor the T-cell response to a subcutaneous injection of PHA-P were related to tissue

concentrations of cadmium, mercury or selenium. Nor was stress response, as measured by time-adjusted corticosterone concentrations, negatively affected by metal concentrations. However, birds with relatively high concentrations of mercury and cadmium were consistently lighter or had lower fat reserves than their counterparts with lower concentrations of these metals. This was probably related to the dynamics of mass gain and loss that occurs in breeding eiders. Vitamin A status was also strongly related to hepatic mercury levels among nesting females.”

**Mark Wayland; Grant Gilchrist; Tracy Marchant;
Judith Smits**

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