



1ST WORLD SEABIRD CONFERENCE Seabirds: Linking the Global Oceans

Abstracts of Contributed 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 Contributed Session.

Victoria Conference Centre
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**C1-1 We 1120-1140 Salon C****Charles Bost****Short and long-term consequences of the dynamic of the Polar Front on King Penguins foraging.**

“In this long-term project performed in the French Antarctic Territories, our goal is to understand the responses of the south Indian food webs to climatic variability through the study of foraging movements of King penguin, a deep diver and long-distance forager. We investigate the use of mesoscale and fine-scale frontal zones by foraging penguins studied by satellite tracking and GPS. The study is performed in 2 localities of the South Indian Ocean (Crozet Islands, 46° S, 51.8°E; Kerguelen Islands: 49.2°S, 70°E). We have been able to constitute a long-term tracking database over 16 breeding seasons at Crozet (1992-2009) and 11 at Kerguelen (1998-2009). Penguins adjusted their trips to the mesoscale dynamics of the Antarctic Polar Front (APF). Intense foraging periods correspond to high SST gradients associated with eddies. Habitat modelization indicates 3 majors physical factors related to intensive foraging (Sea water anomalies, SST and bathymetry gradient). At a long-term scale, a remarkable concurrent change was found between inter-year location of the APF and the foraging range of Crozet king penguins (n=16 years). A progressive change in swimming direction suggests a modification in prey habitat. Strong positive temperature anomalies in the South Indian Basin induced some large shifts in the localization of prey location and ultimately an abrupt decline (30%) in the king penguin population. These temperatures anomalies were independent of the 1997-98 ENSO occurrence.”

Cédric Cotte; Clara Perron; Anne Goarand; Christophe Barbraud; Christophe Guinet

C1-2 We 1140-1200 Salon C**Akinori Takahashi****Spatial movement linked to diving behaviour in Chinstrap Penguins**

“Diving seabirds are thought to adjust their movement both in horizontal and vertical dimensions in response to prey availability, so that they can forage efficiently in the heterogeneous marine environment. To examine the linkages between fine-scale spatial movement and diving behaviour, we fitted GPS-depth data loggers on chinstrap penguins *Pygoscelis antarctica*, a major consumer of Antarctic krill, at Signy Island, South Orkney Islands, Antarctica. We used first-passage time and dive analyses to examine the area-restricted search (ARS) behaviour and foraging success of 37 breeding individuals. Chinstrap penguins from our study colony showed two foraging strategies (‘benthic’ and ‘pelagic’) that had different horizontal and vertical movement

characteristics. In the benthic foraging strategy, penguins concentrated their ARS behaviour in nearshore areas (2 - 6 km from the colony) and dived deeper (mainly 50 - 110 m) to feed on or near the seafloor. In the pelagic foraging strategy, penguins showed ARS behaviour further offshore (4 - 43 km from the colony) and dived to shallower depths (mainly < 40 m) to feed in midwater. Penguins had higher foraging success (based on the dive bottom time) in the ARS zones than outside the ARS zones, both in benthic and pelagic foraging trips. Our results suggest that chinstrap penguins modify their spatial movement in association with underwater foraging success.”

Shinichi Watanabe; Nobuo Kokubun; Michael Dunn; Philip Trathan

C1-3 We 1200-1220 Salon C**Jana Kotzerka****Contrasting foraging strategies of Black-legged Kittiwakes between pre-breeding and breeding stage**

“The Black-legged Kittiwake (*Rissa tridactyla*) is the most abundant gull species in the world, but some populations have declined dramatically in recent years. Although this species is already well studied in many respects, especially detailed knowledge about their foraging strategies and feeding areas is still urgently needed. During breeding 2007 and pre-breeding and breeding in 2008 we deployed GPS-dataloggers to adult Black-legged Kittiwakes on Middleton Island, Gulf of Alaska. We compared the data between both breeding stages and years and analyzed these data in relation to bathymetric, chl-a and SST data of the relevant region. In early pre-breeding stage (April) kittiwakes performed almost exclusively nocturnal foraging flights (95%) in nearly always south-easterly direction of their colony towards pelagic deep sea waters. Foraging was neither related to chl-a nor SST's. Later during the breeding season kittiwakes foraged only over continental shelf areas not deeper than 200m, mainly during daytime. Foraging areas were significantly associated with SST's and chl-a values during the breeding season 2008, but not in 2007. Nocturnal foraging trips lasted significantly longer than foraging trips during daytime. Foraging trip duration was significantly longer during the pre-breeding season (mean: 10.7h) than during the breeding season (mean: 4.5h) and kittiwakes travelled significantly farther from their colony site in April (mean: 55km) than from May-August (mean: 30km). Our results show that Black-legged Kittiwakes perform very different foraging strategies during the different breeding stages from the same colony. Foraging areas are not necessarily related to remote sensing measurements of primary production, which are often used to predict seabird distributions.”

Scott Hatch; Stefan Garthe

**C1-4 We 1220-1240 Salon C****Rosana Paredes****Gender differences in foraging distribution of Black-legged Kittiwakes nesting at two Bering Sea colonies: responses to changing food availability.**

“Sex-specific foraging strategies have been demonstrated in a number of seabirds, and may reflect gender differences in energetic and time constraints during reproduction. Gender differences in parental roles and effort have been suggested in Black-legged Kittiwakes; males spend more time in territory/nest defence, whereas females tend to provide more food for offspring. We examined the foraging ranges of chick-rearing Black-legged Kittiwakes at two colonies in the Bering Sea (St. Paul and St. George Islands, Alaska) during 2008 and 2009, using GPS- and activity-loggers. Although both sexes foraged over the shelf during daytime-trips to provision nestlings, there was a gender difference in foraging distance from the colony. In 2008, males from both colonies foraged an average of 40 km from the colony, mostly over the shelf and mostly on sandlance, fish-offal, and amphipods; females foraged an average of 125 km from the colony, more often over the deep basin and mostly on lipid-rich prey (myctophids) overnight, presumably in response to poor local food availability. In contrast, during 2009 both female and male kittiwakes from St. Paul shifted to foraging mostly on juvenile pollock at an on-shelf ‘hot-spot’; females forsook commuting long-distance to feed on myctophids. Kittiwakes nesting on St. George in 2009 continued to display sex-specific differences in foraging distribution, but males foraged more over the basin compared to 2008, reflecting continued low food availability. Our results indicate that male and female kittiwakes respond differently when food availability is low, likely reflecting their different parental roles.”

David Irons; Daniel Roby; Robert Suryan; Ann Harding; Heather Renner; Rachael Orben; Chris Barger

C1-5 We 1400-1420 Salon C**Paul Thompson****Linking changes in seabird colony dynamics to environmental drivers**

“Over the last 50 years, studies of northern fulmars have demonstrated declines in reproduction and adult survival, overlain by shorter-term fluctuations that are inversely related to the winter NAO. Seabird colony studies such as these provide important insights into demographic change, but uncertainty over the foraging areas used by birds from these colonies often constrains understanding of the mechanistic links underlying these changes. Uncertainty over the spatial scale of foraging also limits the extent to which findings can be generalised to other colonies. To investigate the

environmental drivers underlying observed demographic changes at our Scottish study colony, we used a combination of GLS and GPS loggers to identify the foraging areas used by breeding adult fulmars. Breeding adults foraged up to 2800 km from the colony during both pre-breeding and incubation, while trips during early chick rearing were all within 250km. Most nest failures occurred during incubation; a time when marked individual differences in foraging areas meant that ‘local’ reproductive success was dependent upon resources in areas as disparate as SW Greenland, the North Sea and the Norwegian Shelf. These results indicate that the dynamics of this single colony represent a complex interaction between different colony components that are each likely to respond to environmental variation in spatially distinct ecosystems. Understanding the influence of environmental variation on these dynamics will require individual-based studies to characterise individual foraging areas, and incorporate this information as co-variables in future demographic analyses.”

Lucy Quinn; Ewan Wakefield; Phillips Richard

C1-6 We 1420-1440 Salon C**Scott Shaffer****A tale of two hot spots: at-sea segregation in Hawaiian Albatrosses**

“Laysan (*Phoebastria immutabilis*) and black-footed (*P. nigripes*) albatrosses breed sympatrically throughout the Northwest Hawaiian Islands. Tracking studies conducted at Tern Island reveal that breeding Laysans forage north and west of Tern Island, and black-foots forage northeast. Post-breeding distributions are not well defined, but we hypothesize that habitat segregation is less distinct because adults are no longer tied to the breeding colony. We tagged 42 albatrosses with archival geolocation loggers in 2004 (4 Laysan), 2005 (10 Laysan, 9 black-foot), and 2006 (7 Laysan, 12 black-foot). Time at sea ranged from 128-160 days and albatrosses traveled up to 4,500 km from Tern Island, covering 35,000-43,000 km for Laysans and 50,000-68,000 km for black-foots. Laysans traveled to oceanic waters with a narrow temperature range (12-14°C), whereas black-foots occurred in a broader temperature range (12-20°C). Home-range analysis revealed that Laysan hotspots occurred north-northwest of Tern Island, in the Subarctic Gyre, whereas black-foot hotspots occurred along the coast of central California, north to British Columbia. The home range (i.e. 100% Utilization Distribution) of black-foots is substantially larger than Laysans but the core area (i.e. 25% UD) is smaller. These results indicate that both species segregate at sea year round, which could be a mechanism to reduce competition or partition resources. This segregation has consequences for conservation strategies.”

Scott A; Michelle A; Melinda Conners; Yann Tremblay; Maura B; Marc Romano; John Klavitter; Daniel P



C1-7 We 1440-1500 Salon C

Vitor Paiva

The foraging plasticity of a pelagic seabird species feeding along a marine productivity gradient

“The foraging and behavioural plasticity of a pelagic seabird species, Cory’s shearwater *Calonectris diomedea*, was compared, during incubation and chick-rearing among 7 different breeding sites in the North Atlantic. These sites, with contrasting ecological conditions, were situated in the Azores, Berlengas, Madeira and Selvagens archipelagos. Behavioural and positional data was obtained by intensively deploying compass-temperature and temperature-depth loggers, monitoring a total of 324 foraging excursions. There was a significant positive correlation between the percentage of short foraging trips in the different breeding sites and the concentration of chlorophyll-a in the waters surrounding those sites. Oceanic populations exhibited higher foraging effort, by travelling more time and to more distant areas, and larger home ranges and feeding areas than the neritic population. Birds exploiting neritic areas used shallower depths and shorter dives than birds feeding in oceanic waters. During long trips, feeding areas of both oceanic and neritic populations were mostly characterized by high concentration values of chlorophyll-a and low sea-surface temperature. The behavioural and foraging response of the different populations was mainly dictated by the heterogeneity of their habitat, which was driven by 2 productivity gradients present in the north Atlantic: Higher productivity on northern latitudes and neritic areas than in southern and oceanic habitats. There was a general spatial segregation in terms of the core feeding areas at the population level. Areas of foraging overlap between different populations should be important to apply conservation measures, such as the definition of Marine Important Bird Areas for seabirds over the North Atlantic.”

Pedro Geraldes; Iv·n Ramlrez; Ana Meirinho; Stefan Garthe; Jaime Ramos

C1-8 We 1500-1520 Salon C

Emeline Pettex

Fantastic-elastic: foraging plasticity of Norwegian Northern Gannets in time and space

“Plasticity in seabird foraging strategies is a main conservation issue as it may allow them to cope with degraded marine habitats following global change. Thanks to recent developments in tracking devices (e.g. global positioning systems and global location sensors), variation in feeding behaviour has been shown in terms of foraging effort, prey selection, and preferred feeding areas. Yet such variation has seldom been considered at various spatio-temporal scales, and it is unclear whether it arises due to individual, or population plasticity. Using GPS data loggers, we studied two

colonies of Norwegian Northern gannets (*Morus bassanus*) from the Barents Sea, over three consecutive breeding seasons, and assessed variability in foraging strategies over 339 foraging trips. We used linear mixed models to investigate the effects of individual, site and year on the variability observed in foraging effort (defined by trip duration, distance travelled, maximum distance to the nest, sinuosity, and flight speed). Consecutive trips (3 to 10 per bird, N= 12 and N=14 birds for each colony, respectively) allowed us to investigate intra-individual plasticity while inter-individual variability was estimated by sampling between 14 and 23 birds per site per year. Overall, we found significant levels of foraging plasticity at all considered spatio-temporal scales, including individual, population, and annual scales. Such plasticity may greatly influence key conservation decisions, such as how boundaries of Marine Protected Areas should be defined.”

Svein-Hakon Lorentsen; Olivier Gimenez; Jean-Baptiste Pons; Robert Barrett; C line Le Bohec; David Gr millet

C1-9 We 1540-1600 Salon C

Philippe Sabarros

Fine-scale association between foraging patterns of Cape Gannets and submesoscale fronts

“Oceanic structures such as meso- and submesoscale fronts may become production hotspots through concentration and enhancement processes. Fronts generally attract prey fish of marine predators. In the Benguela upwelling system, such fronts might be used as environmental cues by foraging seabirds. In this study we analyzed high-precision foraging movements (GPS, 1 s) of Cape gannets in relation to daily high-resolution chlorophyll maps (MODIS, 1 km) on which submesoscale fronts were identified. We tested that (i) area-restricted search (ARS) and (ii) diving activity were associated with submesoscale fronts. We found that Cape gannets shift from a transiting mode to an ARS mode at approximately 7 km (2-11 km) from fronts. This suggests that they are able to sense fronts (smell or vision) and that this triggers initiating proper investigation of the surroundings (i.e. ARS). We also found that diving probability is enhanced near fronts in 52% of the tracks investigated suggesting that Cape gannets substantially use fronts for feeding; the other 48% may use other cues including fishing vessels.”

David Gr millet; Herv  Demarq; Christina Moseley; Ralf Mullers; Lorien Pichegru; Nils Stenseth; Eric Machu

**C1-10 We 1600-1620 Salon C****Carlos Zavalaga****Contrasting the foraging movements and diving behavior of upwelling and tropical seabirds: Peruvian vs. Nazca Boobies**

“GPS loggers and time-depth recorders were used to compare the foraging behavior of chick-rearing Peruvian boobies (*Sula variegata*) in Peru (cold-productive waters) and Nazca boobies (*Sula granti*) on Isla Española, Galapagos (warm-poor waters). There were remarkable species-specific differences in foraging behavior. Peruvian boobies foraged only during daylight hours, 1 - 3 times a day, in trips of short duration

(< 5h). The mean foraging range was 25 km (max 68 km). Mean dive depth was 2.5 m (max 8.8 m) with a max dive rate of 37 dives/h-1. In contrast, Nazca boobies showed a bimodal pattern of foraging, with short (mean duration 8.5 h, max foraging distance 239 km) and long trips (mean duration 57 h, max foraging distance > 329 km). Overall, 26% of Nazca boobies spent the night at sea. Dives were shallow (mean 1.53 m, max 5 m) and infrequent (max 5 dive/h-1). Habitat use of the main prey consumed by Peruvian (anchovies) and Nazca boobies (flying fish) explains most of the foraging differences. Remote sensing data revealed that Peruvian boobies feed in areas with sea surface temperature of 18 - 21°C and with chlorophyll-a concentration ranging 1 - 8 mgm⁻³, whereas Nazca Boobies visited waters 26 - 28°C and with chlorophyll-a concentration ranging 0.2 - 0.4 mgm⁻³. We discussed differences in foraging behavior between Nazca boobies from Galapagos and its closely relative, the Masked booby (*Sula dactylatra*) from Clipperton island.”

Steven Emslie; Joanne Halls; Giacomo Dell’Omo; David Anderson; Gina Mori; Scott Taylor

C1-11 We 1620-1640 Salon C**Julia Sommerfeld****Tasman Boobies modulate their foraging behaviour in response to seasonal changes of marine environmental parameters**

“Quantifying how seabird populations respond to changes in the marine environment is essential for the conservation of biodiversity. Advancements in tracking device technologies provides valuable tools to accurately measure the foraging behaviour of predatory seabirds and the influence of environmental changes on foraging behaviour, otherwise difficult or impossible to gain. This study used GPS and Accelerometer devices (recording depth and acceleration along 2 axes) to measure the influence of seasonal changes in the marine environment on foraging behaviour of Tasman boobies *Sula dactylatra tasmani* on Phillip Island (Norfolk Island Group, Australia). Foraging movements, trip duration

and activity at sea have been analysed during early and late chick-rearing phases in relation to marine environmental factors (e.g. sea surface temperature and chlorophyll a content) using a 4D software (Eonfusion Myriax), providing visualisation of time-varying spatial foraging data. Results show that birds forage predominantly along the shelf of the Norfolk Island Ridge, where upwelling waters favour primary production, providing a predictable food resource during the early chick-rearing phase. Foraging trip duration, distance travelled by birds as well as the activity at sea vary slightly during early and late season. This study shows that changes in sea surface temperatures and chlorophyll a content over the course of the breeding season influences the foraging behaviour of Tasman boobies.”

C1-12 We 1640-1700 Salon C**Cédric Cotté****Importance of the filamentary circulation on the foraging activity of a tropical seabird**

“The ocean circulation structures the marine environment at various spatiotemporal scales. Although there are many evidences of this physical control on planktonic organisms, much less is known for upper levels of ecosystems. Recent studies suggested that the distribution and foraging trips of top predators such as seabirds are deeply associated with circulation at mesoscale and submesoscale, i.e. respectively eddies and filaments. However, behaviour and foraging tactics of seabirds within this dynamical environment remain largely unknown because previous studies used low precision loggers. We investigated here the relationship of fine scale 3 dimensional movements of a tropical bird, the great Frigatebird, with the marine filamentary activity in the Mozambique Channel. We analysed 15 trips from 11 birds equipped with GPS measuring location and altitude. The filamentary activity was studied from a Lagrangian diagnostics. Frigatebirds encountered stronger filaments at sunset and sunrise. At sunset, birds exhibited high upward speed and reached high altitude (over 750m) while most feeding opportunities (i.e. altitude<10m) occurred at sunrise. Moreover, this diurnal activity of frigatebirds is modulated by the lunar cycle, acting as an important factor to visually locate filament. These results strongly suggested that the foraging activity of tropical birds is linked to filaments, firstly by structuring their prey along fine frontal zones, and secondly as a way of flying, especially in the vertical dimension probably through ocean-atmosphere heat exchange generating thermal winds.”

Francesco d’Ovidio; Henri Weimerskirch



C2-1 We 0900-0920 Saanich

Allan O'Connell

Hierarchical models for estimating seabird distributions in the Northwest Atlantic

“Seabirds face a variety of potential impacts from offshore energy development, resource extraction, oil spills and climate change, all of which require that regulatory agencies utilize model-based information to mitigate these impacts and improve our understanding of specie-habitat relationships. To meet this need, we developed a spatially-explicit log-linear hierarchical model that allows for estimation of species distribution patterns from a suite of historic surveys. The framework we developed provides a mechanism for the incorporation of disparate surveys across the northwest Atlantic Ocean, making the most efficient use of a variety of datasets. To actuate the model, we placed a 1° degree latitude grid over the study region (Maine to Florida, extending out past the continental shelf) and assigned all survey data from a variety of historic surveys to individual grid cells. We then model the spatially-referenced count data for individual seabird species as a function of biophysical covariates such as sea-surface temperature, chlorophyll, and bathymetry, and included an offset to account for variation in survey effort. Here we use the Wilson's Storm Petrel (*Oceanites oceanicus*) as an example to demonstrate the utility and results of this model. We also note that this flexible framework is flexible and can be updated to include new survey data as they become available. Hierarchical modeling of sea bird distributions is an important step in understanding the potential impacts that can result either from changes in site-specific conditions or broad-scale changes associated with climate change.”

Beth Gardner; Andrew Gilbert

C2-2 We 0920-0940 Saanich

Sébastien Jaquemet

Seabird distribution in relation to mesoscale eddies in the Mozambique Channel

“Within the framework of the Agulhas-Somalia Current Large Marine Ecosystem (ASCLME) project, 3 oceanographic cruises are being conducted in the Mozambique Channel. During these cruises, we investigated seabird-eddy associations to identify the impact of these features on the foraging behaviour of seabirds. Anticyclonic eddies, cyclonic eddies, and boundary regions were surveyed for seabirds. In November-December 2008, the cruise took place in the central part of the Mozambique Channel, in the vicinity of Juan de Nova Island where a large colony of Sooty Tern (*Onychoprion fuscatus*) breed in austral summer. In October-November 2009, a second cruise took place in the southern part of the channel along the Mozambican coasts. Finally the third cruise is planned in the southern part of the channel also

along the coast of the Mozambique in April-May 2010. We related the distributions of satellite and in-situ environmental data (sea-surface height anomalies, current speed and direction, chlorophyll concentration) to seabird distributions, abundance, and to their feeding activities. Preliminary results suggest that seabirds tend to avoid the core of anticyclonic eddies, and favour the core of cyclonic eddies where primary production is higher, or boundary areas where geostrophic currents are stronger and aggregate food resources. In all case however the presence of surface schools of oceanic predators such as tuna and marine mammals resulted in a significant increase in feeding observations.”

Bruce Dyers; Etienne Bemanaja; Sven Kaehler; Jean-François Ternon

C2-3 We 0940-1000 Saanich

Robert Suryan

Chlorophyll persistence indicates 'hotspots' of primary and tertiary productivity: implications for trophic transfer and biodiversity conservation

“Understanding variation in biological activity over large scales is critical for an ecosystem-based approach to management, especially marine spatial planning. Satellite imagery of chlorophyll a (chl a) concentrations can provide a holistic perspective on productivity in large marine ecosystems not available by other means, yet its value to predict mid-to-upper trophic level predator distribution and abundance has remained equivocal. This uncertainty is understandable given time lags in the response of consumers to primary productivity, and the fact that predators do not consume phytoplankton directly. We used a decade of satellite remotely-sensed chl a data and marine bird distributions at sea to test the hypothesis that remotely sensed oceanographic data could be used to locate 'hotspots' corresponding to elevated consumer densities within the California Current System (CCS). 'Hotspots' of co-varying primary productivity and consumer densities were best identified based on a persistence metric of elevated values of chl a in space and time, rather than commonly used mean chl a values. In the central CCS, chl a persistence accounted for 96% of the variation in bird density, twice the variation explained by mean chl a alone. Ecosystem-wide calculation of chl a persistence effectively identified other known locations of high consumer abundance, whereas mean chl a was unsuccessful in depicting some areas relative to background levels. Our chl a persistence calculation appears to integrate time lags, physical forcing, and food web processes that often thwart attempts to link primary production and predator distribution.”

Jarrod Santora; William Sydeman

**C2-4 We 1000-1020 Saanich****Elizabeth Phillips****Anomalous Pink-footed Shearwater abundances in Oregon and Washington coastal waters: an ecosystem indicator in the northern California Current**

“At-sea ecological surveys of the Oregon and Washington shelf waters reveal increased abundances of Pink-footed Shearwaters (*Puffinus creatopus*) in May and June of 2009 compared with prior survey years. Although this species occurred regularly in low numbers during previous survey years between 2003-2008, we suggest that a four-fold increase in 2009 is indicative of significant changes in surface ocean conditions within the northern California Current. Because Pink-footed Shearwaters are associated with warm ocean conditions in the California Current Ecosystem, we examined shearwater abundance compared to surface temperature, nutrients, chl-a, zooplankton, and fish species composition and abundance for evidence of warming effects on surface ocean communities. For example, the presence of fishes such as Pacific saury (*Cololabis saira*) and juvenile sablefish (*Anoplopoma fimbria*) may relate to increases in surface warming and/or offshore-to-inshore transport of water masses. We also examine newly available satellite telemetry data within our survey region from two Pink-footed Shearwaters tagged off southern California in the spring of 2009. These results highlight the value of marine bird surveys as upper trophic-level indicators of changing ocean conditions in the northern California Current.”

**Jeannette Zamon; Josh Adams; David Hyrenbach;
Peter Hodum; Lauren Reinalda**

C2-5 We 1100-1120 Saanich**Martin Raphael****Abundance and productivity of the Marbled Murrelet in the San Juan Archipelago, Washington, USA**

“We conducted annual variable-distance transect surveys of Marbled Murrelets (*Brachyramphus marmoratus*) in nearshore waters around the San Juan Islands, Washington, from 1995 to 2009. Mean density, weighted by the inverse of SE of density, was 5.45 murrelets per km². Annual variation was large; mean density varied from 2.25 to 14.01 murrelets per km². We found no evidence of an increasing or decreasing trend over the years of our study, but annual estimates increased with increasing values of an index of sea surface temperature ($R^2 = 0.34$). Productivity, as estimated by the ratio of HY to AHY birds, was also highly variable, averaging 0.098 and ranging from 0.030 to 0.135. Productivity, like density, had no significant linear trend over the years of our study but did show a positive and significant correlation with the sea surface temperature index. We speculate that numbers

and productivity of murrelets increased in years with warmer at sea conditions in response to greater availability of prey in the San Juans, an ecosystem driven more by local tidal influence than offshore upwelling. In years when nutrients are more limiting in the outer coast, murrelets may move to the more nutrient-rich waters of the San Juans.”

Thomas Bloxton

C2-6 We 1120-1140 Saanich**Martin Renner****Changes in the distribution of hotspots of pelagic species diversity and abundance in the Bering Sea and North Pacific over four decades.**

“Using ship-based pelagic surveys from the North Pacific Pelagic Seabird Database, we examine the distribution of hotspots of seabird species richness and diversity at several spatial scales. We correct for heterogeneous survey intensity, and calculate the a diversity anomaly for each of the four decades. After smoothing and interpolating these anomalies we show areas in which diversity increased and decreased. We then compare these diversity hotspots to hotspots in abundance and their persistence through time.”

John Piatt; Kathy Kuletz; George Hunt, Jr.

C3-1 We 0900-0920 Oak Bay**William Satterthwaite****Unifying quantitative life history theory and field endocrinology to assess prudent parenthood in Black-legged Kittiwakes**

“We examined the relationships between the stress hormone corticosterone (hereafter CORT) and the survival and reproductive success of individual black-legged kittiwakes (*Rissa tridactyla*) breeding on three islands in the Gulf of Alaska, sampled over eight years. We integrated these empirical relationships into a life history model examining optimal tradeoffs between current and future reproduction. For birds breeding on two different islands, apparent mortality (death or permanent emigration) was significantly more likely for individuals with elevated CORT, with CORT having more predictive power than island or year. Among survivors, CORT was not a significant predictor of skipping of reproduction and egg or chick losses the following year. Thus our results provide support for the CORT-fitness hypothesis when applied to black-legged kittiwakes. Kittiwakes appeared to incur substantial mortality risks to raise current chicks, likely sacrificing more future reproductive success than would be optimal according to our model. We discuss reasons selection might favor birds sacrificing more future reproductive success than our simple deterministic model predicts.”

Alexander Kitaysky; Scott Hatch; Marc Mangel

**C3-2 We 0920-0940 Oak Bay****Linda Takahashi Behavioural interactions between breeding Common Murres in relation to corticosterone during co-attendance**

“We studied patterns of colony co-attendance, in Common Murres *Uria aalge* on Gull Island, Newfoundland, Canada. Co-attendance time is often described as being involved in pair bonding and social loafing. However, this time may also be used for negotiating parental duties within the pair. Normally, the pair member returning to the colony brings a fish and exchanges chick brooding with its partner (the brooder), which then departs. We investigated individual differences in behaviours during co-attendance time from the brooder’s perspective. Brooding may be the less effortful parental duty compared to chick feeding and brooders may negotiate longer brooding times by their patterns of interaction with their partners and by delaying their departures. Brooders with higher corticosterone levels had longer co-attendance times and performed more allopreening bouts than birds with lower corticosterone levels. These results suggest that there may be a conflict of interest between the individuals, whereby brooding birds that are stressed may be attempting to monopolize this less exertive parental duty. As a consequence, allopreening and other activities such as delayed departure may be ways in which pair members communicate their physiological status and negotiate behavioural duties in their own self interest.”

Anne Storey; Carolyn Walsh

C3-3 We 0940-1000 Oak Bay**Rachel Sprague****Timing of fledging is influenced by glucocorticoid physiology in Laysan Albatross chicks**

“Fledging is a major life transition for birds, when juveniles move from the safety of a nest into an environment where they must find food and avoid predators. The timing of fledging within a season can have significant effects on future survival and breeding success. Proximate triggers of fledging are unknown: though wing development is likely a primary factor, other physiological changes, such as elevated plasma corticosterone (CORT), may affect fledging behavior. Laysan Albatross (*Phoebastria immutabilis*) chicks have an extended post-hatching period during which they reach 150% of adult mass. However, approaching fledging, chicks fast for days to weeks and lose mass while still putting energy into feather growth. We evaluated chick morphology and physiology to elucidate proximate triggers of fledging. As in some other species, CORT increased as chicks fasted and lost body mass. At the same time, corticosteroid binding globulin (CBG) declined, thus amplifying free CORT prior to fledging. Once chicks reached a morphological threshold, free CORT levels predicted how long they stayed at the colony: chicks with higher free CORT fledged sooner. To perturb the relationship

between body condition, endocrine physiology, and fledging behavior, we supplementally fed chicks for the month before fledging. Fed birds had a slower decrease in body mass, slower decrease in CBG, slower increase in free CORT, and stayed at the colony longer after reaching a morphological threshold. Our study suggests that as chicks lose mass, free CORT acts as a signal of energetic or nutritional state to adjust the timing of fledging.”

Creagh Breuner

C3-4 We 1000-1020 Oak Bay**Katarzyna Wojczulanis-Jakubas****Sex differences in body condition in Little Auk *Alle alle* during the whole breeding season**

“Biparental care in seabirds is regarded as an adaptation to high costs of food obtaining and transport to the nest. Although the males and the females parental activities are similar, their investments are not always the same what is reflected in their body condition. Investigation of sex differences in parental care of seabirds is important to understand the evolution of parental strategies in that group. Here, we investigated the changes of body condition of males and females of colonially breeding and monogamous seabird - Little Auk (*Alle alle*) during the whole breeding season. The study was carried out in three breeding colonies on Svalbard (Bear Island, Hornsund and Magdalenefjorden) in 2003-2008. Body mass and frequency of particular types of leucocytes (including the heterophil/leucocyte ratio - H/L, the commonly used index of stress level) were examined. Body mass of both sexes was the highest during the incubation period and decreased significantly in the course of chick rearing. Males were significantly heavier than females only during the chick rearing period. Higher stress level was recorded for females at the beginning of incubation. However, at the end of that period both sexes had similar H/L ratio. The highest stress level was recorded for both sexes during the mid chick rearing. Only sex differences in hematological parameters were found at the end of the chick rearing period, when males had significantly higher stress level. These results suggest that allocation in parental care during the incubation and chick rearing period is rather male-biased.”

Dariusz Jakubas; Dorota Kidawa; Anna Slonina

C3-5 We 1020-1040 Oak Bay**Glenn Crossin****A carry-over effect of migration underlies individual variation in reproductive readiness and extreme egg-size dimorphism in Macaroni Penguins**

“It is becoming increasingly clear that physiological interactions among life-history stages are widespread.



Important life-history events like migration and reproduction are prone to direct physiological conflicts mediated by carry-over effects, though examples of this are rare, especially in females. Here we show that female macaroni penguins (*Eudyptes chrysolophus*) initiate vitellogenesis and yolk formation while at sea during return migrations to breeding colonies: yolk formation takes approximately 16 days, but females lay only 7-14 days after their return. Once on land, Eudyptes penguins show a unique reproductive pattern of extreme egg-size dimorphism in which the smaller, first-laid A-egg is 55-84% of the size of the larger B-egg. We show that the degree of egg size dimorphism is inversely correlated with time between arrival and laying i.e. females that begin reproductive development well in advance of their return produce more dimorphic eggs. Furthermore, late arriving females, which produced the most dimorphic eggs, had lower plasma levels of the yolk precursor vitellogenin upon arrival, i.e. they showed lower reproductive preparedness. These data show that extreme egg size dimorphism in Eudyptes penguins is due to a physiologic constraint imposed by a migratory carry-over effect, and argue against small A-eggs having a specific, adaptive function.”

**Phil Trathan; Richard Phillips; Alistair Dawson;
Fabrice Le Bouard; Tony Williams**

C3-6 We 1100-1120 Oak Bay

Rebecca Holberton

Body mass may not always reveal important variation in energetic condition during the onset of breeding in the Atlantic Puffin (*Fratercula arctica*)

“We captured adult Atlantic puffins breeding at Machias Seal Island to survey energetic condition and breeding status during breeding onset. Puffins were captured 13-15 May, 2009, by either treadle-style box trapping along the rocky intertidal area (n = 20) or by gently removing birds from nearby burrows (n = 20). All birds were sampled for corticosterone (CORT), triglycerides (TRIG), and glycerol (GLYC) within 2-4 min of initial disturbance (dropping into the trap or first contact in the burrow). The two groups did not differ in body size or mass and neither showed indications of fattening or egg yolk deposition (both had low TRIG). However, box-trapped birds had higher CORT (p = 0.033) and GLYC (p = 0.0001), indicating that they were more likely to be losing energy reserves at the time of capture than those already with eggs in burrows. These results suggest that, independent of mass, birds can vary significantly in important measures of energetic status. (In 2007, a similarly sampled group of box-trapped birds showed severe immune suppression.) Birds captured away from burrows during early breeding onset could represent a behaviorally and physiologically different cohort, with potentially different breeding success than those already in burrows. Such

variation in condition at the onset of breeding may be driven by events occurring away from the breeding areas, resulting in important carry-over effects on subsequent breeding success. Reliance on a single trap method may fail to detect important variation in a colony.”

Antony Diamond

C3-7 We 1120-1140 Oak Bay

Jonathan Green

Evaluating threats to Australasian gannets by measuring energetics

“We investigated the energetics of temperate seabird, the Australasian gannet (*Morus serrator*), at the northernmost extreme of its distribution in Victoria, Australia. This population is exposed to high temperatures in its breeding colony which are likely to increase in future years. Furthermore, its diet and foraging range overlaps with local commercial fishery operations. To investigate how gannets deal with high temperatures we heated and cooled them in the laboratory using a dynamic protocol, and measured climate variables at the breeding colony to investigate how often the gannets are subject to heat-stress. The gannets had an upper critical temperature of 33.3°C and relatively unsophisticated physiological mechanisms to lose excess heat. We used three possible regimes of projected increased temperature to predict how often the gannets might be heat-stressed in future years. The number of heat-stress episodes increased exponentially with increasing temperature and each episode increased in intensity and duration. To evaluate current and future vulnerabilities to fishery or climate-induced changes to food supplies, free-ranging gannets were equipped with heart rate data loggers and the energetic costs of breeding and specific activities were evaluated. While gannets currently seem to be operating safely within likely physiological limits, movement of their preferred prey would substantially increase foraging costs with likely implications for foraging efficiency and breeding success. Our energetic measurements will allow us to predict circumstances where this might occur.”

**Erin Aitken-Simpson; Ashley Bunce; Patrick Butler;
Peter Frappell**

C3-8 We 1140-1200 Oak Bay

Vincent Viblanc

Holding the fast: energetic and behavioral adjustments in courting and incubating male King Penguins

“When breeding, parents must balance their own energy requirements with those of their offspring. The trade-off becomes challenging when resource availability is absent (i.e. periods of prolonged fasting), as observed in seabirds that



forage at sea but breed on land. Successful reproduction is then tributary to the efficient management of energy stores ashore. This should be particularly the case for king penguins, subantarctic seabirds where males undergo fasting periods of up to one month while courting and incubating. Metabolic adaptation of this bird to prolonged fasting has been well studied under captive and non-breeding conditions. However, nothing is known on how birds freely breeding in a social context actually adjust their energy expenditure. Using bio-logging, we continuously monitored heart rate (HR), a proxy to energy expenditure, core body temperature, and physical activity (actimeter) throughout courtship and then first incubation shift in male king penguins breeding on Possession Island (Crozet Archipelago). We determined that HR decreases constantly throughout courtship but increases again during the first incubation shift. This increase was specific of males and did not occur in unsuccessful breeders or captive birds. The changes in HR were paralleled by a constant decrease in activity, whereas body temperature remained unchanged (except for a small decrease at the end of fast). We suggest that decreased physical activity but no significant hypothermia may be used to sustain the long courtship-incubation fast. An increase in HR upon laying may relate to increased social stress or 'emotional' investment paralleling increased reproductive value of the egg."

Nelly Malosse; Claire Saraux; Renè Groscolas

C3-9 We 1200-1220 Oak Bay

Michelle Kappes

Comparative foraging behavior and energetics in three species of albatrosses

"While animals can maximize fitness by optimizing energy acquisition through the selection of preferred habitats, trade-offs exist when foraging habitats are not near breeding habitats. For pelagic seabirds, access to preferred marine habitats during the breeding season depends on location of the breeding colony, reproductive stage, and energetic costs of travel. We investigated the comparative foraging behavior and energetics of Laysan (*Phoebastria immutabilis*) and black-footed albatrosses (*P. nigripes*) breeding on Tern Island, Northwest Hawaiian Islands, and Indian yellow-nosed albatrosses (*Thalassarche carteri*) breeding on Amsterdam Island, Southern Indian Ocean, to evaluate how proximity to preferred marine habitats during breeding has shaped the foraging strategies of these species. During the incubation period, all three species traveled to subtropical-subpolar transition zones, where marine productivity is high. However, Hawaiian albatrosses traveled further, and for longer durations, to reach these habitats due to the low-latitude location of the breeding colony. During the brooding period, all species retracted their foraging ranges and reduced time at sea. Consequently, Hawaiian albatrosses foraged in a warm,

oligotrophic environment during this stage. Field metabolic rates were significantly lower for Laysan and black-footed albatrosses compared to yellow-nosed albatrosses, and may reflect an adaptation to foraging in a low-productivity environment. Black-footed albatrosses alone expended more energy when landing frequently and foraging at distant locations; higher foraging costs associated with these behaviors may relate to larger body size and higher wing loading in this species."

Scott Shaffer; Henri Weimerskirch; Yann Tremblay; Daniel Costa

C3-10 We 1220-1240 Oak Bay

Jannik Schultner

Application of the two-sample doubly labeled water method alters behaviour and affects estimates of energy expenditure in Black-legged Kittiwakes

"Despite the widespread use of the doubly labeled water (DLW) method in energetic studies of free-ranging animals, effects of the method on study animals are rarely assessed. We studied behavioral effects of two alternative DLW protocols. During two consecutive breeding seasons, 42 parent black-legged kittiwakes received either the commonly used two-sample (TS) or the less invasive single-sample (SS) DLW treatment. A third group served as a non-treated control. We evaluated the effect of treatment with respect to the time birds took to return to their nest after treatment and recaptures, and the nest attendance during DLW measurement periods. We found that TS kittiwakes needed on average 20 times longer to return to their nest than SS kittiwakes after initial treatment, and nest attendance was reduced by about 40% relative to control birds. In contrast, nest attendance did not differ between control and SS kittiwakes. Estimates of energy expenditure of SS kittiwakes exceeded those of TS kittiwakes by 15%. This difference was likely caused by TS birds remaining inactive for extended time periods while at sea. Our results demonstrate that the common assumption that the TS DLW method has little impact on the behaviour of the study subjects is in some circumstances fallacious. Estimates of energy expenditure derived by the SS approach may thus more accurately reflect unbiased rates of energy expenditure. However, the choice of the protocol may be a trade-off between their impact on behaviour, and hence accuracy, and their different precisions. Adopting procedures that minimize the impact of TS protocols may be useful."

Jorg Welcker; John Speakman; Erling Nordøy; Geir Gabrielsen



C3-11 We 1400-1420 Oak Bay

Gal Ribak

Hydrodynamics of avian foot-propulsion while feeding near the bottom

“While feeding near the bottom diving ducks propel with their feet constantly to overcome buoyancy and remain submerged. We analyzed the hydrodynamic mechanism and energetics of this feeding behavior in captive ducks (*Bucephala islandica*) filmed while diving for food in a vertical dive tank. The motion of the feet during paddling near the bottom was extracted from the movies and a biomechanical model of the hydrodynamics was used to estimate the forces and energy associated with paddling. We found that due to the angle of the body (76 degrees below the horizontal) 98% of the propulsive force was directed against buoyancy and allowed the birds to stay near the bottom. The estimated energy for moving both feet through water in a paddling cycle was 1.1 ± 0.2 J, or 3.9 ± 0.54 W. These values for the mechanical energy spent on staying near the bottom are 2 fold higher than previous estimates that neglected the energy spent on propulsion inefficiency. Our results quantify the energetic cost of bottom feeding and show that this feeding behavior is energetically expensive due to the high buoyancy of ducks.”

David Jones

C3-12 We 1420-1440 Oak Bay

Shiway Wang

Estimating seabird diets using quantitative fatty acid signature analysis: the effect of fatty acid composition and variability of forage species

“A powerful approach for studying trophic relationships in marine ecosystems uses fatty acids (FA) to qualitatively characterize and quantitatively estimate predator diets. Quantitative estimates using quantitative fatty acid signature analysis (QFASA) requires a catalog of all potential prey FA compositions. Although the overall efficacy and accuracy of the FA method of diet analysis is well established, important questions remain of how potential spatial and temporal variability in FA composition of individual prey species affects quantitative estimates. We evaluated the magnitude of variability in FA composition of principal forage species supporting upper trophic level marine predators in the Bering Sea and examined the effect of this variability on QFASA diet estimates for seabirds. Our results demonstrated within and among species FA variability for prey in the Bering Sea library. Species in the Bering Sea prey library were reliably differentiated from each other using multivariate methods and more rigorous QFASA simulations. Additionally, the same species from other locations (Gulf of Alaska, Prince William Sound) could be reliably differentiated from the same and other species by location (Bering Sea, Gulf of Alaska, Prince

William Sound). We found that spatial and temporal variability of prey FA signatures can affect QFASA diet estimates: substituting species from one location with the same species from different locations, or species from one location with the same species from that location from a different year, affected QFASA estimates of diet. Our results have important implications in the application of QFASA to the study of marine predator diets.”

Alan Springer; Sara Iverson

C4-1 Th 1120-1140 Lecture Theatre

Peter Barham

Non-invasive monitoring of colonial seabirds using computer vision: scope and limitations as exemplified on African Penguins and Bank Cormorants

“For decades, external markers have been crucial to the study of avian population dynamics and ecology. However, many traditional methods can have deleterious effects on performance and welfare, while the population data retrieved is often sparse or comes at a significant time and effort cost. Computer vision can offer new perspectives that minimize disturbance and manual effort. Using specifically designed software, we demonstrate the possibilities of automated animal biometrics as a means to provide non-invasive monitoring of colonial seabirds at Robben Island, South Africa. We will show that a computer vision system designed to monitor African penguins (*Spheniscus demersus*) using unique plumage features is capable of robustly matching individuals to a population database under field conditions. False individual identifications occurred in under 0.01% of comparisons, while the monitoring capacity of the system was estimated to be above 13% of birds that passed a camera during a trial period. Theoretical and empirical development of this capacity suggests high levels of enrolment and recapture over time frames of a few months. In addition, a test system for visual nest observations on bank cormorants (*Phalacrocorax neglectus*) provides an example of how the approach can be generalized to provide information on difficult to access or easily disturbed species, without colonial intrusions. Finally, we outline the current state-of-the-art, the limitations and the practical preconditions for the use of computer vision systems as tools in non-invasive field-identification in general. To date, the technology provides a viable and timely alternative to complement and extend existing monitoring efforts.”

Tilo Burghardt; Richard Sherley

**C4-2 Th 1140-1200 Lecture Theatre****Philip Trathan****Penguins from space: estimating Emperor Penguin (*Aptenodytes forsteri*) populations through faecal stains and image recognition analysis of individuals and huddles**

“Emperor penguin distribution is poorly mapped, partly due to its breeding habits and the difficulty in accessing its breeding habitat. In a recent study we located almost all the extant breeding colonies using the Landsat Image Mosaic of Antarctica (LIMA). This low resolution image resource allowed us to map and assess their breeding distribution, allowing for future analysis in relation to climate change. Emperor penguins breed on sea ice, and their colonies exist in situ between May and December each year. Faecal staining at these locations shows on the LIMA as brown patches, the only staining of this colour on sea ice. This staining can therefore be used as an analogue for colony locations. The whole continental coastline was analysed, and each possible signal was identified visually and checked by spectral analysis. This study identified colony locations of emperor penguins at a total of 38 sites. Of these, 10 were new locations, and six previously known colony locations were repositioned (by over 10 km) due to poor geographical information in old records. Six colony locations, all from old or unconfirmed records, were not found or have disappeared. Most recently, our international consortium has been working to access Digitalglobe high resolution satellite imagery. This has revealed a total of 43 sites of which six are new since our earlier study. We confirm that only one colony found in the Landsat survey could not be found with this imagery, this was due to early break-up of sea-ice in that region. All previously confirmed locations were captured in a single breeding season. Modifying previously published image analysis methods, we used pan-sharpened images to estimate population sizes. In this paper we present the latest results from our study.”

Peter Fretwell; P Morin; M LaRue; C Porter; G Kooyman; B Weineke; H Brolsma; A Fox; A Fleming

C4-3 Th 1200-1220 Lecture Theatre**Jenna Cragg****Using radar to test the consistency in use of forest nesting habitat by Marbled Murrelets**

“High-frequency marine radar has become the standard tool to count Marbled Murrelets (*Brachyramphus marmoratus*) flying from the sea to inland nesting areas and to monitor watershed populations in British Columbia. We investigated consistency in use of nesting habitat in watersheds where loss of forest nesting habitat from logging was minimal during the sampling period. In 2006 we made radar counts at 14 stations covering 15 watersheds in Clayoquot Sound, southwest Vancouver

Island, repeating surveys that had been done a decade earlier in 1996-1998. We used the same radar units, followed the same protocols, and sampled the same seasonal period. In 2006, as in 1996-1998, there was no significant seasonal trend in murrelet counts throughout the core sampling period. We found no significant change in the mean counts of murrelets between 1996-1998 and 2006, either for dawn or dusk surveys. Two watersheds showed significant increases in 2006 and two showed decreases, but counts for the remaining watersheds were remarkably similar to those a decade earlier. There was no significant difference among years in the coefficient of variation (CV) for dawn counts; however the CV for dusk counts in 1998 was significantly greater than all other years. These results suggest a stable population in this area and consistent use of nesting habitat within relatively undisturbed watersheds, despite changes in the marine ecosystem, such as El Niño events and changes in prey stocks.” **Alan Burger**

C4-4 Th 1220-1240 Lecture Theatre**Rachel Buxton****Acoustic monitoring of island recovery: A case study in the Aleutian Archipelago**

“Exotic predator eradication programs have made advances towards successful island restoration in the past few decades; there is now an urgent need for consistent methods to monitor seabird population recovery. It is well known that introduced predators have devastating effects on colonial seabirds and other island avifauna. Removal of these predators has potentially large benefits to extirpated or depleted populations. However, the rate and means by which avian populations recover on islands after eradication has gone largely unstudied, and development of monitoring techniques needs more attention. We used acoustic monitoring to study patterns in recovery of nocturnal seabirds on islands at different stages of recovery from introduced foxes and rats in the western Aleutian Archipelago. We deployed a total of 19 automated acoustic recorders on six islands throughout the 2008 and 2009 summer seasons. We used a hierarchical method, from presence/absence to a quantitative activity estimate, in order to assess vocal activity. We then compared these activity levels to site characteristics such as years since fox eradication, presence and proximity of refugia, number of other seabird calls present, and proximity to suitable feeding grounds using an information theoretic approach. Overall, we found little support for years since fox eradication as an explanation for level of call activity at different sites. We discuss different patterns of call activity observed throughout the western Aleutian sites and their implications for restoration, and how acoustic monitoring can act as an affordable, practical, and efficient method for monitoring seabird recovery patterns.”

Ian Jones; Jeff Williams; Heather Major

**C4-5 Th 1400-1420 Lecture Theatre****Abe Borker****Acoustic measures of activity as an index of relative abundance at seabird colonies**

“Seabirds face large conservation threats at breeding colonies. Monitoring programs to assess seabird populations and measure the success of conservation actions are hampered by the remoteness of many seabird colonies and the global scale of threats. Innovative technology may allow us to remotely monitor seabird colonies at scale. Automated acoustic sensors offer a low-cost, low-impact method for monitoring seabirds. Here we tested the efficacy of acoustic sensors to measure relative seabird abundance at colonies. We deployed acoustic sensors to record ambient acoustic activity at 5 Forster's Tern (*Sterna forsteri*) breeding colonies (38-108 pairs) in San Francisco Bay. Sensors recorded 1 of 10 minutes, 24h/day, for an average of 90 days during the 2009 breeding season (~220 hours/unit). We used an automated method (spectrogram cross-correlation) to detect and count tern vocalizations from recordings (correlation>0.4). We calculated mean calling rates (calls/min) at different time scales and compared these to nest counts at colonies. Our results show a significant relationship ($r \leq 0.78$) between colony size (mean nests) and acoustic activity (calls/min). Furthermore, our method discriminates between adult and fledgling vocalizations; sensors confirmed breeding success and examined the relationship between productivity and fledgling vocal activity showing potential for productivity monitoring. Acoustic monitoring of seabird colonies is a promising method for documenting relative population size, inter-annual changes, breeding success, and detecting rare or elusive species such as burrow/crevice nesting birds. Quantifying the relationship between acoustic activity and relative abundance is a fundamental step in designing effective acoustic monitoring programs for seabirds.”

Matthew McKown; Josh Ackerman; Collin Eagles-Smith; Donald Croll; Bernie Tershy

C5-1 Th 0900-0920 Saanich Room**Genevieve Jones****Sex-biased chick production in Wandering Albatrosses: who produces the rarer sex?**

“Manipulating offspring sex allows individuals to maximise their fitness by balancing condition and reproductive ability with the requirements of raising more or less energetically costly young. There may also be fitness tradeoffs if the sex ratio of the population is skewed, especially for monogamous species. We found significant biases towards the production of female Wandering Albatross *Diomedea exulans* chicks on Marion Island using molecular sexing techniques. First time breeders tended to produce greater proportions of females,

consistent with the smaller energetic investment required to produce female offspring. However, among experienced breeders (birds with at least 8 years breeding or 4 prior breeding attempts), female young were more common for birds with higher average reproductive success (‘high quality parents’), whereas parents with poor reproductive histories (‘low quality parents’) produced a higher proportion of males. Linear mixed models failed to detect significant effects of body condition or parental quality and experience on sex allocation. High quality parents may produce more offspring merely because they produce less costly female offspring. Parents producing males may be taking a more risky reproductive approach that results in lowered lifetime reproductive success. This strategy might have been successful when sex ratios among adult albatrosses were female-biased, but currently there is an excess of males apparently due to greater fishing mortality of females. Under this scenario, higher rates of female offspring production may be an adaptive response to a male biased operational sex ratio.”

Mareila Techow; Peter Ryan

C5-2 Th 0920-0940 Saanich Room**Lindsay Young****A male's dream come true: causes and consequences of female-female pairing in Laysan Albatross**

“Widespread female-female pairing in several seabirds suggests this behavior may be a plastic and potentially adaptive response to variable demographic and environmental conditions. However, individual and population level effects of this phenomenon are unknown. We examined how the high frequency of unrelated female-female pairs (30%) in Laysan Albatross on Oahu affected fitness, sexual selection, and population growth. We used multi-state mark-recapture models to compare survival and demographic transitions between females in female-female pairs vs. male-female pairs. We employed five states representing successful and failed female-female and male-female pairs, and skipped breeding. Females in successful same-sex pairs skipped the next breeding season more often than those in successful male-female pairs (0.405 ± 0.076 vs. 0.246 ± 0.040), suggesting a higher reproductive cost for female pairs. The probability of transitioning to the opposite pair type was low in successful male-female pairs (0.008 ± 0.008) and failed female pairs (0.016 ± 0.008), but much higher in failed male-female pairs (0.044 ± 0.015) and successful female pairs (0.071 ± 0.040). Because female pairs also had lower annual reproductive success (0.21 vs. 0.60), these results suggest males assess female quality and choose mates based on reproductive performance, thereby exerting sexual selection and forcing low quality females into same sex pairs. However, female pairs contributed 14% of chicks fledged in the colony



indicating these birds still made a significant contribution to the population. These results demonstrate that flexibility in mating systems under varying demographic conditions, such as a skewed sex ratio, may allow a population to exploit and adapt to varied ecological and evolutionary opportunities.”

Eric VanderWerf

C5-3 Th 0940-1000 Saanich Room

Sveinn Are Hanssen

White wing plumage as a signal of individual quality in both sexes

“It is well established that female choice may lead to sexual selection on quality-revealing ornaments in males. However, in many species both sexes display conspicuous characters which may reflect individual quality/condition. We examined the correlations between various measures of condition/quality and variation in white wing plumage in both sexes of the south polar skua (*Catharacta maccormicki*), the great skua (*Stercorarius skua*) and female common eiders (*Somateria mollissima*). We found that whiteness was related to different indices of reproductive performance and condition in females of these species. And, perhaps surprisingly, white wing plumage seemed to a lesser degree to be related to quality/condition in the male skuas. When both sexes display a similar ornament this has most commonly been explained by sexual selection for the ornament in the male and the female ornament just ‘hitchhiking’ with male ornament evolution. Evidence supporting this hypothesis would be that ornamental variation should be more closely associated with male fitness traits. And perhaps even more interesting, in south polar skuas, there were clear associations between female wing patch variation and a fitness trait such as survival, while no significant associations were found between wing patches and survival in males.”

Jan Ove Bustnes; Sophie Bourgeon

C5-4 Th 1000-1020 Saanich Room

Yukiko Inoue

Variations of the timing of breeding and fledging success in Great Cormorants among years and colonies: Is there an effect of food quality?

“Variation in the quality and seasonal availability of prey affect reproductive success and timing of breeding in seabirds. We observed hatching date, fledging success, body condition of chicks and diets of great cormorants (*Phalacrocorax carbo*) at four colonies, two were located in shore-side (at a peninsula and an estuary) and others were inland, during 2007-2009. Source of nutrients used for egg formation was estimated using stable isotope ratio of egg albumen. During egg laying parents fed on shore fish and brackish fish at shore-side colonies and river fish at inland colonies. Breeding was more synchronized in shore-side

colonies than inland colonies. During chick rearing parents in the inland colonies caught river fish in all three years. Parents in the shore-side colonies caught gizzard shads (*Konosirus punctatus*) often in 2007 and 2008. In 2009, parents in the peninsular colony caught flathead mullets (*Mugil cephalus*) but those in estuary colony caught river fish. Lipid content was next to highest in gizzard shads and lowest in flathead mullets and that of river fish was between these prey. Number of nestlings in peninsula colony was reduced in 2009 comparing with those in 2007 and 2008. Food quality and seasonal availability may affect the timing of egg-laying and chick survival in the cormorants that have limited foraging range (<15 km).”

Hidegori Fujii; Hirofumi Kuroki; Kenji Tsuchiya; Yasuaki Niizuma; Yutaka Watanuki

C5-5 Th 1020-1040 Saanich Room

Sergio Ancona

El Niño in the Warm Tropics: local sea temperature predicts breeding parameters and growth of blue-footed boobies

“Breeding participation, growth rates and fledging success of several seabirds are dramatically depressed during intense El Niño events. Increasing evidence indicates that these impacts are common to temperate and cold tropical regions but long-term studies documenting similar effects in the warm tropics are scarce. Moreover, different reproductive parameters of seabirds may be differentially sensitive to El Niño conditions but such sensitivity has been rarely explored. Analysis of 18 years of breeding data for a long-lived tropical seabird, the blue-footed booby, showed that El Niño influences breeding participation and fledging success, as well as other breeding traits such as onset of breeding, clutch size, hatching success and brood size. Inter-annual variation in the eight breeding parameters was strongly related to the global Southern Oscillation Index and even more strongly related to temperature anomalies in the surrounding waters, which themselves were good predictors of local productivity and, presumably, prey availability for breeding boobies. Additionally, growth data of five years revealed that chicks grow more slowly when local surface waters are warmer. Differential sensitivity of breeding parameters and chick growth to varying ecological conditions could be crucial to understanding how seabirds deal with major climatic fluctuations like El Niño Southern Oscillation.”

Salvador Sánchez-Colón; Cristina Rodríguez; Hugh Drummond

**C6-1 Th 0900-0920 Oak Bay Room****Donald Lyons****Predator-prey interactions between seabirds and salmonids: a global perspective**

“Anadromous salmonids (anadromous members of the family Salmonidae; primarily those in genera *Onchorhynchus*, *Salmo*, and *Salvelinus*) constitute some of the most ecologically, economically, and culturally important fish populations in the world. In numerous locations across their geographic range, predation on juvenile salmonids by piscivorous seabirds has been reported as a factor possibly regulating salmonid populations. We surveyed peer-reviewed and gray literature, fisheries biologists, and seabird biologists to identify common characteristics of perceived conflicts. We found reported conflicts to be more common at the southern (low-latitude) range limit of salmonids, in areas with high human population and human land use, where salmonid populations are depressed compared to historical levels, where a large proportion of salmonids produced are reared in hatcheries, and where human perturbations have created abundant nesting habitat for piscivorous birds. Most reported conflicts occurred in estuarine and coastal areas and the associated freshwater rearing and/or migratory habitats. Gulls (*Laridae*) and cormorants (*Phalacrocoracidae*) were cited in conflicts more frequently than other piscivorous bird species, although Caspian terns (*Hydroprogne caspia*; *Sternidae*) are also mentioned as an important predator in isolated cases. Pelagic seabirds sometimes consume juvenile salmonids over continental shelf areas as well; however, these situations are less documented. Proposed management options to reduce predation levels more often focused on management of bird populations than on altered management of salmonids or other aspects of the marine and freshwater ecosystems.”

Daniel Roby; Jessica Adkins; Allen Evans; Ken Collis**WITHDRAWN C6-2 Th 0920-0940****Villy Christensen Oak Bay Room****Ecological impact of forage fisheries: mechanism, effect, and management options**

“Fisheries, including for forage species, are by and large managed without consideration of their ecological consequences, and this is notably the case for their impact on seabirds, which fisheries scientists consistently ignore. Contrary to often-stated beliefs, this is an expression of current practices in fisheries management, rather than a lack of capacity to make such evaluations. Hundreds of marine ecosystems have been modeled to explore how food webs are impacted through exploitation, and understanding the role of forage fishes have in many cases been important aspects of the modeling. Experience indicates that food web structure is an important factor for how predators, such as seabirds, will

be impacted by forage fisheries. I illustrate this with case studies highlighting how management strategy evaluation can be used to evaluate the robustness of alternative management procedures, and show how well different management procedures perform given uncertainty about future environmental conditions (including climate change) combined with uncertainty about population sizes and exploitation rates. I will use retrospective analysis to evaluate strategies that limit the risk of forage fish population crashes such as we have witnessed for many of the world’s important populations with their dramatic impact on the predators, be they fish, birds, mammals or humans, that rely on them.”

C6-3 Th 0940-1000 Oak Bay Room**Troy Guy****Understanding the risk and voluntarily reducing seabird bycatch in the United States West Coast groundfish fisheries**

“Incidental fisheries bycatch is considered a primary threat to albatross and other seabird populations worldwide. Recognizing that the distribution of short-tailed albatross overlaps the West Coast fishing grounds, NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) initiated a process under the Endangered Species Act (ESA) to evaluate and minimize the effect of West Coast groundfish fisheries on this species. New regulations to minimize seabird mortality in West Coast fisheries could emerge from this process. Further, a recent analysis indicates that black-footed albatrosses are being incidentally killed in West Coast Groundfish Fisheries. Black-footed albatross are being considered for listing under ESA, exacerbating concern. To understand the threat to seabirds from fishing operations, we analyzed spatial and temporal distributions of seabirds using a compilation of recent seabird census data and albatross satellite telemetry data within and across depth bins and fishery management areas. Management areas determined to have high concentrations of sensitive seabirds became the focus of targeted outreach efforts to promote the voluntary use of bycatch mitigation. The results of seabird bycatch and fishery management area overlap will allow us to strategically target key West Coast fleets for introducing the use of seabird deterrents. Initial efforts in 2009-10 include distributing streamer lines to Treaty Tribes and non-treaty commercial fishing fleets in Washington at no cost through the USFWS and NOAA Fisheries.”

Robert Suryan; Sarah Jennings; Edward Melvin


C6-4 Th 1000-1020 Oak Bay Room
Stephani Zador
Fast-tracking seabird data into Alaskan fisheries management decisions

“Seabirds are numerically-abundant top predators in Alaskan marine ecosystems. They interact with fisheries through competition for prey, foraging on fisheries discards, and physical interaction with fishing gear. Because both direct (e.g., bycatch mortality) and indirect (e.g., demographic responses to fishery-based ecosystem impacts) effects occur, seabirds are a concern for fisheries managers and ecosystem scientists alike. By mandate, commercial fisheries in the United States must be managed using ecosystem-based fishery practices. However, methods to accomplish ecosystem-based fishery management are still in development. In Alaska, ecosystem data are currently integrated into decisions made by the North Pacific Fishery Management Council, the body responsible for setting annual fisheries quotas. In this talk I will review how seabirds have been incorporated into fishery management decisions through the required protection of endangered species, through bycatch mitigation, and through research on the distribution, abundance and demography of seabirds with respect to fisheries activities. Mechanisms for further inclusion of seabird data in management decisions will be discussed, as will the mechanisms that currently exist but are not fully utilized for effecting management changes by incorporating seabird data directly into the management process.”

Ed Melvin
C6-5 Th 1020-1040 Oak Bay Room
Stephen Votier
Individual responses of seabirds to commercial fisheries revealed using GPS tracking, stable isotopes and vessel monitoring systems

“The large amount of discards produced by commercial fisheries can have major impacts on seabird populations, but the ecology of scavenging behaviour is poorly understood. Using recent developments in stable isotope mixing models (Stable Isotope Analysis in R, or SIAR) and GPS tracking combined with the Vessel Monitoring System (VMS), we investigate behavioural responses of individual northern gannets *Morus bassanus* to fisheries. SIAR reveals marked intra-population variation in the proportion of fishery discards in the diet. These individual differences were consistent in the short-term, but also showed flexibility, and were negatively correlated with foraging trip length and body condition, indicating potential fitness consequences for different scavenging tactics. At-sea path tortuosity of 25 GPS-tracked individuals revealed scale-dependent adjustments in response to VMS-derived fishing vessel locations, as well as to sea

surface temperature, chlorophyll-a concentration and copepod abundance. Our results suggest that effective management of fishery/scavenger interactions should not treat individuals as ecologically equivalent. Moreover, we propose that using VMS alongside GPS tracking, especially in combination with SIAR, provides a powerful tool to study interactions between seabirds and fisheries.”

Stuart Bearhop; Matthew Witt; Richard Inger; David Thompson; Jason Newton
C6-6 Th 1100-1120 Oak Bay Room
Leigh Torres
Fine-scale GPS tracking data reveal gender differences in overlap rates of Buller's Albatross with commercial fishing vessels

“During the early 1990s, Buller's albatross (*Thalassarche bulleri*), a New Zealand endemic, was identified as one of the most frequently caught seabird species in the bycatch of New Zealand fisheries. To determine the effects of this additional mortality on the population trajectory of this species a demographic study was initiated at a major breeding site on The Snares in 1992 and continued annually until 2010, resulting in a study population where the gender and age of most birds is known. GPS tags were deployed on Buller's albatrosses during the guard stage of three field seasons (2008, 2009, 2010*) to record their fine-scale movement patterns. These tags recorded a position at 2-minute intervals and the tracks were compared to spatially and temporally concurrent fishing effort distribution data recorded by Vessel Monitoring Systems aboard the vessels and Catch-Effort logs. Preliminary analysis on the rate of GPS track overlap with fishing vessels shows a significant difference between genders ($F=4.47$, $P=0.04$). A greater proportion of GPS points from tracks of male albatrosses ($n = 18$) overlap fishing vessels than females ($n = 16$). Furthermore, females travel for a significantly longer duration than males ($F=6.22$, $P=0.02$), but no difference in trip distance was detected. No significant relationships were detected between age (range: 11-28) and trip duration, trip length, or percent overlap with vessels. Our work demonstrates how the integration of high-resolution seabird tracks with synoptic fishing activity data enables improved understanding of the threats posed by commercial fishing at both individual and population scales. * Data will be collected in April 2010 and included in this analysis to be presented at the World Seabird Conference in September 2010.”

Paul Sagar; David Thompson; Richard Phillips

**C6-7 Th 1120-1140 Oak Bay Room****Yann Tremblay****In-situ underwater videos of foraging seabirds shed light on feeding success and relationships with prey and other predators**

“Ship-based observations and remote observations of seabirds using biologging devices yield a wealth of knowledge in the past 20 years. However, the fine scale relationships of seabirds with their prey and other marine predators remains elusive with these means of observation. In this work, we used underwater video footages shot by ‘Galatée film’ for the production of the movie ‘Ocean’. These footages allows to clearly observe schools of pelagic fish (sardines) being attacked by Cape gannets, with occasional presence of dolphins and sharks. We measured behavior (rate of attacks, prey capture, foot-propelling behavior) as well as quantity and density of fish in the patch (using image analysis techniques). We document here how the feeding success varies in relation to the characteristics of the prey fields (quantity, density) and the presence and behavior of con-specifics and/or other sub-surface predators. The functional response at the level of a group of predators is estimated, and its relationship with the individual (‘true’) functional response is discussed. The results are discussed in the light of the actual population and ecosystem changes that are occurring in the distribution range of this vulnerable species.”

Andr a Thi bault**C7-1 Th 1440-1500 Oak Bay Room****Lise Aubry****Age-specific trade-offs and unobserved heterogeneity in a long-lived seabird: implications for senescence**

“We used a 30 year study of black-legged kittiwakes breeding in Brittany to study the evolution of trade-offs between reproduction and survival, and their implications for the study of senescence. We first addressed the relationship between recruitment age, age-specific reproductive success (RS), and reproductive senescence, while accounting for breeding experience and temporal variation in RS. We then examined the relative influence of fixed, dynamic reproductive states, and frailty on age-specific survival, and assessed whether observed variability in survival was best explained by immediate, cumulative reproductive investments, or both. We detected late-life improvement in RS across all recruitment groups which we recognized as within-generation selection. When such ‘frailty’ was accurately accounted for, we showed that all individuals suffered reproductive senescence after improvement to the middle of life. Attempting or not to breed explained variability in survival better than other reproductive states (e.g. hatching 0-3 eggs, fledging 0-3 chicks). Interestingly, the more

individuals cumulated reproductive attempts, the lower their mortality risk. Similarly, early recruits suffered a lower mortality risk than individuals that delayed recruitment. These results indicate that both recruitment age and cumulated breeding attempts may be good indicators of individual quality. Lastly, we found that frailty contributed more to variability in survival than fixed and dynamic sources of observed heterogeneity (>23%). Our findings stress the importance of accounting for both observed and unobserved heterogeneity while estimating reproductive and survival trajectories, and for the complex costs involved in survival and reproductive trade-offs (short and long-term).”

David Koons; Samuel Pavard; Jean-Yves Monnat; Emmanuelle Cam**C7-2 Th 1500-1520 Oak Bay Room****Rene Beamonte-Barrientos****Love at older ages: courting behavior in senescent Blue-footed Boobies**

“Recent studies indicate that old individuals in wild populations show decreased reproductive success, but it is not clear which components of the breeding cycle are negatively affected by senescence and whether older animals adjust their breeding strategy to maximize their life-time reproductive success. To investigate whether courting strategy of males and females varies with age in a long-lived bird that shows reproductive senescence, we studied courtship behavior of 33 known-age pairs (range: 2-19 years) of the blue-footed booby. Male and female rates of intra-pair courtship increased with age. However, males showed a greater courting rate when paired to young and mature females than when paired with senescent females, while female intra-pair courtship rate did not vary with mate age. Extra-pair courtship rates were not affected by age. Hence, courtship rates did not decline with age as expected by somatic deterioration. Reduced displays toward old females suggest discrimination against low quality individuals. Blue-footed boobies during courtship display green turquoise feet, a sexual trait whose brightness decreases with age. Thus, increased rates of courtship by older males, particularly when paired to higher quality females, might be an adaptive strategy whereby boobies counteract the decline with age in some components of sexual attractiveness.”

Hugh Drummond; Roxana Torres**C7-3 Th 1540-1600 Oak Bay Room****Kyle Elliott****The prudent parent meets old age: senescence in Thick-billed Murres**

“The ‘rate of living’ theory suggests a tradeoff between metabolism and survival and is supported by inverse correlations between metabolic rate and survival rates.



Charadriiform seabirds are exceptions to this pattern because they live exceptionally long despite having sustained high metabolic rates. We investigate the tradeoff between metabolic rate and survival in Thick-billed Murres (*Uria lomvia*). Reproductive success increased with age between 7-11 years of age, before leveling off, with experience being a better predictor for reproductive success than age during the first 12 years of life. Reproductive success was lower during the final year of life compared to previous years and baseline cort higher, suggesting that death may be related to health effects evident in the last year of life. Hematocrit and metabolic rate appeared to decrease linearly with age, perhaps as a strategic adjustment to reduce the effect of heart disease in old age. Foraging ability appeared to be independent of age. When foraging conditions were experimentally worsened, time spent at the colony increased with age, with 33% of the youngest birds abandoning altogether. Furthermore, cort response levels to handling were higher in younger birds. We concluded that young birds were 'prudent parents', and willing to sacrifice future reproductive success for current offspring leading to an increase in reproductive success with age, while old murres showed signs of deteriorating health when 20-25 years."

Tony Gaston; Katie O'Reilly

C7-4 Th 1600-1620 Oak Bay Room

Jack Cerchiara

Reproductive age and telomere length In Magellanic Penguins (*Spheniscus magellanicus*)

"Physiological systems deteriorate as a result of aging in most species. Senescence is the decline of these physiological systems with age. Under life-history theory, long-living species should invest more in maintenance systems like immune function, and these are likely to be key factors in adult survival. Magellanic penguins (*Spheniscus Magellanicus*) live more than 25 years in the wild. Life history theory predicts that penguins should favor maintenance over immediate reproduction, as longevity leads to more reproductive events. Telomeres are the tandem repeating non-coding sequences that protect the coding regions of the DNA, during cell replication. In long-lived species, telomeres shorten more slowly than in short-lived species, however the life-history decisions that drive the shortening of telomeres is poorly known. We examined the telomere lengths and telomere rate of change for 100 known age Magellanic penguins to determine whether telomeres shorten more rapidly in individuals that reproduce more frequently. We also examined whether the body condition of younger and older penguins differed and whether telomere length was longer in birds of the same age that were in better condition."

P. Dee Boersma

C7-5 Th 1620-1640 Oak Bay Room

Yuichi Mizutani

Annual dynamics of telomere length in black-tailed gull in the wild

"Telomeres, peculiar basis, are located at the end of eukaryotic chromosome. In vitro, telomere length is shortened at every cell division, and cell division will stop if telomere length reaches a critical length. Therefore, it has been suggested that telomere might be related to cell and individual senescence. In the case of birds, however, previous studies showed that the relationship between telomere length and age differed among species and there was considerable variation in telomere lengths even in a group of same ages. Thus, it is important to measure the age-related change of telomere length in sequence for each bird to find the other factors influencing telomere such as the external conditions, physiological states and sex. In this study, we examined the annual dynamics of telomere length in adult black-tailed gulls *Larus crassirostris* by repeatedly sampling individual birds of known age during two or three consecutive breeding seasons. We found that the telomere length of almost all individuals tended to shorten. However, there were differences in annual rates of change of telomere length between individuals and between years within the same individual. Interestingly, the telomere length of all females were shorten, while that of some old males extend and that of one male experienced both telomere extending and shortening. It is possible that gulls have high active telomerase that inhibits telomere shortening and/or older males have suffered low stress or strong stress-resistance. In summary, the telomere length of long-lived birds, as gulls is likely to be affected by sex-related factors."

Yuichi Mizutani; Naoki Tomita; Yasuaki Niizuma; Ken Yoda

C7-6 Th 1640-1700 Oak Bay Room

Vincent Lecomte

Patterns of aging in an extremely long-lived seabird, the Wandering Albatross, *Diomedea exulans*

"How does an animal age in natural conditions? Because of their generally extended lifespan (more than 50 years for albatrosses), seabirds have recently emerged as predominant models for aging research. We recently conducted a multidisciplinary study of aging in an emblematic seabird, the Wandering Albatross (Lecomte et al., *Patterns of aging in the long-lived wandering albatross*, P.N.A.S., 2010). We monitored foraging behaviour of 106 birds (age 6-48 years) using satellite tracking, activity loggers and corticosterone assays, and monitored nine markers of baseline physiology known to reflect senescence in vertebrates. Age strongly affected foraging behavior and reproductive performance from 30 years of age onwards in males, but not baseline



physiology. Specifically, we found an unexpected pattern of spatial segregation by age: old males foraged in remote Antarctic waters, whereas young and middle-aged males never foraged south of the Polar Front. Old males traveled a greater distance but were less active at the sea surface, and returned from sea with elevated levels of stress hormone. Interestingly, there were no detectable age-related patterns in baseline physiology (i.e. humoral immunity, oxidative stress, antioxidant defenses, hormone levels) in either sex. We conclude that foraging ability might play a central role in shaping aging patterns in natural conditions. Our results highlights why seabirds offer a fertile ground for future research on aging.”

Olivier Chastel; Henri Weimerskirch; Gabriele Sorci

C8-1 Fr 1440-1500 Lecture Theatre

Etienne Bemanaja

Is there a future for seabirds of Madagascar?

“Although Madagascar holds less than 1% of the seabirds of the western Indian Ocean, this country is a major breeding ground for some species like the roseate tern, the great crested tern and the Caspian tern. Other species like the red-tailed tropicbird and the wedge-tailed shearwater breed on only two islands of the Country, and these islands should be regarded as sanctuaries at a national scale. However the conservation status of seabirds and their breeding places is very worrying throughout the Country. On most islands seabirds are used by coastal villagers as a source of proteins (through egg harvest and direct hunting of chicks and adults), with no attempt to regulate the harvest. We found only three islands where seabirds are protected by local communities. However sustainable and non consumptive uses of seabirds (like ecotourism) may be particularly appropriate in Madagascar. These uses would be beneficial to both seabird biodiversity and coastal human communities (through economic incomes). In this talk we will present a national overview of the breeding population sizes and conservation status of seabirds in Madagascar and make adapted and site-specific recommendations to improve this status, both locally and nationally.”

Matthieu Le Corre

C8-2 Fr 1500-1520 Lecture Theatre

Evgeny Syroechkovskiy

Navarin seabird cliffs: first inventory of the last unexplored big seabird colony in the North Pacific

“Seabird cliffs of over 300 km long are located in South Chukotka, Russia and where never counted before. We surveyed them in 2001, 2003 & 2005-2008. 29 colonies with total numbers from 250 to 330,000 birds were visited along

the coastline in between cape Ginter and Ain river mouth. Key areas are located near to Beringovskiy Town and Cape Navarin ñ reach marine biodiversity area. Total of 1 530 000 birds counted and considering areas missed during counts total number is estimated as over 2 million birds, which make it the biggest breeding seabird concentration in at Russia Bering Sea. 12 species recorded breeding with Fulmar, both Murrs, with domination of Thin-billed and Kittiwake being the most numerous. New breeding location of Crested Auklet discovered. Pelagic surveys had registered 5 new species for Southern Chukotka waters: Black-footed Albatross; Least Auklet; Spectacled Guillemot, Ancient Murrelet and Red-faced Cormorant. Potential breeding sites of Kittlitz Murrelet are found at nearby areas. Community monitoring program established in 2007 to monitor changes in bird number by photographing of model cliffs by local people. Feeding radius study at colonies makes for IBA program enabled us to provide recommendations to include these areas to the project of ‘Beringia’ National Park. Key threats are oil pollution; plans for coal mining and building a port just next to the biggest seabird colony; disturbance by fishing boats. Very low breeding success recorded in some years and concentrations of dead birds regularly found ashore.”

Nikolay Yakushev; Alexander Artyukhov

C8-3 Fr 1540-1600 Lecture Theatre

Gregg Howald

A global review of mammal eradications on islands and their role in seabird conservation

“Most seabirds are obligate island breeders and have a suite of behavioral, morphological and life history adaptations to the mammal-free islands on which they evolved. However, these traits make them particularly vulnerable to invasive mammals, the leading cause of seabird extinction and endangerment. Fortunately, invasive mammal eradication is an effective conservation tool that can restore seabird populations and prevent extinctions. To provide seabird conservationists with an overview of invasive species eradication we compiled a database of global invasive mammal eradications from islands. There have been >800 island eradications of 25 species of mammals. Most eradications have been of rodents (>350) and bovid ungulates (>160). Moderate numbers of eradications have been of cats (>70), pigs (>41), canids (>40), mustelids (>30) and rabbits (>40). There have been <10 eradications of other seabird predators such as mongooses and raccoons. Development of improved techniques and protocols has systematized the eradication of rats and ungulates so that they have a high probability of success on islands >10,000 and 100,000 ha respectively. Techniques, protocols and success rates for mouse, rabbit and small carnivore eradications continue to vary and are less systematized. Consequently, success is more dependent on practitioner skill and high probabilities of success are more likely on islands of < 100 ha for mice,



<1,000ha for rabbits and <100 - <10,000 ha for different species of small carnivores. Seabird conservationists can use our online database of eradications to place proposed projects in context, better understand how technically ambitious they are and find contact information for people knowledgeable about each eradication.”

Bradford Keitt; Karl Campbell; Bill Waldman; Kelly Newton; Reina Heinz; Bernie Tershy

C8-4 Fr 1600-1620 Lecture Theatre

Daniel Roby

Island building to replace a declining critical habitat resource and restore colonial seabirds

“Many species of colonial seabirds rely on nesting habitat that is sufficiently insular to exclude land-based predators. This habitat has declined due to a variety of anthropogenic factors, including human disturbance, introduced predators, introduced vegetation, island erosion, and sea level rise. Despite declines in availability of suitable island nesting habitat, colonial seabirds of conservation concern may be limited by other factors as well, such as food supply, competitors, and avian predators. We are monitoring and evaluating the efficacy of island-building by the U.S. Army Corps of Engineers as a means to restore Caspian terns as a nesting species to a number of sites in western North America. The Corps has built 8 of 10-13 new islands planned as nesting habitat for Caspian terns and other colonial waterbirds, in California and Oregon. The remaining 2-5 islands are planned for the San Francisco Bay area, where the breeding population of Caspian terns has been in decline due to declining availability of suitable nesting habitat. One of the first tern islands that the Corps built was a 1-acre rock-core island in Crump Lake in the Warner Valley of south-central Oregon, which was remarkably successful in attracting nesting Caspian terns and other colonial waterbirds. In 2009, just the second breeding season for the island, nearly 700 breeding pairs of Caspian tern attempted to nest on the island. Our results suggest that colonial seabirds can benefit from artificial nesting habitats that mimic the habitat lost through anthropogenic factors.”

C8-5 Fr 1620-1640 Lecture Theatre

Stephen Kress

Predicting outcomes of seabird restoration projects

“The outcomes of seabird restoration projects intended to establish new breeding populations at historic nesting sites are highly variable even for the same species. This paper reviews factors affecting the success of chick translocation and social attraction projects. Here we examine variable outcomes with Atlantic Puffin, (*Fratercula arctica*), Leach’s Storm-petrel,

(*Oceanodroma leucorhoa*), Common Murre, (*Uria aalga*), Northern Gannet, (*Morus bassanus*), and Common Terns, (*Sterna hirundo*). This paper reviews the relative importance of distance, size and growth of nearby source colonies, life history characteristics such as philopatry, the influence of predators, variation in methodology as well as chance events. The objective of the paper is to find common factors that explain why some projects succeed and others fail. This is important, because restoration projects are expensive and typically require long term commitments of staff and resources. Projects were likely to succeed when they were located near large and increasing source populations, where predators were either few or under successful management and when the program spanned at five or more years. Length of the program was important, especially for translocation projects, but not necessarily for social attraction projects. Social attraction projects are most successful for species such as terns and gulls which exhibit low natal philopatry, while chick translocation is most successful for species with high philopatry such as puffins, although local circumstances such as habitat quality and proximity to large source colonies can influence outcomes.”

C.Scott Hall

C8-6 Fr 1640-1700 Lecture Theatre

Erin McCreless

Prioritizing seabird breeding islands for invasive mammal eradications

“Seabirds are among the most threatened groups of birds, and 69% of threats to seabirds occur at breeding colonies. Most breeding colonies are on islands, where invasive mammals are a leading cause of seabird endangerment and extinction. BirdLife International identifies 32 island-breeding seabird species as being threatened by invasive mammals. Fortunately, invasive mammals can be eradicated from islands, often leading to recovery of seabird colonies. Invasive mammal eradication can be a cost-effective strategy for seabird conservation; however, funds for eradications, like all conservation funds, are limited, so thoughtful planning is needed to identify top priority islands. The up-front costs of eradications, and their potential benefits to seabird populations, vary widely across islands and archipelagos. Identifying the most important islands for eradication projects thus requires consideration of both benefits and costs. For each seabird species with island-based threats from invasive mammals, we compiled data on seabird population size, IUCN threat status, and severity of threat from each invasive species. We then estimated island-specific eradication costs using data on island size, isolation, climate, protection status, human population density, type(s) of invasive mammal, and non-target species. We used two optimization techniques ñ integer programming and simulated annealing ñ to determine the best islands for eradications based on a variety of seabird



conservation goals. Compared to selecting islands randomly, our methods substantially increase the benefits to seabirds and the cost-effectiveness of eradication projects. Our results should help direct eradication effort and funding; moreover, these methods can be adapted to guide other conservation decisions.”

Chris Wilcox; Reina Heinz; Dena Spatz; Don Croll; Bernie Tershy

C9-1 Fr 0900-0920 Saanich Room

Carsten Egevang

Fuelling up for the world’s longest annual migration: the importance of at-sea hot-spots

“Identifying offshore important marine areas for pelagic seabirds by conventional methods is not an easy task. With the introduction of new tracking devices in seabird migration studies, however, our understanding of how birds use hot-spots, areas of high biological production along their migration routes, has improved significantly. Recently, the annual migration of the Arctic Tern (*Sterna paradisaea*) between breeding sites in Greenland/Iceland and their wintering grounds in the Weddell Sea, Antarctica, was mapped using geolocators. In addition to estimates of the epic distance travelled by the species, the study documented their use of marine hot-spots along the migration route, as well as unequal travel speeds in rich versus poor foraging regions. The study revealed a previously unknown autumn at-sea stop-over site for Arctic Terns in the central North Atlantic Ocean. The birds paused in their southbound migration, spending an average of 25 days at this oceanic site, located at the junction between cold, highly productive northern water and warmer, less-productive southern water. This may be a critical area at which Arctic Terns are required to restore endogenous resources prior to a ‘dash’ over less productive equatorial waters. By November, the Arctic Terns reached 38-40° S and shifted to a pattern of predominantly east-west movements along the highly-productive southern polar front, before finally entering the winter quarters further south, approximately one month later.”

Iain Stenhouse; Richard Phillips; Aevor Petersen; James Fox; Janet Silk

C9-2 Fr 0920-0940 Saanich Room

Iain Stenhouse

Trans-equatorial migration route and important stopover sites of the Sabine’s Gull

“Understanding spatial and temporal dynamics of migration in pelagic seabirds, and overlap with offshore human activities (commercial shipping, fisheries, etc.), is critical to the identification of important biodiversity hotspots, marine Important Bird Areas, and marine protected areas. The

migrations of many seabird species remains poorly understood, particularly for small pelagic species and during the non-breeding period. With the recent development of miniature archival data loggers, known as geolocators, it is possible to track annual movements of small seabirds. Discovered in Greenland in 1818, the Sabine’s Gull (*Xema sabini*) exhibits a circumpolar breeding distribution, and loose colonies are found in Arctic and sub-Arctic regions. In the 1960s, this species was confirmed to winter in the southern hemisphere, but little is known of their wintering ecology. We used geolocators to track migration and explore the broad-scale winter habitat use of Sabine’s Gulls breeding in Northeast Greenland. Of 30 geolocators deployed in 2007, 11 (37%) were retrieved in 2008, and results highlight an extensive overlap with several major world fisheries. Sabine’s Gulls staged in waters off Portugal on their southerly journey in autumn, and off northern West Africa (Morocco, Mauritania, Senegal) on their northerly return in spring, both areas of intense commercial fisheries. In both directions, they made quick transits over areas of low productivity at the equator. They wintered in tight association with the cold waters of the Benguela Current, one of the world’s most productive fishing grounds, and an area that has undergone a major ecosystem regime shift since the 1990s.”

Carsten Egevang; Richard Phillips

C9-3 Fr 0940-1000 Saanich Room

Lorna Deppe

Spatio-temporal dynamics of albatross breeding on New Zealand’s Chatham Islands during the breeding and non-breeding season

“Albatross species are considered globally at risk and facing numerous threats in both the marine and terrestrial environment. To implement effective conservation and mitigation measures, impacts need to be identified and evaluated according to species specific spatio-temporal dynamics. We studied the distributional and behavioural patterns of three species that breed in close proximity on two islands belonging to the Chatham Island Group: the Chatham Island albatross, *Thalassarche eremita*, Northern Buller’s albatross, *T. bulleri platei* and Northern Royal albatross, *Diomedea sanfordi*. Using short-term deployment of Global Positioning System (GPS) devices and long term deployment of Global Location Sensing (GLS) loggers, we were able to record the albatross movements and activity during chick-rearing, migration and wintering periods. Here we present a multi year (2007-2009) as well as multi species comparison, including El Niño and La Niña episodes. We show individual and species specific migration patterns, spatio-temporal segregation in South American wintering areas and the use of common ‘hot spots’ during both the breeding and non-breeding seasons. Results of a habitat analysis will be shown, where we determine how environmental factors drive observed habitat



selection. Using a synthesis of this data we are able to classify the importance but also the risk potential (e.g. overlap with commercial fisheries) of certain marine areas on both temporal and spatial scales.”

Paul Scofield

C9-4 Fr 1000-1020 Saanich Room

Laura McFarlane Tranquilla

Year-round tracking of murres reveal species, colony, and individual-specific wintering locations in the Northwest Atlantic

“Winter distribution and ecology are very poorly known for most seabirds. This knowledge gap precludes efforts to understand environmental influences affecting seabirds year-round, information that is critical to interpreting how seabirds adjust to changing ecosystem conditions and how they can be used as indicators of variation in the marine environment. Bird-borne devices can record the behaviour and location of free-ranging seabirds in remote ocean areas throughout the year. We used archival geolocators (British Antarctic Survey) to track Common Murres (*Uria aalge*) and Thick-billed Murres (*Uria lomvia*) from 7 breeding colonies from the Canadian Arctic to Newfoundland and Labrador (Prince Leopold, Coats, Digges, Minarets, Gannets, Funk and Gull Islands). We mapped the winter distribution (Oct – April) of 41 (2007-2008) and 52 (2008-2009) individuals. Preliminary results indicate that important marine wintering areas for these murres include the Labrador Sea, Davis Strait, the southwest coast of Greenland, the Grand Bank, and the Flemish Cap. The importance of these wintering areas differed between species and among colonies, with individuals showing similar, colony-specific wintering patterns. Individuals exhibited consistent winter movement patterns across years. There was large inter-specific variation in movement patterns, with the more northerly breeding Thick-billed Murres ranging much more widely in their oceanic habitat than Common Murres. Thick-billed Murres from two colonies were unexpectedly farther offshore in the NW Atlantic during April, prior to migration. This knowledge provides robust biological data on important marine areas for seabirds, useful for informing effective conservation/management strategies for Arctic and Atlantic seabirds.”

William Montevecchi; April Hedd; Chantelle Burke; Paul Smith; Gregory Robertson; Tony Gaston; David Fifield; Richard Phillips

C9-5 Fr 1020-1040 Saanich Room

Anders Mosbech

The year-round migration pattern of thick-billed murres breeding in W and NW Greenland tracked with satellite transmitters and geolocators

Knowledge of the year-round distribution pattern is needed to understand ecology and population development in colonies of thick-billed murres under pressure from hunting and oil pollution in the non-breeding period. We tracked thick-billed murres from three colonies in eastern Baffin Bay, Greenland (Ritenbenk 69° 48' N, Kippaku 73° 43' N and Saunders Ø 76° 34' N), with satellite transmitters, geolocators and time-depth recorders. Implanted satellite transmitters (n=37) using system ARGOS provided relatively detailed tracks for up to 166 days while geo-locators (n=38) generally provided year-round tracks, but with much less accuracy. After leaving the colony in late July –mid August, the murres perform a swimming migration, during which the adults moult their flight feathers and the male parent accompanies the chick. The obtained ARGOS tracks (n=27) from the Ritenbenk colony showed sexually segregated migration routes and we found that swimming migration is characterised by a maximum speed between ARGOS locations of 3 km/h. Combined results show that the murres on autumn migration from northern Baffin Bay tended to stage in several areas in northern Baffin Bay including the mouth of Lancaster Sound before heading south on an S-shaped track through the eastern offshore part of Baffin Bay and south-west into the Labrador Current in the western part of the Davis Strait and the Labrador Sea before wintering in the areas around Newfoundland. The tendency to deviate from the shortest route to the winter area towards the eastern offshore part of the southern Baffin Bay on the autumn migration, match with recent survey data on both murre and polar cod densities. It was also found that the murres were diving considerably deeper in the wintering areas than in the breeding areas.”

Kasper Johansen; Morten Frederiksen; Flemming Merkel; David Boertmann; Knud Falk; Jannie Linnebjerg; Aili Labansen; Christian Sonne

C9-6 Fr 1100-1120 Saanich Room

Jean-Baptiste Thiebot

Winter migration of diving predators tracked by light-based geolocation

“Eudyptes penguins are the most important consumers amongst seabirds of the Southern oceans. So far as vulnerable species, the study of their distribution at sea is essential to determine the habitat they depend on. However, very little is known about the at-sea behavior of these predators during the critical period of winter (5ñ7 months) that they spend



exclusively off the colonies. In this study we used extra-miniaturized light and temperature recorders (GLS) to track the winter migration of penguins. Three species were studied: the Northern (*Eudyptes moseleyi*) Rockhopper on Amsterdam island, the Southern (*E. chrysocome*) Rockhopper and the Macaroni (*E. chrysolophus*) penguins on Kerguelen and Crozet islands, French Southern Territories, Southern Indian Ocean. We instrumented 18 to 22 individuals per species and breeding site; recovery rates were high (50 to 67 %). We examined the spatial winter distribution of individuals according to the sex, species and breeding site. The large-scale movements observed were segregated in space and/or time among populations tracked, and consistent with stable isotopic ratios of C and N measured on the animals at their return on colony. Environmental parameters were used to characterize the key areas used during winter migration. These data are the first to document the winter spatial distribution of these species (Bost et al. 2009) and raise questions about conservation of populations with such broad geographical ranges.”

**David Pinaud; Yves Cherel; Philip Trathan;
Charles-Andr  Bost**

C9-7 Fr 1120-1140 Saanich Room

Maria Bogdanova

Carry-over effects of breeding success on overwinter movements and distribution of Black-legged Kittiwakes

“Understanding how events in one period of the annual cycle affect events in subsequent periods is key to understanding individual life histories and population dynamics in migratory species. However, the opportunities to study such carry-over effects are often limited due to difficulties in following animals across seasons. In seabirds, little is known about overwinter movements and distributions and their links to events during the breeding season, despite the critical importance of the winter period for individual survival. We explored links between breeding success and subsequent movements and distribution in Black-legged kittiwakes (*Rissa tridactyla*) breeding on the Isle of May, SE Scotland after a poor breeding season and over a winter when return rate was below the long-term average. Data on movements and use of wintering areas were obtained using miniature geolocation loggers. Four main wintering regions were identified (West Atlantic, Central Atlantic, East Atlantic and the North Sea). Unsuccessful breeders left the colony earlier than successful ones but returned at the same time the following spring. A larger proportion of unsuccessful individuals travelled to the West Atlantic whereas there were significantly more successful birds present in the East Atlantic. Within the West Atlantic, unsuccessful breeders spent more time and utilised larger areas compared to successful ones. In contrast, among birds that visited the East Atlantic, unsuccessful breeders spent

less time and utilised smaller areas than successful ones. No such differences were found in the remaining two regions. Our results highlight the importance of breeding performance for subsequent overwinter distribution.”

**Francis Daunt; Mark Newell; Michael Harris;
Sarah Wanless**

C9-8 Fr 1140-1200 Saanich Room

April Hedd

Year-round tracking of Sooty Shearwaters from the Falkland Islands identifies important marine bird areas in the North and South Atlantic

“For marine birds, at-sea distributions and areas of importance are often poorly known, particularly outside the breeding period. Here we use British Antarctic Survey geolocators to study the movements of Sooty Shearwaters (*Puffinus griseus*) when resident at the breeding colony (Kidney Is, Falkland Islands) and during their trans-equatorial migration to the Northern Hemisphere. While breeding (December–March; 2007-08, 2008-09), shearwaters (n=18) foraged within 600-700 km of the colony, making extensive use of waters over the southern Patagonian Shelf. Between mid-March and mid-April, birds departed the colony and commenced a 2-3 week, ~14,000 km northward migration. Most birds (14/18) spent late April–early June in deep waters west of the mid-North-Atlantic Ridge in what we speculate is an important moulting area (~45-50°N and ~33-40°W). In mid-June, birds moved onto the Eastern Canadian Grand Bank, where they resided until September. Southern hemisphere *Puffinus* spp. are the primary avian consumers of fish within this ecosystem during the Northern summer. Shearwaters headed south by mid-September, reaching the Patagonian Shelf 2-3 weeks later, having made an ~30,000 km round trip migration. Rapid northward and southward transits suggest minimal use of other areas during migration. In the Atlantic Ocean, bycatch of Sooty Shearwaters has been recorded in gillnet, bottom trawl and longline fisheries off Canada and the United States, and in longline fisheries off Uruguay, but the overall magnitude is unknown. The species’ highly migratory nature makes assessment of cumulative anthropogenic impacts (bycatch, oiling) difficult. Year-round tracking aids the identification of important marine bird areas and highlights regions where conservation efforts should be focused.”

William Montevecchi; Helen Otley; Richard Phillips

**C9-9 Fr 1200-1220 Saanich Room****Takashi Yamamoto****Individual consistencies in migratory behaviour of streaked shearwaters over two successive years**

“Post-breeding migration is an important aspect to understand the ecology of seabirds and its relationship with marine environment. In this regard, the fundamental question in bird migration is whether the migratory behaviour of individual birds is fixed from one year to the next. However, little is known about the individual consistency in post-breeding migration over multiple seasons. To examine the timing of migration and wintering site, we attached global location sensor loggers to streaked shearwaters *Calonectris leucomelas*. We obtained data from 26 birds for two successive years in 2006 and 2007. Shearwaters migrated over 3500-5400 km from Japan to three areas during the non-breeding period in 2006: seas off northern New Guinea (n=18), Arafura Sea (n=5), and South China Sea (n=3). In the following year, all individuals returned to the same wintering sites as the previous year. The timing of outward/inward migrations varied largely among individuals, but it was consistent in each individual over two successive years. Our results suggest that streaked shearwaters from our study colony exhibited individual-specific migratory strategies.”

Akinori Takahashi; Nobuhiro Katsumata; Katsufumi Sato; Philip Trathan

C9-10 Fr 1220-1240 Saanich Room**Patrick Pinet****Effect of daylight duration and moon phases on the migrating behaviour of a tropical seabird, the Barau's Petrel (*Pterodroma barau*) in the Indian Ocean**

“Although the foraging behaviour of breeding seabirds is now well understood, much less is known about the interbreeding period. Here, we present the first results on the post-breeding migration of a tropical seabird, the Barau's Petrel. Using miniaturised light sensors, we studied the migration pattern of 23 Barau's petrels during two years. We found that migration behaviour is influenced by both daylight duration and moon cycles. All birds consistently left the breeding colony when the photoperiod was 7.8 ± 0.4 hours of daylight per day and reached their wintering area when the daylight duration was 7.5 ± 0.1 hours. After 5 lunar cycles, they left their wintering areas and started their migration back to Reunion Island. Interestingly the daylight duration at the date of departure of the return migration was exactly the same as the one of their arrival to the wintering area (7.5 ± 0.1 hours). The dates of arrival to the breeding colony were different between years and mostly influenced by moon cycle: Barau's petrels

synchronously arrived to their breeding grounds during the full moon of September. Furthermore, during the post-breeding period, activities at night changed synchronously with the lunar cycle: during full moon, birds spent up to 80% of their time at night flying whereas during new moon they spent 90% of their time sit on water. This study suggests for the first time that migrating seabirds use both solar and moon cycles as proximal cues to regulate their migrating behaviour.”

Matthieu Le Corre

C10-1 Fr 0900-0920 Oak Bay Room**Katrin Ludynia****The first Namibian Islands Marine Protected Area: a conservation measure for endangered seabirds in the Benguela Upwelling System**

“The northern Benguela Upwelling system supports a range of seabirds, including several globally and locally endangered species. Threats to these species include a lack of food, human disturbance, habitat destruction and severe weather conditions possibly exacerbated by climate change. Namibia's first Marine Protected Area (MPA) was proclaimed in 2009. It stretches 400 km along the southern Namibian coast and covers almost 10,000 km², including all seabird breeding islands in Namibia. One of the MPA's key objective is to protect the breeding sites as well as foraging areas of three globally and/or locally endangered seabirds breeding and feeding along Namibia's coast. Using a zoned approach, the MPA places restrictions on human activities, including fishing, mining, guano harvesting and recreational activities in the area. We present data on the foraging distribution of endangered African penguins (*Spheniscus demersus*), Cape gannets (*Morus capensis*) and bank cormorants (*Phalacrocorax neglectus*); this information played a crucial role in the design of the MPA. Monitoring programmes to track the species' foraging distributions, diet, breeding success and population trends will be continued to evaluate the MPA's success as a seabird conservation tool. We will give an overview of some of the management measures implemented in the MPA and will highlight some of the potential shortcomings of the MPA.”

Jessica Kemper

C10-2 Fr 0920-0940 Oak Bay Room**Susie Grant****Using seabird distribution data in the selection and design of Antarctic marine protected areas**

“The development of marine protected areas (MPAs) is a global priority, but the identification of significant, vulnerable or representative areas is often challenged by a lack of spatial



information on biodiversity and ecosystem characteristics, especially in remote, data-sparse regions. The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has undertaken a broad-scale bioregionalisation analysis to identify 11 priority regions where efforts to develop MPAs in the Southern Ocean should be focused. We used a systematic conservation planning process and Marxan reserve selection software to identify candidate areas for protection in one of these priority regions (South Orkney Islands), on the basis of remotely-sensed and satellite-tracking data including kernel density ranges for 6 albatross and petrel species, tracking data for 2 penguin species, physical habitat features, and the distribution of the krill fishery. Based on this analysis, the South Orkney Islands southern shelf MPA (94,000km²) was designated by CCAMLR in 2009, and is the first MPA anywhere in the world to be established entirely in the high seas. In extending a similar methodology to other CCAMLR priority regions including the western Antarctic Peninsula, we are addressing further challenges including identification of winter at-sea distributions for a range of land-based marine predators, and the use of MPAs to build resilience in seabird populations to the effects of climate change.”

Susie M; Phil Trathan; Jamie Tratalos; Janet Silk

C10-3 Fr 0940-1000 Oak Bay Room

Gail Davoren

The importance of prey biology and behaviour in identifying and delimiting marine biological hotspots in Eastern Canada

“The formation of biological hotspots is often driven by persistent high-density aggregations of forage species. Capelin (*Mallotus villosus*) is the focal forage fish in the Northwest Atlantic on which most top predators rely for prey. We examined the distributional patterns of predators and capelin through at-sea surveys off the northeast Newfoundland coast during July–August, 2000–2009. We found that biomasses of chick-rearing seabirds, dominated by Common Murres (*Uria aalge*) and Northern Gannets (*Sula bassana*), and mammals, dominated by whale species, were persistently concentrated among years in the same 10 km² area. Fishing for Atlantic cod (*Gadus morhua*) was concentrated within this hotspot resulting in the bycatch of breeding murres in gillnets (estimated mortality: 3,053–14,054 murres/year). To investigate the mechanisms underlying hotspot formation, we combined hydroacoustics with underwater imagery and bio-physical monitoring. The hotspot was centered on four persistently used deep-water (17–40 m) spawning sites of capelin, where high abundances of spawning capelin aggregated. These sites were located within bathymetric depressions that allowed the retention of suitable sediment (range: 0.25–22.5 mm) for successful spawning. The timing of spawning and hotspot formation was significantly

earlier in years when temperature during capelin gonadal development (Feb–Jun) was warmer ($r^2=0.650$, $p=0.053$). As this hotspot was well defined in space and time, restricted fisheries activities during capelin spawning within this area is a suitable management option. This study illustrates the importance of elucidating the biology and behaviour of prey species when delimiting hotspot areas for protection as well as possible shifts in space and time among years.”

Paulette Penton; Joseph Allen

C10-4 Fr 1000-1020 Oak Bay Room

David Lieske

A model-based atlas of Atlantic Canadian seabirds-at-sea: mapping distribution for conservation priority setting at the regional level

“Region-wide species distribution maps are important tools for anticipating and mitigating potential conservation threats facing seabirds in the marine environment. Model-based methods allow predictions to be made in unsampled locations, but generally suffer from the structural difficulties (e.g., the ‘zero-inflation problem’) associated with sampling sparsely distributed individuals that can also occur in large, localized concentrations. Under these conditions, abundance distributions are highly skewed, resulting in greater variability than can be accommodated under traditional distribution models (e.g., the ‘overdispersed’ Poisson). To achieve our goal of mapping at-sea distributions of three species of Alcids (*Dovekie*, *Alle alle* and murres, genus *Uria*), the Black-legged Kittiwake (*Rissa tridactyla*) and the Greater Shearwater (*Puffinus gravis*), we investigated the utility of the negative binomial distribution for relating nearly four years of at-sea surveys under the Eastern Canadian Seabirds-at-Sea (ECSAS) program to season, sea depth, and presence of sea banks. Results suggested that the stratification of Distance sampling-derived densities to 75km x 75m grid cells was a good balance between the need for acceptable model fit and sufficient sample size for model construction. On the basis of AIC and Wald Tests, sea depth, sea banks, and season were universally influential, as was the interaction between sea depth and season. R² values varied from 0.223 (for Greater Shearwater), to 0.355 (Common and Thick-billed Murres, *Uria aalga* and *U. lomvia*, respectively), affirming the challenges inherent in predicting habitat usage in dynamic and rapidly changing marine environments.”

Carina Gjerdrum; David Fifield


C10-5 Fr 1020-1040 Oak Bay Room
Stefan Garthe
Protected areas in German offshore waters: designation, retrospective consideration and current perspectives

“In 2004, Germany designated ten marine protected areas in the German Exclusive Economic Zones (EEZs) of North and Baltic Seas according to European Union Directives. Two of these areas were designated for birds as Special Protection Areas (SPAs) based on the EU Birds Directive. The site in the North Sea was selected mainly because of the major winter and spring aggregation of Red-thoated Loons while the area in the Baltic Sea was chosen because of the huge numbers of wintering Long-tailed Ducks, Velvet Scoters and Common Scoters as well as internationally highly important numbers of Slavonian Grebes and several other species. In this talk, we report on the site selection process that took place in 2002 and 2003. We review the methodology, criteria and selected borderlines of the two SPAs by evaluating the comprehensive data sets that were collected before and after the designation process. Based on these data sets we will show analyses of consistency and variability for both piscivorous and benthivorous species. For all species, seasonal differences were much more pronounced than between-year effects. Benthos-feeding birds were much less variable in their overall distribution than piscivorous birds that were responding strongly to various hydrographic and meteorological factors. Despite the variability described above, the fundamental distribution patterns could be confirmed throughout all survey years.”

Nicole Sonntag; Nele Markones
C10-6 Fr 1100-1120 Oak Bay Room
Kerstin Kober
Identifying marine protected areas for seabirds in United Kingdom offshore waters

“The European Union Birds Directive places a legal obligation on its member states to establish a network of Special Protection Areas (SPAs), both at sea and on land, for rare, vulnerable and migratory species of bird. The UK Joint Nature Conservation Committee has undertaken analyses of an extensive database on the at-sea distribution of seabirds to meet this obligation. The European Seabirds at Sea database hosts more than 2 million records of seabird distribution in NW European waters, collected mainly from vessels of opportunity since 1979. Spatial interpolation (Poisson kriging) and subsequent hotspot analyses (Getis-Ord statistic) of these data revealed the existence of several regularly-occurring and seasonally important concentrations of seabirds over the UK continental shelf. When placed in the context of the UK SPA selection guidelines, this outcome offers a sound evidence

based solution for the identification of SPAs for seabirds at sea. It also serves as a potential model for the identification of MPAs in other parts of the world where a similar data resource exists.”

Kerstin Kober
C10-7 Fr 1120-1140 Oak Bay Room
Andy Webb
Using the spatial distribution of inshore marine birds to identify sites for MPAs around the United Kingdom

“A network of protected areas for marine birds in UK waters will be based mainly on sites classified as Special Protection Areas (SPAs) under the European Union Birds Directive. The Directive requires that the ‘most suitable territories in size and area’ are selected for rare, vulnerable and migratory birds. In 2000, the Joint Nature Conservation Committee (JNCC) began a programme of surveys in inshore waters around the UK. The objective was to identify the most important aggregations of seaduck Anatidae, divers (loons) Gaviidae, and grebes Podicepsidae. Distance sampling was used to estimate total numbers of birds present during aerial surveys, and their spatial extent was modelled using kriging and kernel density estimation. While guidelines exist for selection of the most suitable sites as SPAs, defining boundaries around bird aggregations in inshore waters has proved more problematic. This paper describes the techniques applied in determining the distribution patterns of these inshore seabirds and the eventual novel methods (maximum curvature) chosen for setting objective boundaries for MPAs. Some of the first sites to be proposed as marine SPAs for inshore seabirds in the UK are presented in this paper.”

Nadim M
C10-8 Fr 1140-1200 Oak Bay Room
Patrícia Amorim
Important areas for seabirds in Azores

“The Azores archipelago is located in the subtropical region of the Northeast Atlantic Ocean, with an Exclusive Economic Zone (EEZ) of approximately 1 million km². Cory’s shearwater (*Calonectris diomedea borealis*) is the most abundant species in this area (400.000 individuals). This is the largest population in the world and contains more than 75% of the borealis subspecies, while the Roseate Tern (*Sterna dougallii*) population is referred to as the largest in Europe. Other breeding species in the region are new endemic species Monteiro’s Storm Petrel (*Oceanodroma monteroi*) and other 5 species. Eleven Marine Important Bird Areas (IBAs) have been identified in the Azores EEZ, nine of which were



considered 'Seaward extensions of breeding colonies' and the remaining two were classified as 'Offshore foraging areas'. This work involved an intensive compilation of seabird data from marine surveys (ESAS and POPA methodology), individual tracking of seabirds (data-loggers with kernel analysis) and annual monitoring census data. Geostatistical modeling was performed to analyze the influence of environmental variables (e.g. sea surface temperature, chlorophyll-a, wind, productivity fronts, topographic aspects, distance to colonies) in the spatial structure of seabird sightings. Spatial analyses integrating all data sources followed a Marine IBA selection protocol, developed by the project LIFE-IBAs in Portugal, in agreement with the numerical criteria defined by Birdlife International."

Ivan Ramiréz; Pedro Galdes; Ana Meirinho; Vítor Paiva; Maria Magalhães; Joël Bried; Verónica Neves

C10-9 Fr 1200-1220 Oak Bay Room

Pep Arcos

Identification and designation of Marine Protected Areas regarding seabirds: Spain as a pioneering example

"Marine Protected Areas (MPAs) play a key role in the preservation of marine biodiversity, but have largely overlooked wide-ranging species such as seabirds. Under the BirdLife International Important Bird Area Programme (IBA) framework, SEO/BirdLife and SPEA took on the pioneering challenge of identifying the marine IBAs of Spain and Portugal, respectively, by means of two sister EU-Life Projects (2004-2009). The reasons for this initiative were: (1) the increasing level of threat that faces the marine environment, including seabirds; (2) the availability of new technologies and logistical facilities that allow to get reliable information on seabird distribution patterns at sea (mostly remote tracking, boat surveys and modelling tools); and (3) the EU political willingness of extending the Natura 2000 network to the marine environment. Both projects successfully attained their objectives. In Spain, the marine IBA inventory consists of 42 sites (42.883 km²), including coastal and offshore areas well distributed within the Spanish marine territory. The Spanish authorities have started the designation of the marine Special Protection Areas (SPAs, the bird component of Natura 2000) based on the marine IBA inventory, a process that will likely finish in 2010. Additional work is required to develop adequate management plans that ensure the preservation of the SPAs values, a task already started by SEO/BirdLife through two EC-funded new projects, Life INDEMARES and Interreg FAME."

Asunción Ruiz; Juan Carlos; Juan Bècares; Beneharo Rodríguez

C10-10Fr 1220-1240 Oak Bay Room

Kathy Kuletz

Using broadscale distributions of murre, kittiwakes, and their prey on the Bering Sea Shelf to inform decisions on MPA's

"Ecosystem management and designation of marine protected areas (MPAs) require an understanding of predator-prey dynamics at a broad scale. In Alaska, the Bering Sea outer shelf and slope is a 'hotspot' for seabirds and fish. Here, we examined distributions of surface-feeding Black-legged Kittiwake (*Rissa tridactyla*) and pursuit-diving Thick-billed Murre (*Uria lomvia*) in relation to two key prey, age-1 Walleye Pollock (*Theragra chalcogramma*) and euphausiids. We conducted concurrent surveys of birds and prey from 66-m vessels, following a systematic shelf-wide grid (covering 411,494 km²) in June and July of 2007-2009. Strip-transect coverage for seabirds was ~9,000 km/year, and acoustic sampling of prey was ~15,000 km/year. Both bird species showed colony effects, with high densities <300 km of St. Matthew and the Pribilof islands. Kittiwakes were more dispersed with greater inter-annual variability in distribution than murre. Murre densities were consistently highest between the Pribilof Islands and the underwater Pribilof Canyon. Though non-significant, murre distribution matched best with euphausiids while the kittiwake's matched best with pollock. Unlike murre, the variation in kittiwake distribution suggests they were sensitive to shifts in pollock distribution, which will make it difficult to define MPAs; possibly the case for all wide-ranging, aerial foragers. The distribution of juvenile pollock and euphausiids may be too unpredictable to assist in structuring MPAs for seabirds on the shelf. Rather, habitat features (i.e., Pribilof Canyon) can be identified, and thereby focus management actions."

Patrick Ressler; Elizabeth Labunski; Mike Sigler; Martin Renner; Anne Hollowed

C10-11Fr 1400-1420 Oak Bay Room

James Lovvorn

Linking habitat dependence and oceanography to model protected areas for wintering eiders in the Bering Sea

"The world population of Spectacled Eiders winters in pack ice of the Bering Sea. Assessing this species' habitat needs requires identifying thresholds of needed resources, and long-term shifts in the resource mosaic that suggest future variability. We linked data on benthic prey, sea ice, and weather from 1970-2001 with a spatial simulation model of eider energy balance that integrated field, laboratory, and remote sensing studies. Areas estimated to have adequate prey in 1970-1974 did not include most areas that were viable 20 years later (1993-1994). The area with adequate prey in



1993–1994 was greatly reduced by 1999–2001. These patterns suggest decadal changes in wind-driven currents that redistribute settled organic matter and associated benthos. During long non-foraging periods (as at night), eiders can save much energy by resting on ice versus floating on water; thus, loss of ice cover might decrease the area in which prey densities are adequate to meet the eiders' energy needs. Changes in key benthic species from almost complete absence to superabundance at the same locations suggest the importance of refugia to recolonization. Thus, resilience of these food webs to perturbation may depend strongly on spatial heterogeneity that maintains sources of dispersing recruits and opportunities for settlement. Considering such spatiotemporal effects, and the physical and biotic factors that maintain heterogeneity, may be critical to delineating adequate areas for protection.”

James R; Jacqueline M; Lee W

C11-1 Fr 1440-1500 Oak Bay Room

Lynda Chambers

Climate change and seabirds: recent findings from the Australian Region

“Climatic variation and change influence Australian seabirds through changes in distribution and breeding success, southward range movement and altered phenologies. The more-strongly affected species share many characteristics: tropical-nesting, generally larger breeding populations, predominantly pelagic foraging, synchronous breeders with young fed at relatively long intervals, long pre-fledging periods and slow overall growth rates, increasing their sensitivity to ENSO-related fluctuations in food availability. Many Australian seabirds have only limited information on prey distributions and biology, foraging and movement patterns, and their ability to alter prey species or life-cycle timing, making generalisations about climatic impacts and adaptive capacity difficult. Southward-expansion of breeding colonies will be limited by available nesting and foraging habitats and prey. Sea level rise is likely to reduce existing breeding habitat, particularly for burrow and surface-nesting species on sandy coasts and low-lying islands. Increased fire frequency and severity may severely impact some colonial seabirds and higher temperatures increase heat-related mortality. In many cases, localised assessments of resilience or adaptive capacity may be required. Adaptation options include managing breeding habitats to increase resilience to climate change, reducing non-climatic threats to improve the likelihood of autonomous adaptation and reducing anthropogenic resource competition. Research and monitoring of key species is required, including determining which species and systems are vulnerable to climate change, where generalisations about impacts and adaptation can be made, and which species are appropriate indicators of climatic impacts on higher trophic level predators.”

Bradley Congdon; Nic Dunlop; Peter Dann; Eric Woehler; Carol Devney

C11-2 Fr 1500-1520 Oak Bay Room

Sarah Burthe

Phenological changes across four trophic levels in a marine ecosystem: evidence of trophic mismatch in the North Sea

“Many seabird populations in the North Sea, UK have undergone declines that have been attributed to reduced availability of sandeels, their predominant prey during breeding. Sandeel declines have been linked to climate-related reductions in their copepod prey. One potential cause of changes in prey abundance may be trophic mismatch, whereby rates of phenology change differ between trophic levels leading to mismatch between the timing of prey availability and the period of demand by the predator. Here we compared the rates of change in seabird phenology with those of three lower trophic levels to identify whether mismatch is occurring. We used data between 1980 and 2007, a period when the North Sea shifted from a boreal to a warmer-temperate system, to compare trends using standardized linear regressions. We quantified first or median egg laying dates for five seabirds from the Isle of May, Scotland. The timing of peak primary production (diatoms) and primary consumption (copepods) were quantified using data from Continuous Plankton Recorder surveys. Sandeel hatch dates were estimated by modelling size-at-date data of larval sandeels. We found a diversity of phenological trends across the trophic levels. Kittiwake and guillemot laying became later, with no significant trends in the other three species. This contrasted with sandeels, which had hatch dates that became later until 1995 and then became earlier. In general, diatoms and copepods showed no significant trends in phenology. We therefore found evidence of mismatch across all four trophic levels in the North Sea and discuss whether this could be contributing to seabird declines in this area.”

Morten Frederiksen; Adam Butler; Martin Edwards; David Elston; David Johns; Stephen Thackeray; Sarah Wanless

C11-3 Fr 1540-1600 Oak Bay Room

Henrik Skov

Responses by non-breeding seabird populations to wide-ranging regime shifts in the Baltic Sea

“Over the past three decades, the Baltic Sea has undergone large-scale ecosystem changes as a result of climatic changes, eutrophication and overfishing. In an attempt to study the response of wintering seabird populations to these changes the SOWBAS project (Status of wintering Waterbird populations



in the Baltic Sea) with participants from all countries surrounding this regional sea undertook the first co-ordinated survey of the Baltic Sea for 15 years in 2007-2008. In addition to the surveys, which provided estimates of changes in distributions and total numbers between two survey periods trends were estimated using data from selected areas surveyed regularly over the past 30 years. Statistical analyses of integrated time series on seabird densities and climatic, physical oceanographic and biological conditions, including trends in food supply served to tease out linkages between trends in seabird distribution and potential key ecological drivers in the benthic and pelagic ecosystems of the Baltic Sea. The results show widespread distribution changes linked to climatic changes, and significant reductions in the total populations of several species in response to both eutrophication, climatic changes and other pressures. The paper discusses the spatio-temporal similarities and differences in the responses between species, ecotypes and habitats/areas.”

Ramunas Zydalis

C11-4 Fr 1600-1620 Oak Bay Room

Dariusz Jakubas

Response of Dovekie to climate-induced changes of marine conditions in the high Arctic

“As breeding ecology of seabirds is often influenced by fluctuations of oceanographic conditions, this group of animals is considered as sensitive indicators of changes in marine ecosystems. Dovekie (*Alle alle*) is planktivorous colonial seabird breeding in the high Arctic. This region is currently undergoing climate-induced changes in the sea currents ranges and zooplankton communities. To test how Dovekies breeding on Spitsbergen respond to those changes we studied chick diet composition and food provisioning in seasons and areas differing in predominance of water masses (cold Arctic vs. warm Atlantic). Dovekies, to cover their extremely high energetic demands, focus on energy-rich zooplankton associated with cold water, which due to climate changes, is replaced by less profitable counterparts carried by warm Atlantic current. Studies performed in seasons and areas differing in water temperature and zooplankton community demonstrated flexibility of Dovekie time and energy budget. Energetically less valuable food delivered to chicks in warmer years/areas were compensated by higher number of feeds. Parents also spent more time outside the colony. This indicates that Dovekies in warmer seasons/areas are forced to spend more time on searching for preferred food in suboptimal conditions and/or to fly to distant foraging grounds. The increased inflow of warm Atlantic water masses in the vicinity of Dovekie breeding colonies may affect them negatively by worse feeding efficiency and gradual decrease of breeding success. The southernmost LA populations in Greenland and Iceland have already collapsed after warming

period following the ‘Little Ice Age’.”

Katarzyna Wojczulanis-Jakubas; Lech Stempniewicz; Marta Gluchowska

C11-5 Fr 1620-1640 Oak Bay Room

George Divoky

From too cold to too hot in four decades: a short-lived thermal window closes for Black Guillemots in northern Alaska

“In northern Alaska, Black Guillemots (*Cepphus grylle*) have experienced rapid modifications in their nesting habitat with changes in annual snow and ice duration and extent. Warming temperatures allowed the species to colonize the region in the late 1960s, as the annual snow-free period began to exceed the 80 days needed for successful reproduction in ground-level cavities. During the 1970s and 1980s, the species thrived in the region as the summer snow-free period continued to increase and the arctic pack ice remained within the 40 km foraging range of breeding colonies, providing parent guillemots access to the favored prey, arctic cod, throughout the nestling period. Manmade nest sites were readily occupied and breeding success was high. However, at the end of the 1980s a change in the Arctic Oscillation further increased temperatures and the rate of retreat of summer pack ice. By the early 21st century guillemot nesting failures associated with a lack of arctic cod were starting to occur. Continuing retreat of summer ice increased numbers of a subarctic nest competitor, the Horned Puffin (*Fratercula corniculata*) and a nestling predator, the polar bear, reducing hatching and fledging success since 2002. In 2009 Horned Puffins and polar bears killed 90 percent of guillemot nestlings causing an almost complete nesting failure. Since the frequency and numbers of both puffins and polar bears will increase with the predicted decreases in summer ice extent, it is unlikely that Black Guillemots will be able to regularly breed successfully again in northern Alaska in the foreseeable future.”

C11-6 Fr 1640-1700 Oak Bay Room

Gary Borstad

Satellite observations of winds and ocean colour accurately hindcast inter-annual variability in seabird productivity at Triangle Island

“We have used observations of oceanic winds and satellite ocean colour to accurately hindcast the timing and success of breeding by rhinoceros auklets (*Cerorhinca monocerata*) at the largest seabird colony on the British Columbia coast. Elevated chlorophyll concentration is a robust indicator of a more productive ecosystem at many trophic levels. Around the Triangle Island seabird colony, it marks water masses with abundant food for both adult and juvenile auklets, and



especially for egg-laying females. The timing of the bloom is controlled by the alongshore wind regime in Queen Charlotte Sound in April, which in turn is a result of large-scale atmospheric conditions. A very close relationship between breeding success and spring chlorophyll concentration up to the time of egg laying suggests a powerful oceanographic bottom-up effect on breeding success mediated through links to zooplankton and the survival and growth of the birds' most important prey, 0-class sandlance. When the spring bloom of phytoplankton occurs early in April, the diet of the auklet chicks contains a larger fraction of high caloric juvenile sandlance which, in turn, are eating phytoplankton and herbivorous zooplankton in the first month or two of their life. The chicks grow larger and more of them successfully fledge. A correlation between spring surface chlorophyll concentration and the % adult sandlance in the chick's diet the following year, suggests that chlorophyll also controls recruitment of the sandlance."

William Crawford; Richard Thomson; Mark Hipfner

C12-1 Sa 0900-0920 Salon C

Birgit Braune

Effect of climate change on diet and contaminant exposure in seabirds breeding in northern Hudson Bay

"Warming ocean conditions and longer ice-free periods have been documented for Hudson Bay over the last 25 years. Studies have shown that there has been a shift in the diet of thick-billed murres breeding on Coats Island in northern Hudson Bay from arctic cod (*Boreogadus saida*) and benthic fish species to capelin (*Mallotus villosus*) and sandlance (*Ammodytes hexaptera*) over the period 1980-2002, a trend which has continued into more recent years. Using $\Delta 15N$ values as an index of trophic position, we have noted a decrease in trophic position as reflected in thick-billed murre eggs from Coats Island from 1998-2008 compared with 1993 values. Fish samples were collected in 2007 and 2008 from adult murres bringing food to their chicks on Coats Island, and those samples were analyzed for a suite of chemical contaminants to determine if exposure of thick-billed murres to contaminants through their diet on the breeding grounds has changed with the change in diet. The arctic cod fed to thick-billed murre chicks occupy a higher trophic position and have higher concentrations of total mercury and other contaminants in them than either the capelin or sandlance. The change in diet suggests that there may have been a shift to a lower exposure to contaminants through diet. However, the effects of the change of prey to the nutritional/energetic value of the diet still needs to be investigated."

Tony Gaston; Magaly Chambellant; Kyle Elliott; Jennifer Provencher

C12-2 Sa 0920-0940 Salon C

Alejandro Gatto

Trophic resource partitioning among terns in different species coexisting contexts: an integrated classical and isotopic niche approach

"The trophic ecology of South American (*Sterna hirundinacea*), Cayenne (*Thalasseus sandvicensis eurygnathus*) and Royal (*Thalasseus maximus*) terns was evaluated at the colonies of Punta Leòn (43°S) and Punta Loma (42°S), Patagonia, Argentina. Cayenne terns bred with the larger Royal terns in the former and with the smaller South American terns in the latter. The diet and use of marine areas were evaluated by means of prey delivery observation, radiotelemetry and stable isotope analysis. Data were then compared and integrated to evaluate the potential differences in their use of trophic resources. At each colony, the larger tern species showed a higher prey specialization, included a larger proportion of the prey with higher energetic content (*Engraulis anchoita*), and showed a higher trophic level than the smaller one. The larger tern species in both colonies preyed upon larger fish than the smaller one. Telemetry data suggest that tern species have a similar use of foraging areas, but differ in their temporal foraging patterns. Royal and Cayenne terns at Punta Leòn showed higher amplitude in the isotopic niche in relation to the trophic level of their prey, but a relatively low amplitude in the use of the marine space. In contrast, Cayenne and South American terns at Punta Loma showed higher amplitude in the use of the marine space and relatively low amplitude in relation to prey trophic level. Results suggest that tern species differ in their trophic resource utilization, and that differences are dependent on the combination of coexisting tern species."

Pablo Yorio

C12-3 Sa 0940-1000 Salon C

Larisa Lee Cruz

Intraspecific competition and sexual segregation in the Galapagos Blue-footed Booby evaluated through stable-isotope analysis

"Competition for food occurs within species, but it can be reduced or prevented by foraging segregation (i. e. individuals feed in different grounds or at different times), which has been associated to sexual size dimorphism in some seabirds. Blue-footed boobies present a marked reversed sexual size dimorphism and foraging segregation has been documented in some colonies, but not in the Galapagos Islands. The Galapagos Islands, due to their location, have marine regions with diverse oceanic productivity, presumably creating different feeding conditions for seabird colonies within the Archipelago. Here we studied diet of blue-footed boobies breeding at two sites, with presumably different feeding



conditions, in the Galapagos Islands. We analysed $\Delta^{13}\text{C}$ and $\Delta^{15}\text{N}$ from adult and chick feathers to look at difference in diet between colonies, between the breeding and non-breeding period, and between sexes during the non-breeding period. In one site we also analysed stable isotopes from chick blood to look at foraging specialisation during the chick-rearing period. We found differences between colonies during the breeding and non-breeding period; sexual segregation was present only in one colony, and no foraging specialisation was apparent from stable isotope ratios data. We conclude that different feeding conditions between colonies determine at some degree intraspecific competition and foraging sexual segregation in blue-footed boobies in the Galapagos, and that this can have consequences on reproductive success and population numbers.”

Rona McGill; Keith Hamer

C12-4 Sa 1000-1020 Salon C

Ann Edwards

Variable foraging strategies of Laysan Albatross in relation to ecosystem change and fisheries overlap

“Stable isotope data indicate that a fundamental shift in foraging dynamics has occurred among Laysan Albatross (*Phoebastria immutabilis*) over the last 100 years. Discards from offshore fishing operations have introduced a novel food source, further contributing to long-term shifts in foraging dynamics. What are the limits of foraging flexibility in light of ecosystem change, and how do foraging limits and requirements affect overlap with fisheries? We used $\Delta^{15}\text{N}$ values from targeted primary feathers (grown May – Oct) as indices of foraging strategy. Two patterns emerged. The ‘recovery and maintenance period’ following the end of the breeding season (approximately May – July) was marked by a great diversity of foraging strategies, both historically ($\Delta^{15}\text{N}$ range: 8-18‰) and recently (11-19‰). The absence of low values today (33% of historic values were below today’s observed values) suggests resiliency to the loss of foraging opportunities during this flexible May-July foraging period. Isotope values of fisheries-associated birds in Alaska were distinct from other birds during this flexible season, but not at other times, suggesting season-specific flexibility facilitates overlap with distant fisheries. In contrast, the ‘preparation period’, or the period prior to arrival at the breeding colony (approximately Aug – Oct), was more conservative for all birds, marked by foraging strategies that were less variable, with current mean values indistinguishable from historical values. Consequently, the more conservative foraging requirements of Laysan Albatross prior to breeding may limit their ability to adapt to ecosystem change, but also may reduce their potentially fatal overlap with Alaskan fisheries.”

Shannon Fitzgerald; Julia Parrish

C12-5 Sa 1020-1040 Salon C

Nick Hatch

Seasonal differences in the diet of Kittlitz’s Murrelets, a seabird of conservation concern, as inferred from stable isotope analysis

“Prey resources for apex marine predators, such as seabirds, are highly variable in space and time, which can result in poor foraging conditions either spatially or temporally. Seabirds are capable of foraging at multiple trophic levels and can adapt their foraging strategies by switching to more abundant prey or by shifting foraging location to capitalize on prey aggregations. We used stable isotope analysis to assess seasonal variability in the foraging ecology of Kittlitz’s Murrelets (*Brachyramphus brevirostris*), a non-colonial alcid endemic to coastal Alaska and eastern Russia. To test the hypothesis that diet varies across the annual cycle, we measured $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in feathers and whole blood from 131 Kittlitz’s Murrelets in southeast Alaska, 2007-2009. From each bird, we collected two feather types, one grown in September and the other in April, and whole blood from two stages, early and late, of the breeding season. We found that $\delta^{15}\text{N}$ nitrogen signatures progressively increased by 5‰ between spring and fall, equivalent to an increase of 1.5 trophic levels for assimilated prey, whereas $\delta^{13}\text{C}$ remained relatively constant. These results suggest that the pre-breeding diet was comprised primarily of low trophic level prey, such as macrozooplankton and/or larval fish. During the breeding season, murrelets gradually switched to consuming higher proportions of planktivorous fish. The post-breeding diet was comprised almost exclusively of higher trophic level prey, presumably fish. Understanding the role of seasonal foraging plasticity, particularly outside the breeding season, is vitally important to the management and conservation of many sensitive marine species, including Kittlitz’s murrelet.”

Michelle Kissling; Daniel Roby

C12-6 Sa 1100-1120 Salon C

Michael Polito

Stable isotopes reveal regional variation in the pre-breeding diets and foraging habitats of sympatrically breeding Pygoscelis penguins in the Antarctic Peninsula

“While the foraging ecology of the Adélie penguin (*Pygoscelis adeliae*) and Gentoo penguin (*P. papua*) has been well studied, little is known about the diets and foraging areas of these species outside of the breeding season. In this study we used stable isotope analysis of eggshells to examine the pre-breeding diets and foraging habitats of female Adélie and Gentoo penguins from 21 breeding locations along the Eastern and Western Antarctic Peninsula (AP), South Shetland and South Orkney Islands in 2006. Eggshell carbon (^{13}C) and



nitrogen (^{15}N) isotopic values differed between species, with Gentoo penguins exhibiting significantly higher isotopic values than Adèlie penguins. These results indicate that Gentoo penguins feed at more inshore, benthic habitats and consume a higher percentage of fish during the pre-breeding period than Adèlie penguins, similar to differences observed during the chick-rearing period. While little spatial variation in Gentoo penguin eggshell isotopic values were observed, the isotopic values of Adèlie penguin eggshell varied across the four breeding regions examined. Adèlie penguin eggshells from the Eastern AP, South Shetland and South Orkney Islands shared similar isotopic signatures and were significantly lower in both ^{13}C and ^{15}N values than eggshells from birds breeding along the Western AP. Our findings suggest that Adèlie penguin populations that are geographically separated during the breeding season to the north and south of the Adèlie Gap, a 400 km region along the Western AP devoid of breeding Adèlie penguins, also inhabit geographically distinct habitats prior to the breeding season.”

Heather Lynch; Ron Naveen; Steven Emslie

C12-7 Sa 1120-1140 Salon C

Maelle Connan

Diet of Sooty and Light-mantled albatrosses breeding in the Prince Edward Islands: a multiple-indicator approach

“Understanding the foraging ecology of seabirds has been hampered by sampling difficulties, but has been revolutionized by the development of techniques such as stable isotope and lipid analyses. We used these, combined with traditional approaches, to examine resource partitioning between two closely related Southern Ocean albatross species. The breeding ranges of the endangered Sooty *Phoebastria fusca* (SA) and near-threatened Light-mantled *P. palpebrata* (LMSA) albatrosses, are largely exclusive latitudinally, with the exception of the Prince Edward Islands and the Crozet Archipelago (South Indian Ocean) where they breed in close proximity to one another. We examined resource partitioning between them during both the breeding season and the moulting period, working on Marion Island in April and May 2009. Stomach content, blood and feather samples were collected from adults and chicks from both species (38 SA and 26 LMSA). Three complementary techniques were used to investigate their diet at different time scales: conventional food analysis (last meal information), fatty acids of stomach oils as trophic markers (last foraging trip information), stable isotope ratios of carbon and nitrogen as indicators of the foraging areas and trophic levels respectively (adult and chick blood: breeding season information; adult feathers: moulting period information). Initial results from stable isotope analyses suggest that SA foraged in warmer waters than LMSA during the breeding and the moulting periods. Adult LMSA feather signatures show high inter-individual

variability with an extreme Antarctic signature, suggesting a diet of Antarctic krill in Antarctic waters.”

Christopher McQuaid; Bo Bonnevie

C12-8 Sa 1140-1200 Salon C

Renata Medeiros

An ecologist’s worse nightmare: using molecular tools to study the diet of small seabirds

“Almost nothing is known about the diet of storm petrels and other seabirds during their long-distance migrations, because of the difficulty of catching birds on passage, and of obtaining food samples. Here we describe large between-year fluctuations in the level of body reserves carried by the smallest Atlantic seabird, the European Storm Petrel (*Hydrobates pelagicus*), during their northward migration past the coast of SW Portugal. The pattern of body mass variation over the 21-year study period (1990-2010) follows a smooth oscillation, which is not an artefact of differences between years in the distribution of capture effort, body size, sex ratio changes, etc. Multivariate analyses reveal sea surface temperature (SST) and net primary production (NPP) along the migration route to be key factors associated with between-year changes in storm petrel body reserves. However the nature of these relationships varies according to the birds annual cycle. Our current research includes the use of molecular techniques to determine the diet of storm petrels during these long distance migrations, in order to understand these relationships in more detail. Very few studies report the use of molecular techniques to study birds’ diet. However, these can provide unique data based on DNA detection of prey items in faecal samples, collected noninvasively. Based on these results we are able to hypothesize on how these birds will respond to different scenarios of possible changes in climate.”

William Symondson; Jaime Ramos; R. Andrew King; Mark Bolton; Rob Thomas

C12-9 Sa 1200-1220 Salon C

Ine Dorresteijn

Foraging ecology of planktivorous least auklets indicates regulation of zooplankton availability by physical processes in the Pribilof Domain

“The Bering Sea ecosystem is sensitive to inter-annual and seasonal climate variability which may differ within and between oceanographic domains. We examined how climate variability affects foraging ecology of planktivorous least auklets (*Aethia pusilla*; LEAU) breeding in different regions of the Pribilof Domain. We compared inter-annual and seasonal dynamics in diet composition (as reflected in species



composition of chick meals and stable isotope values of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in red blood cells of adults) and food availability (as reflected in titers of corticosterone in plasma of breeding birds) between LEAUs breeding at St. George (shelf-break region; SG) and St. Paul (shelf region; SP) during the relatively 'warm' seasons of 2003-05 and the 'cold' seasons of 2008-09. The diet compositions differed between birds breeding on SP and SG reflecting a colony's location relative to the shelf-break. These differences were most pronounced during warm years, when large calanoid copepods disappeared from the diet of LEAUs breeding on SP but remained in the diet of LEAUs breeding on SG. At the same time, inter-annual and seasonal dynamics of stable isotopes signatures and food availability were in parallel between LEAUs breeding on SP and SG. Obtained results suggest that although compositions of zooplankton communities differ between different regions of the Pribilof Domain 1) LEAU breeding on SP and SG respond to climate variability in tandem, and 2) inter-annual and seasonal changes in food availability to planktivorous predators are likely driven by a physical oceanographic mechanism(s) operating at the scale of the entire domain."

Vernon Byrd; Alexander Kitaysky

C12-10Sa 1220-1240 Salon C

Leslie Slater

When the Menu is Just a Starting Point: Chick Response to Variable Diet Resources

"As interests in the effects of climate change increase, the value of baseline data on patterns of ecosystem change is being increasingly recognized. Changes in marine food webs are of high interest in this regard. Saint Lazaria Island is one of eight annual monitoring study sites on the Alaska Maritime National Wildlife Refuge and is the site nearest the origins of the Alaskan Current, a system in which productivity diminishes as it flows northward and enters a downwelling domain. We studied chick growth rates and productivity of rhinoceros auklets (*Cerorhinca monocerata*) nesting there between 1995-2009. Concurrently, we collected data on prey delivered by adults to young, focusing on species composition and size parameters (mass and length) of individual fish. We noted a substantial change in prey species composition during the period. Sand lance nearly disappeared from samples (particularly since 2005) and there were considerable swings in capelin and Pacific herring occurrence. We present findings on chick growth and reproductive success as a result of the effects of diet change over time."

Vernon Byrd

C12-11Sa 1400-1420 Salon C

Alexander Bond

Aleutian auklets, climate, and copepods: investigating the relationship between ocean climate and chick diet over two decades

"Growing evidence links both broad-scale and local oceanography to the demography of top predators in the marine environment. We have shown that such factors correlate with both the reproductive success and annual adult survival of Crested (*Aethia cristatella*), Least (*A. pusilla*), and Whiskered Auklets (*A. pygmaea*), three species of planktivorous seabirds breeding at three widely separated colonies in the Aleutian Islands, Alaska over a 20-year period. Based on the patterns of covariation observed, we postulated that climate-driven change in the abundance or availability of prey was the primary causal factor. Here, we tested this explanation by quantifying variation in contents of auklet nestling diet, and dietary overlap across species. We analyzed 2561 auklet chick meals collected at Buldir, Kiska, and Kasatochi Islands, Aleutian Islands, Alaska during 1994-2006, and examined the relationships among species and islands, as well as with indices of large-scale climate in the North Pacific Ocean from. Overall, we found that Whiskered Auklet diet seems unrelated to climate indices, but the biomass of both euphausiids and Neocalanus copepods in Least and Crested Auklet chick meals was correlate with indices of climate variation in the North Pacific Ocean."

Ian Jones; William Sydeman; Shoshiro Minobe; Jeffrey Williams; Vernon Byrd; Heather Major

C12-12Sa 1420-1440 Salon C

Michael Schrimpf

The influence of bottom-up physical forcing on the provisioning of alcid chicks

"In eastern boundary current systems, food web productivity is driven by marine physical forcing. Here we examine whether interannual oceanographic forcing signals can be detected in the diet of a breeding seabird by studying the chick provisioning of common murre (*Uria aalge*) on Tatoosh Island, Washington, United States. Murre provisioning was observed from blinds in one-hour watches from 1996 through 2009. Many studies of alcid diet have focused on prey species composition, but, in the interest of finding a currency meaningful to chicks, we use the rate of energy return, and its constitutive factors: (1) meal return rate and (2) average energy per meal, to analyze changes in diet. A multivariate analysis, incorporating multiple indices that describe oceanographic and climatic variability at a range of spatial and temporal scales, shows that diet strongly responds to physical forcing only in certain years, with the largest responses in years with the most extreme oceanographic conditions. Meal return rate and average energy per meal



relate best to different oceanographic variables, and are thus to some degree independent. Furthermore, changes in energy return rate do not necessarily reflect shifts in prey species composition. Finally, we document evidence that adult murrens constrain their energy delivery by returning smaller fish to very young chicks. Therefore, we conclude that bottom-up forcing may influence alcid chick provisioning in particularly good or bad years, but that adult foraging choices can also play an important role in determining the ultimate energy delivery to chicks.”

Julia Parrish

C13-1 Sa 0900-0920 Saanich Room

Yasuko Suzuki

Bonanza or scourge? Metapopulation dynamics of Caspian Terns in the Pacific Coast Region of North America

“The largest known breeding colony of Caspian Terns (*Hydroprogne caspia*) in the world, located at East Sand Island (ESI) in the Columbia River estuary, has raised concerns over the impact of avian predation on juvenile salmonids from threatened and endangered populations that migrate through this estuary. To inform current management initiatives for Caspian Terns, we investigated parameters of this metapopulation by color-banding adults and chicks at 9 breeding colonies during 2001-2008 and re-sighting throughout the Pacific Coast Region during 2002-2009. Natal philopatry of terns banded as chicks was > 80% at the core colony on ESI, compared to 50-70% at smaller satellite colonies. Less than 5% of individuals banded as adults at the core colony and re-sighted at least once since then were re-sighted at satellite colonies, whereas > 10% of individuals banded as adults at satellite colonies were re-sighted at different colonies. Although philopatry and site fidelity were higher at the core colony than at satellite colonies, emigrants from the core colony to satellite colonies were key for persistence or growth of satellite colonies because the core colony was > 10 times larger than the satellite colonies. The greatest dispersal distance from the core colony was by a breeding adult to a newly-established colony in Alaska, > 2,000 km. These results suggest that the large core colony at ESI is key to the overall dynamics for the metapopulation of Caspian Terns in the Pacific Coast Region of North America.”

Daniel Roby; Donald Lyons; Robert Suryan; Ken Collis

C13-2 Sa 0920-0940 Saanich Room

Emily Barlow

Quantifying dispersal rate, distance and direction over a large spatial scale in the European Shag (*Phalacrocorax aristotelis* (L.))

“Natal dispersal, defined as dispersal from natal to breeding location, is a fundamental but poorly understood process in ecology. In order to interpret population dynamics and predict future change, comprehensive studies of natal dispersal in natural populations are needed. The study area must be sufficiently large to cover the full potential range of dispersal, detection probabilities should be high, and the proportion of individuals that remain undetected should be estimated. Accordingly, we quantified the rate, distance and direction of natal dispersal in a North Sea population of European shags (*Phalacrocorax aristotelis*), a region experiencing rapid environmental change. Upper and lower limits to natal dispersal rate were determined by estimating detection probability based upon resightings of marked individuals on both breeding and wintering grounds across a large spatial scale. The estimated natal dispersal rate was as 10-15%. The maximum distance surveyed from the natal colony to potential breeding location was 2.5 times greater than the maximum dispersal distance observed. Fewer dispersed individuals were observed at colonies closer to the natal colony than would be expected by chance and greater dispersal distances were observed to the north than the south. These data show that natal dispersal occurred at a relatively low rate and settlement occurred non-randomly and was bidirectional. In addition we demonstrate field methodology for estimating detection rate based upon winter resightings of individuals not located at breeding colonies, which will improve the accuracy of estimates of dispersal rate.”

Jane Reid; Francis Daunt; Stephen Cavers; Sarah Wanless

C13-3 Sa 0940-1000 Saanich Room

Derek Lee

Impacts of climate variability on Cassin’s Auklet (*Ptychoramphus aleuticus*) in Central California

“We assessed impacts of climate variability on planktivorous Cassin’s Auklets (*Ptychoramphus aleuticus*) breeding at Southeast Farallon Island, California from 1981-2009. We tested the hypothesis that major oceanographic perturbations (e.g., El Niño) have strong negative effects on survival, breeding propensity, and recruitment. We tested this hypothesis by estimating age- and year-specific vital rates using multi-state capture-recapture models to provide estimates of age-dependent probabilistic recruitment (transition from non-breeder to breeder state), survival, and breeding propensity. Model selection of age functions indicated that a cubic function best characterized recruitment



probability. Age-dependent survival from fledging to 15 years was best modeled as a quadratic function of age, which is evidence of actuarial senescence. Age-dependent breeding propensity was best modeled as an inverse 'plateauing' age function, but a constant (null) model was equivalent. Breeding propensity was reduced only during strong El Niño events and during anomalous ocean circulation conditions observed in 2005. Annual survival showed similar trends, with slightly more inter-annual variation. Recruitment was the lowest in 2006 and no strong recruitment effects were observed during El Niño years. Winter Southern Oscillation Index (SOI) was positively correlated with breeding propensity and survival for the next breeding season. This study highlights the need for detailed demographic data to fully understand population level effects of climate variability on wildlife populations. This information will help prioritize management actions to mitigate the effects of future climate change on species of conservation concern."

Russell Bradley; Pete Warzybok; Jaime Jahncke

C13-4 Sa 1000-1020 Saanich Room

Kyle Morrison

Demographic consequences of extreme climate events for three North Pacific seabird species

"Climate change is predicted to increase the severity and frequency of extreme climate events, raising concern over how animal populations will respond. Why climate variation impacts adult survival rate of some seabird species, but not others, remains poorly understood. Recent hypotheses predict that climate variation will have stronger effects on the survival rates of seabirds that feed at a low trophic level, have small body size, and a short lifespan. To test this, we compared adult survival rates of three Pacific auks: Cassin's Auklet (*Ptychoramphus aleuticus*), Rhinoceros Auklet (*Cerorhinca monocerata*) and Tufted Puffin (*Fratercula cirrhata*) on Triangle Island, British Columbia. Our 15 year study (1994-2008) included extreme climate events in 1997-1998 (El Niño) and 2005 (atmospheric blocking event). Adult survival of female Cassin's Auklets, a small-bodied zooplanktivorous species, was halved during both extreme climate events, from a background rate of 0.84 ± 0.05 (95% CI) to 0.44 ± 0.10 , whereas survival of males was constant, but lower (0.75 ± 0.03). Extreme climate events had no effect on adult survival in medium-sized Rhinoceros Auklets (0.86 ± 0.02 in both sexes) or large Tufted Puffins (0.96 ± 0.05 in females, and 0.91 ± 0.06 in males), both of which tend to feed at a higher trophic level than Cassin's Auklets. In general, our results support the idea that responsiveness of adult survival to climate extremes varies with life-history traits, including trophic level and body size. However, why effects were seen on female but not male Cassin's Auklet is unknown."

Mark Hipfner; Gwylim Blackburn; David Green

C13-6 Sa 1100-1120 Saanich Room

Celine Le Bohec

Modelling demography and extinction risk in the King Penguin under climate-warming scenarios

"Predicting the impact of climate changes on populations and biodiversity is of key issue today. It is crucial to understand how organisms cope with climatic variation, especially in polar systems where the effects of climate change are strongest. However, the climate forcing on population dynamics might depend on population composition, as environmental changes may affect various subsets within a population differently. The first step is to understand which fitness components and groups are the most sensitive to changes. Several demographic parameters of King penguins monitored in the Crozet Archipelago from 1999 to 2008 were used to model the viability of the population. Using age-structured matrices, we found that population growth rate λ remained stable during our studied period despite a continuous slight decrease (λ between 0.1197 in 1999 and -0.0085 in 2007). The elasticity analysis of λ to changes in the demographic parameters showed that λ was mainly sensitive to adult survival (37%) and early ages' (between 2 and 5 year-old, or from their first trip to sea to their first breeding attempt; 30%) survival. Population growth rate was positively affected by annual chlorophyll concentrations centred on Crozet and annual Southern Oscillation Index with a 1 to 2 year lag. Under the IPCC forecast scenario for global warming, extinction of this king penguin population was predicted in about 120 years."

Joël Durant; Philippe Sabarros; Nils Stenseth; Claire Saraux; Michel Gauthier-Clerc; Roger Pradel; David Beaune; Dag Hjermann; Yvon Le Maho

C13-7 Sa 1120-1140 Saanich Room

Louise Emmerson

Adèlie penguin survival: age structure, temporal variability and the influence of the marine ice environment

"Adèlie penguin survival is influenced by a variety of processes operating at different spatial and temporal scales. For example, previous research shows that penguin survival is related to the marine ice environment through the indirect effect that ice has on their access to food. During the winter months, extreme northward sea-ice extent and minimal sea-ice extent are thought to negatively affect their ability to reach optimal winter foraging grounds for some populations. Penguin survival can also be related to their condition during the previous breeding season, predation and their success at breeding, and there is evidence that survival varies with penguin age with the younger penguins being more susceptible. In this talk we present results in which we examine survival of the Bèchervaise Island Adèlie penguin



population in relation to a range of direct factors and mediating influences including population parameters which indicate the condition of the breeding season immediately prior winter as well as variables of the marine ice environment at various times during the winter months. Our analyses show a clear indication that survival is linked with the sea-ice environment in their presumed winter foraging grounds but that the relationship and importance of the physical marine environment varies according to penguin age.”

Colin Southwell

C13-8 Sa 1140-1200 Saanich Room

Matthieu Fortin

Variation in demographic parameters in the European Shag *Phalacrocorax aristotelis* in Brittany, France

“There is an increasing need to develop reliable indicators of the ecological state of marine environments to support ecosystem-based management of living resources. Seabirds may be useful in this process, and particularly demographic parameters which may be sensitive to variation in food supply. We provide multisite estimates of survival, fecundity, and abundance of European shags studied in Brittany since 1987 by capture-mark-recapture. The number of breeding pairs was highly variable from year to year from 370 ± 34 to 780 ± 51 with a mean of $\sim 565 \pm 250$. The annual population growth rate for the period 1987-2009 was estimated at 1.011 ± 0.004 . The number of breeding pairs was negatively related to the sea surface temperature and sea surface height anomalies in winter and spring around the breeding islands ($R \leq$ from 0.31 to 0.48). Adult, first year and second year survival probabilities were respectively 0.812 ± 0.034 , 0.438 ± 0.040 , and 0.760 ± 0.073 . In addition to age effects on survival parameters, strong cohort and island effects were detected using an information theoretic model selection approach. Average breeding success was 1.00 ± 0.47 , but also varied importantly between years and islands. This suggests that local and regional environmental factors affect several demographic parameters of the shag in Brittany. Identifying these environmental factors will help developing indicators based on shag demographic data.”

Christophe Barbraud

C13-9 Sa 1200-1220 Saanich Room

Eric VanderWerf

Estimating survival and life stage transitions in a long-lived seabird, the Laysan Albatross, using multi-state mark-recapture models

“We used monitoring data from a Laysan Albatross colony at

Kaena Point, Oahu from 2003-2010 to illustrate how multi-state mark-recapture models can be used to estimate annual survival and life stage transitions in long-lived seabirds. We grouped birds by sex and employed five states to represent pre-breeders, breeders, failed breeders, observed skipped breeders, and unobserved skipped breeders. Survival was higher in pre-breeders (0.988 ± 0.017) than breeders (0.969 ± 0.013), suggesting there was a cost to reproduction, and lowest in skipped breeders (0.920 ± 0.054), suggesting skipped breeders were energetically stressed. Survival of males was 2-3% lower than survival of females in all states, and causes of higher male mortality warrant further investigation. Successful breeders were more likely to skip the next breeding season (0.22 ± 0.05) than were failed breeders (0.14 ± 0.05). Pre-breeding females were more likely to become breeders (0.29 ± 0.04) than were pre-breeding males (0.25 ± 0.04), due to the unusually high occurrence of female-female pairs in this colony. Increased monitoring effort resulted in substantial improvements in encounter probability of pre-breeders and skipped breeders and revealed that most skipped breeders still visited the colony occasionally. Models without a state for unobserved skipped breeders did not perform as well, underestimating encounter probability of breeders and rate of skipped breeding, and overestimating survival of breeders and skipped breeders. Laysan Albatross colonies on Oahu are small but easily accessible, allowing regular complete censuses of breeders and pre-breeders and unbiased estimation of parameters that are often difficult to measure, and this information may prove useful for understanding demography of larger colonies.”

Lindsay Young

C13-10Sa 1220-1240 Saanich Room

Christine Hunter

Estimating robust survival estimates for species that don't return to breeding colonies every year.

“Albatross and other large seabirds that remain at sea during skipped breeding seasons continue to present a challenge for the estimation of demographic rates such as survival and the construction of demographic models. When birds don't return to the breeding colony in a given year they are unavailable for capture, which introduces unobservable states into multi-state mark-recapture models. Multi-state models with unobservable states and no parameter constraints can have redundant parameters that cannot be estimated separately. We developed multi-state models for albatross that include unobservable post-breeding stages. We present results on tests of parameter estimability for these models with different types of time variation in parameters, e.g. constant, linear trend, or freely time varying, and constraints among parameters, e.g. survival probability equal for successful and post-successful breeders. We present survival and breeding probabilities for albatross



from Bird Island, South Georgia and evaluate hypotheses about the relationships among parameters and with environmental covariates. Breeding probabilities differ among states more than survival rates and were influenced more strongly by time variation. Further we present estimates of population growth, birth intervals and recruitment time and discuss the effects of survival changes on albatross birth intervals.”

Hal Caswell; Jaume Forcada

C13-11Sa 1400-1420 Saanich Room

Michelle Kissling

Multistate models for estimation of demographic parameters of a solitary nesting seabird, the Kittlitz's Murrelet

“Many seabirds are long-lived and highly mobile, and may delay breeding and/or breed intermittently. These life history traits create problems for monitoring population size, trend, and other demographic parameters, particularly for solitary nesting species. We developed multistate models to estimate survival, reproduction, and movements of a solitary nesting species, the Kittlitz's Murrelet (*Brachyramphus brevirostris*), using data from 122 radio-marked birds captured during the breeding season in Icy Bay, Alaska, 2006-2009. Multistate models allow birds to transition between ‘states’ to account for temporary emigration from the population. We estimated daily probabilities of five states: alive in the study area, alive out of the study area, alive at nest, dead in study area, and unknown fate. We relocated murrelets every 1-3 days from a fixed-wing aircraft and investigated mortalities and nests when possible. Kittlitz's Murrelets had a 0.14 probability of moving out of the study area each day and a similar probability of returning to the study area. They had approximately a 0.003 daily probability of moving to a nest site if they were not currently at a nest. The daily mortality rate for a Kittlitz's Murrelet in Icy Bay was 0.002, which is relatively high for a species that breeds infrequently. We use these daily probabilities to help inform demographic models and to estimate the super-population of Kittlitz's Murrelets using the Icy Bay area. These results are important for evaluating the influence of survival, reproduction, and movements on the observed declines in population estimates derived from at-sea surveys in Icy Bay.”

Paul Lukacs; Scott Gende; Stephen Lewis

C13-12Sa 1420-1440 Saanich Room

Dan Esler

The role of the non-breeding period in population dynamics of sea ducks: a peek inside the black box

“The vast majority of seabird studies focus on the breeding season, due in part to logistical difficulties of working during other annual cycle stages. However, biologists understand, at least conceptually, that events and conditions during non-breeding periods can have important influences on individual fitness and population dynamics. This is particularly true for seabirds, given that their life histories are generally predicated on assurance of high annual survival and most species spend the majority of their annual cycle away from breeding areas. Sea ducks are a tractable group of seabirds to study during the non-breeding period because of their nearshore occurrence, and here I synthesize studies by my research group that evaluate direct and indirect effects of events during moulting, staging, and wintering periods on sea duck condition and demography. This includes considerations of direct effects of foraging conditions, contaminants, and habitat choice on winter mortality for several species. Also, studies of moulting strategies of several species highlight the variety of solutions employed to maximize survival and energetic/nutritional status. Finally, I summarize staging and migration studies that illustrate potential cross-seasonal mechanisms by which conditions during non-breeding periods affect reproduction. This body of research provides generalities that are relevant for considering the importance of non-breeding periods for other seabird taxa.”

C14-1 Sa 0900-0920 Oak Bay Room

Nicholas Carlile

Establishment of a new, secure colony of the critically endangered Bermuda Petrel

“The Bermuda petrel *Pterodroma cahow* breeds only on four small islets in south-eastern Bermuda. Although intensive management of the population since 1960 has led to a substantial increase in population size (now approximately 85 pairs), the nesting habitat is being increasingly inundated, eroded and destroyed by high seas associated with hurricanes and other storm events. To aid the long-term conservation of the species an attempt was made to establish a new colony of Bermuda petrels at a more secure site on nearby Nonsuch Island. Between 2004 and 2008, a total of 104 near-fledged chicks were translocated to artificial burrows on Nonsuch Island, where they were hand-fed meals of fish and squid. All but three of the translocated chicks fledged successfully, having first emerged from their burrows up to 13 days earlier. Translocated birds were first recorded returning to Nonsuch Island in February 2008. Of the 15 birds so far recorded on



Nonsuch Island, nine were translocated there in 2005 and five in 2006. A single non-translocated bird, a fledgling from 2005, has paired with one of the translocated birds. The first egg was laid in January 2009, and the resultant fledgling departed the Island in June 2009, the first to do so in more than 300 years. The establishment of this new colony, at a site that is much more secure than existing nesting sites, demonstrates the importance of translocation as a tool for the conservation of threatened seabirds.”

David Priddel; Jeremy Madieros

C14-2 Sa 0920-0940 Oak Bay Room

Graeme Taylor

Saving the critically endangered Magenta Petrel from extinction

“Magenta petrels (*Pterodroma magentae*) were rediscovered in 1978 on the Chatham Islands (east of New Zealand) and only 17 breeding pairs are known in a world population of about 150 birds. This talk will review the innovative management required to avert extinction in this critically endangered seabird. Finding burrows involved capturing birds near the coast as they flew inland at night and tracking them to ground using radio telemetry. Ground searching using trained dogs and handlers has also been successful. The birds nest in dense rainforest 5 km from the coast, spread over 5000 ha of habitat. Burrows can be up to 5 m long and wooden nesting chambers have been installed at some sites to allow access to chicks. All burrows are protected from alien invasive species including feral cats, pigs and rats, by trapping programmes and poison bait grids. Since 2006, pit tags have been injected into most birds to monitor activity at known burrows. Information collected on 12-volt battery powered dataloggers charged by solar panels includes a roll call of annual survival and key breeding parameters. All birds handled since 1996 have had blood samples collected for DNA analysis of sex and genetic relationships. Male-biased recruitment and in-breeding depression are new problems. We have begun a ‘dating service’ by catching females near the coast to introduce to compatible unpaired males at burrows. A predator-proof fence funded by the community initiated Chatham Island Taiko Trust has enabled us to begin establishing a second secure breeding site and all 34 chicks reared since 2007 have been shifted to this site for fledging.”

C14-3 Sa 0940-1000 Oak Bay Room

Juan Martínez Gómez

The demographic dilemma of Townsend’s Shearwater

“The Townsend’s Shearwater (*Puffinus auricularis*) is a critically endangered species endemic to the Revillagigedo Archipelago. Previous population models used to forecast potential extinction times for the species under different

scenarios were based on matrix projections that assumed a geometric growth in all age or stage classes. However, this kind of models do not fully apply to Townsend’s Shearwater, and other seabirds, because of the nature of its breeding colony. This shearwater nests in areas that are confined to montane areas of Socorro Island and have a limited extension that imposes a density dependent limiting factor for the demographic growth of the first age class of the species. New models that incorporate this limitation yield population projections with accelerated potential extinction times. It becomes clear that the species is experiencing a severe population decline and demographic instability could happen any time soon if conservation actions are not applied immediately. The international seabird community must urge the Mexican government to implement effective conservation actions to prevent the extinction of this species.”

Ana Rodriguez-Muslera; Victor Rico-Gray

C14-4 Sa 1000-1020 Oak Bay Room

Erin Hagen

Threats to Pink-footed Shearwaters on their breeding colonies

“Pink-footed Shearwaters (*Puffinus creatopus*), a globally threatened species endemic to Chile, encounter distinct on-colony threats across their three known breeding islands, Santa Clara and Robinson Crusoe islands in the Juan Fernández Archipelago and Mocha Island. As part of a long-term study of the conservation status of the species, we investigated factors potentially limiting breeding populations. On all three breeding islands, we assessed burrow occupancy and reproductive success of shearwaters, documented predation rates, and quantified impacts by grazing animals. In the absence of introduced European rabbits (*Oryctolagus cuniculus*), burrow occupancy and reproductive success were consistent across colonies and islands. Predation rates by feral cats varied by colony on Robinson Crusoe Island, ranging from 1-4% for adult birds, whereas nestling mortality appeared to be negligible in most years. Predation by humans on Mocha Island has been estimated to historically account for the death of 20% of the island’s chicks annually. During the 2010 breeding season no predation on adult shearwaters was recorded on Mocha Island. Competition with introduced European rabbits reduced burrow occupancy by 40% across colonies on Robinson Crusoe and Santa Clara islands. Burrow destruction by cattle currently disturbs only one major colony on Robinson Crusoe Island; however, damage affected 48% of nesting burrows in that colony. These known on-colony threats are being mitigated through community conservation and education programs and active collaboration with CONAF, the Chilean Forestry Service.”

Michelle Wainstein; Amanda Gladics; Peter Hodum; Jessica Hardesty

**C14-5 Sa 1020-1040 Oak Bay Room****Judy Jacobs****Short-tailed Albatross recovery: results of chick translocation and rearing project**

“The short-tailed albatross (*Phoebastria albatrus*), was nearly exterminated by hunting prior to the twentieth century. Now protected, the breeding population has reached 500-550 pairs, nesting on two Japanese islands. One of these is not accessible for political reasons, and Torishima, the main breeding site, is an active volcano. The Short-Tailed Albatross (STAL) Recovery Plan requires additional STAL breeding colony establishment to achieve recovery. Our objective is to facilitate new colony formation by rearing STAL chicks on a new safe colony site, where they will hopefully return to breed. This project, a collaboration between U.S. Fish & Wildlife Service and Yamashina Institute for Ornithology, began in 2006, with translocation and rearing of ten post-guard stage Laysan albatross (*Phoebastria immutabilis*) chicks in Hawaii. Only four fledged, and methodologies were revised. In 2007, ten black-footed albatross (*Phoebastria nigripes*) chicks were moved to Mukojima, a small island in the Bonin (Ogasawara) chain where a new colony site had been prepared. Nine of these chicks fledged. In February 2008, ten STAL chicks were moved to the Mukojima site, and all fledged in May 2008. In February 2009, 15 STAL chicks were moved to Mukojima, and all fledged. In 2010, 15 chicks were moved and are being reared. Here we report the results of all five years, including satellite telemetry data from fledged STAL chicks. This effort represents the first successful long-term rearing of a surface-nesting seabird. The methodologies developed will inform future attempts to establish or supplement colonies of other rare surface-nesting seabirds.”

Tomohiro Deguchi; Robert Suryan; Greg Balogh**C14-6 Sa 1100-1120 Oak Bay Room****Maria Gavriilo****Breeding habitats of the ivory gull in Russian Arctic and climate change: monitoring, threats and protection**

“Russia holds ca. 85% of the world breeding ivory gull population. Breeding range in Russia is restricted and colonies are sporadic. Environmental factors affecting breeding habitats selection including ice regime in surrounding seas and multiple characteristics of terrestrial biotopes are discussed. Strategy of breeding site selection is arctic fox avoidance achieving through different tactics. Terrestrial habitats use within Russian range differs remarkably from the rest of the species range. A small low-laying land spot bounded by ice, either sea or glacier ice, is a principal breeding habitat where ca. 75% of Russian or ca. 60% of the world ivory gull population breeds. Exact colony

locations may be alternated, but a network of core breeding areas is stable. Monitoring of selected core colonies may reflect population status over entire Russian range. Monitoring scheme is suggested. Warming climate is a major hazard to ivory gull and its habitats, both marine and terrestrial. Threats related to sea-ice cover loss and alternations expected in terrestrial habitats are discussed. Habit of concentrating in several large flat-ground colonies put ivory gulls breeding in Russia at high risk to indirect effect of climate change related to human impact. Easier access to high-Arctic will lead to increased disturbance, habitat loss and pollution due to development schemes. A need of effective protection of a core breeding areas network in Russia is emphasized since it serves a refuge for ivory gulls during recent Arctic warming. Representativeness of existing SPAs network in Russia is discussed in terms of ivory gull conservation.”

C14-7 Sa 1120-1140 Oak Bay Room**Victor Yu****Research and conservation of the world's rarest seabird; the Chinese Crested Tern**

Chinese Crested Terns (*Thalasseusa bernsteini*, henceforth CCT) were first discovered in 1863 but there are few records and the last sighting was 1937. After this, there is no reliable record of CCT until 2000 when eight adults and four chicks were found in the Matsu Archipelago, Taiwan. That same year, a tern Refuge was established in Matsu by the government. Since then, annual population surveys have been conducted in the Refuge where the birds breed. One (2001) to 16 (2008) adults have been observed. In 2009 Chinese and Taiwanese collaborated for the first synchronized survey of CCT breeding areas along the SE coast of China and within the Refuge. All CCT counted were sharing breeding sites with Great Crested Tern (*Sterna bergii*; henceforth GCT). Although breeding areas have been identified, where CCT winter is unknown. To address this, and breeding site fidelity, five satellite transmitters were attached to GCT and another 43 were color banded at the Refuge in 2008. GCT were used as a surrogate species because of their high population number, large body size, and because CCT breed within GCT colonies. In 2009 there were three resightings of banded GCT in the Refuge and in Fujian Province, China. The satellite tracking revealed that four GCT flew to Vietnam and one to the Philippines. In 2010 more surveys and banding are planned as well as an invasive predator assessment study. Scientific research and close collaboration between Taiwan and mainland China are essential.”

Shou-Hwa Chang



C14-8 Sa 1140-1200 Oak Bay Room

Janos Hennicke

Foraging ecology, blood parasites and challenges for conservation: the critically endangered Christmas Island Frigatebird

“The Christmas Island Frigatebird (*Fregata andrewsi*), endemic to Christmas Island (CI) in the Eastern Indian Ocean, is listed as critically endangered. The breeding population is estimated at approx. 1,200 pairs and is declining. Causes for the decline are completely unknown. In an interdisciplinary approach, the ecology of this species is investigated to create a scientific foundation for its protection. Using GPS-loggers and satellite transmitters on breeding adults, the birds’ foraging ecology during different stages of the breeding cycle was investigated. Blood samples were examined for parasite infestation. Gender specific foraging behaviour was found in chick rearing males and females with sexes using different foraging areas in the north and south of CI respectively. During late chick rearing and post-chick rearing periods both sexes undertook long and distant foraging trips to coastal marine areas north of CI (Java Sea, South China Sea). These areas are strongly affected by human activities like fishing, hunting, and pollution which are likely to put birds at risk. In addition, in these areas the frigatebirds might get infected with a newly discovered and potentially species-specific blood parasite which is likely to negatively affect body condition and reproductive performance. Infection pathways, vectors and impact of this blood parasite are currently investigated and latest results will be presented in the talk. Results will be discussed in comparison to other seabirds of CI potentially being exposed to the same threats and with regard to challenges for developing effective protection measures for the endangered CI Frigatebird and its habitat.”

C14-9 Sa 1200-1220 Oak Bay Room

Lisa Nupen

Population connectivity and the conservation genetics of Cape Gannets (*Morus capensis*)

“The Vulnerable Cape Gannet (*Morus capensis*) is endemic to the Benguela Upwelling Ecosystem, breeding at only six colonies along the coasts of South Africa and Namibia. Collapse of pelagic fish stocks off Namibia in the 1970s caused dramatic decreases in gannet numbers in the northern Benguela. Off South Africa, a recent south-eastward shift in the distribution of pelagic fish food resources (sardines *Sardinops sagax* and anchovies *Engraulis capensis*) is having a detrimental impact on Cape Gannet populations. This shift might be the result of commercial fishing pressure and/or environmental change. Increased foraging effort by breeding adult gannets is required to ensure sufficient food provisioning for developing chicks. We use mitochondrial and nuclear DNA markers to investigate genetic diversity,

population connectivity and gene flow across the distributional range of the Cape gannet. Ringing data show that while adult gannets are philopatric, a subset of juveniles migrate to colonies where their pelagic prey is more abundant. Census data suggest that the colony at Bird Island, Algoa Bay, on the south-east coast, has grown rapidly in recent years, whereas colonies on the west coast have declined. In the absence of data on either historic or current migration rates, we investigated the evolutionary history of Cape Gannets across their breeding range within a phylogeographic framework. We determined historical connectivity among colonies using a number of measures of gene flow and tested for evidence of migrant individuals. Our results are discussed within the current conservation framework for the species.”

Jacqueline Bishop; Peter Ryan

C14-10Sa 1220-1240 Oak Bay Room

Rhys Bullman

Assessing the impacts of marine wave and tidal energy devices on seabirds in Scottish territorial waters

The Scottish Government has committed to generating a significant proportion of renewable energy from wave and tidal current devices. We discuss a seabird survey protocol to collect data to inform assessments relating to the potential impacts of these devices on seabird populations in Scottish territorial waters. We also present a modelled process for considering the conservation implications of seabird disturbance or mortality due to collision or displacement by wave and tidal devices. Such modelled impacts are then considered cumulatively where multiple developments may affect protected seabird colonies. We also demonstrate how various tracking methods can be used to determine whether or not seabirds from Special Protection Areas are foraging in sea areas identified by the Crown Estate for the deployment of marine energy devices and present result from sonar trails which may be used to demonstrate seabird behaviour in response to them.

Mark Trinder

C14-11Sa 1400-1420 Oak Bay Room

Bryan Watts

Waterbirds and wind: establishing sustainable limits on incidental mortality for seabirds within the western Atlantic Basin

“Near shore waters along the east coast of North America support an estimated 96 gigawatts of available wind resources in close proximity to major electricity markets. Capturing enough of this potential energy to meet current green policies



would require the construction of the largest number of over-water hazards ever produced during the next 15-year period. The Atlantic Flyway supports one of the largest near shore movement corridors of seabirds in the world including many species of conservation concern. The life history strategy of most seabird species leads to high elasticities in adult mortality and an associated high vulnerability to incidental, human-caused mortality. I use a form of harvest theory that incorporates uncertainty to develop a framework for establishing an upper bound on sustainable, incidental mortality and apply this framework to seabird populations within the western Atlantic Basin. Species vary widely in their vulnerability to absolute mortality rates. Evaluating the effective impact of a new class of mortality hazard such as wind turbines on population dynamics requires estimates of accumulated mortality from all anthropogenic sources. There is an urgent need to monitor collective, human-caused mortality rates in order to ensure that rates are held below sustainability thresholds.”

C14-12Sa 1420-1440 Oak Bay Room

Philipp Schwemmer

Effects of ship traffic on divers and sea ducks in German offshore waters

“Almost all anthropogenic activities at sea are related to shipping. However, shipping is an important source of disturbance for sensitive seabirds. Due to increasing

anthropogenic activities (particularly due to offshore wind farm sites) many countries worldwide are currently forced to develop spatial planning schemes while at the same time implementing conservation sites for sensitive species at sea. The effects of ship traffic on sensitive seabirds are currently too poorly understood to allow for proper planning and conservation concepts. We used aerial surveys and experimental disturbance to elucidate effects on distribution patterns, habitat loss and species-specific flight reactions of birds due to shipping. Divers (*Gavia spec.*) showed significantly lower densities in areas exhibiting high shipping intensity, whereas lesser black-backed gulls (*Larus fuscus*) showed a preference for such sites. Escape distances of four sea duck species differed significantly with highest values for common scoter (*Melanitta nigra*) and lowest for common eider (*Somateria mollissima*). Escape distances increased with flock size, but were lower in areas with channelled ship traffic, indicating habituation. As free ranging ships such as recreation and fishing vessels are unpredictable for birds, they reduce the possibility of habituation. Our findings show that ship traffic has substantial effects on seabirds, with varying intensity between species. Taking into account data on spatio-temporal distribution patterns of sensitive seabird species, spatial planning should aim to harmonize the needs of sensitive seabirds and ship traffic particularly in a marine protection areas.”

Bettina Mendel; Stefan Garthe

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