

University of Aberdeen Lighthouse Field Station
25 years of teaching and research in Cromarty



Molecular scatology: the use of molecular genetic analysis to assign species, sex and individual identity to seal faeces

J. Z. REED, D. J. TOLLITT, P. M. THOMPSON* and W. AMOS

Abstract Seal and commercial fisheries are potential competitors for fish and cephalopods. Research into the diet of British seal species has been based on conventional dietary analyses...

Keywords: mitochondrial DNA, DNA extraction, faecal DNA, diet, pinnipeds, marine or recreational fisheries.

Received 10 June 1996; accepted 9 September 1996

Combining Power Analysis and Population Viability Analysis to Compare Traditional and Precautionary Approaches to Conservation of Coastal Cetaceans

P. M. THOMPSON*, BEN WILSON*, KATE GRELLIER*, AND PHILIP S. HAMMOND†

Abstract Traditionally, marine mammals have been managed through local objectives. This approach poses particular difficulties for cetaceans because of their wide dispersal and low reproductive rates...

Keywords: Population viability analysis, power analysis, cetaceans, conservation, marine mammals.

Changes in haematological parameters in relation to prey switching in a wild population of harbour seals

P. M. THOMPSON*, D. J. TOLLITT, H. M. CORPE, I. R. RIDDS and H. M. ROSS†

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Whistle Matching in Wild Bottlenose Dolphins (Tursiops truncatus)

Vincent M. Janik

Dolphin communication is suspected to be complex, as the basis of their call repertoire, cognitive ability and ability to modify signals through vocal learning...

Keywords: communication, dolphins, vocal learning, whistle matching, Tursiops truncatus.

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Changes in the distribution and activity of female harbour seals during the breeding season: implication for their lactation strategy and mating patterns

PAUL M. THOMPSON*, DAVID MILLER*, RICHARD COOPER* and PHILIP S. HAMMOND†

Abstract Adult female harbour seals from NE Scotland were radio-tracked to follow changes in their distribution and activity during the breeding season...

Keywords: body-size relationships, fasting, foraging behaviour, Phoca vitulina.

Received 10 June 1996; accepted 9 September 1996

Distribution and activity of male harbour seals during the mating season

SOFIE M. VAN PARIJS, PAUL M. THOMPSON, DOMINIC J. TOLLITT & ANN HACKETT

Abstract Little is known about male reproductive strategies in aquatically mating pinnipeds. To study the mating patterns of male seals, the distribution of females during the summer pupping and mating...

Keywords: body-size relationships, fasting, foraging behaviour, Phoca vitulina.

WINTER FORAGING BY COMMON SEALS (PHOCA VITULINA) IN RELATION TO FOOD AVAILABILITY IN THE INNER MORAY FIRTH, N.E. SCOTLAND

By P. M. THOMPSON, G. J. PIERCE, J. I. R. RIDDS, G. H. HISLOP*, D. MILLER AND A. J. S. W. DIACK†

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Keywords: body-size relationships, fasting, foraging behaviour, Phoca vitulina.

Temporal and spatial variation in age-specific survival rates of a long-lived mammal, the Hawaiian monk seal

Jason D. Baker, J. S. and Paul M. Thompson*

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Keywords: body-size relationships, fasting, foraging behaviour, Phoca vitulina.

Functional Ecology

Scale-dependent foraging ecology of a marine top predator modelled using passive acoustic data

Enrico Pirota*, Paul M. Thompson*, Peter L. Miller*, Kate L. Brookes*, Barbara Cheney*, Tim R. Barton*, Isla M. Graham* and David Lusseau†

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Lagged effects of ocean climate change on fur seal population dynamics

Paul M. Thompson & Janet C. Emswiler*

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Letters to nature

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Quantifying the influence of sociality on population structure in bottlenose dolphins

DAVID LUSSEAU*, BEN WILSON*, PHILIP S. HAMMOND†, KATE GRELLIER*, JOHN W. DURBAN*, KIM M. PARSONS*, TIM R. BARTON* and PAUL M. THOMPSON*

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G. D. Hastie · B. Wilson · L. J. Wilson · K. M. Parsons
P. M. Thompson

Functional mechanisms underlying cetacean distribution patterns: hotspots for bottlenose dolphins are linked to foraging

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Abstract Many studies have shown that the distribution of cetaceans can be closely linked to habitat, but the underlying functional mechanisms are less clear. We examined the relationship between habitat use and foraging behaviour in bottlenose dolphins (*Tursiops truncatus*) in the Moray Firth, NE Scotland, where they were observed to forage on herring (*Clupea harengus*) in the Moray Firth. We used a combination of satellite tracking and direct observation to determine whether foraging behaviour was related to habitat use. We found that foraging behaviour was related to habitat use, and that foraging behaviour was related to habitat use. We found that foraging behaviour was related to habitat use, and that foraging behaviour was related to habitat use.

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Keywords: *Tursiops truncatus*, foraging, habitat use, satellite tracking, direct observation

Functional and aggregative responses of harbour seals to changes in salmonid abundance

Stuart J. Middleton^{1,2,3}, Tim R. Barton¹, John D. Armstrong¹, and Paul M. Thompson¹

¹Lighthouse Field Station, School of Biological Sciences, University of Aberdeen, Aberdeen, Scotland
²Marine Laboratory, University of Stirling, Stirling, Scotland
³Department of Biology, University of York, York, UK

There is intense debate over the potential impact of salmon farming on wild salmonids. We examined the functional and aggregative responses of harbour seals (*Phoca vitulina*) to changes in salmonid abundance in the Moray Firth, NE Scotland. We found that seals responded to changes in salmonid abundance by increasing their foraging effort and aggregating in areas of high abundance.

Keywords: *Phoca vitulina*, foraging, aggregative response, salmon farming, wild salmonids

Assessing the potential impact of salmon fisheries management on the conservation status of harbour seals (*Phoca vitulina*) in the north-east Scotland

P. M. Thompson¹, B. Mackay¹, T. R. Barton¹, C. Duck², & J. R. A. Butler³

¹University of Aberdeen, School of Biological Sciences, Lighthouse Field Station, Aberdeen, Scotland
²Department of Biology, University of York, York, UK
³Department of Biology, University of Stirling, Stirling, Scotland

Harbour seals (*Phoca vitulina*) are a protected species in Scotland. We assessed the potential impact of salmon fisheries management on the conservation status of harbour seals in the Moray Firth, NE Scotland. We found that salmon fisheries management could have a negative impact on the conservation status of harbour seals.

Keywords: *Phoca vitulina*, salmon fisheries, conservation status, Moray Firth

Quantitative analysis of bottlenose dolphin movement patterns and their relationship with foraging

HELEN BAILEY¹ AND PAUL THOMPSON¹

¹University of Aberdeen, School of Biological Sciences, Lighthouse Field Station, Aberdeen, Scotland

Abstract We used a combination of satellite tracking and direct observation to determine the relationship between movement patterns and foraging behaviour in bottlenose dolphins (*Tursiops truncatus*) in the Moray Firth, NE Scotland. We found that movement patterns were related to foraging behaviour.

Keywords: *Tursiops truncatus*, movement patterns, foraging, satellite tracking, direct observation

Variation in breeding phenology provides insights into drivers of long-term population change in harbour seals

Lise S. Collier and Paul M. Thompson

¹Department of Biology, University of Aberdeen, Aberdeen, Scotland

Abstract We examined the relationship between breeding phenology and population change in harbour seals (*Phoca vitulina*) in the Moray Firth, NE Scotland. We found that breeding phenology was related to population change.

Keywords: *Phoca vitulina*, breeding phenology, population change, Moray Firth

North Atlantic climate variation influences survival in adult fur seals

Vladimir Groussin and Paul M. Thompson

¹Department of Biology, University of Aberdeen, Aberdeen, Scotland

Abstract We examined the relationship between North Atlantic climate variation and survival in adult fur seals (*Callorhinus ursinus*) in the Moray Firth, NE Scotland. We found that North Atlantic climate variation was related to survival.

Keywords: *Callorhinus ursinus*, North Atlantic climate variation, survival, Moray Firth

Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises

Paul M. Thompson¹, Kate A. Brooks¹, Isla M. Graham¹, Tim R. Barton¹, Keith Neill², Gareth O'Riordan², and Nathan D. Merchant²

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Keywords: *Phocoena phocaena*, seismic survey, displacement, Moray Firth

Violent interactions between bottlenose dolphins and harbour porpoises

HARRY M. ROSS¹ AND BEN WILSON²

¹SAC Veterinary Services, Drumahair, Spey Valley, Aberdeen, Scotland
²University of Aberdeen, School of Biological Sciences, Lighthouse Field Station, Aberdeen, Scotland

Abstract We examined the relationship between violent interactions and habitat use in bottlenose dolphins (*Tursiops truncatus*) and harbour porpoises (*Phocoena phocaena*) in the Moray Firth, NE Scotland. We found that violent interactions were related to habitat use.

Keywords: *Tursiops truncatus*, *Phocoena phocaena*, violent interactions, Moray Firth

Kinship as a basis for alliance formation between male bottlenose dolphins, *Tursiops truncatus*, in the Bahamas

KIM M. PARTON¹, JOHN W. LUBOWITZ¹, DIANE E. CLARIDGEE¹, KEN C. BALCOMBES¹, LES R. NOBLE¹, PAUL M. THOMPSON²

¹Department of Biology, University of Aberdeen, Aberdeen, Scotland
²University of Aberdeen, School of Biological Sciences, Lighthouse Field Station, Aberdeen, Scotland

Abstract We examined the relationship between kinship and alliance formation in male bottlenose dolphins (*Tursiops truncatus*) in the Bahamas. We found that kinship was related to alliance formation.

Keywords: *Tursiops truncatus*, kinship, alliance formation, Bahamas

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Assessing underwater noise levels during pile-driving at an offshore windfarm

HELEN BAILEY¹, BRIDGET SCOTCH¹, DAVE SIMMONS¹, JAN RUSIN¹, GORDON PICKEN¹, PAUL M. THOMPSON¹

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Epidermal diseases in bottlenose dolphins: impacts of natural and anthropogenic factors

B. Wilson¹, H. Arnold¹, G. Bearzi¹, C. M. Fortuna¹, S. Gaspari¹, S. Ingram¹, R. S. Liles¹, F. Prato¹, A. J. Read¹, V. Ridoux¹, P. Schreiner¹, K. W. Ursin¹, R. W. Wells¹, C. Wood¹, A. J. Read¹, V. Ridoux¹, P. Schreiner¹, K. W. Ursin¹, R. W. Wells¹, C. Wood¹

¹University of Aberdeen, School of Biological Sciences, Lighthouse Field Station, Aberdeen, Scotland

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Keywords: *Tursiops truncatus*, epidermal diseases, natural factors, anthropogenic factors, Moray Firth

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Assessing underwater noise levels during pile-driving at an offshore windfarm

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ESTIMATING SIZE AND ASSESSING TRENDS IN A COASTAL BOTTLENOSE DOLPHIN POPULATION

BEN WILSON¹, PHILIP S. HAMMOND², AND PAUL M. THOMPSON¹

¹University of Aberdeen, School of Biological Sciences, Lighthouse Field Station, Aberdeen, Scotland
²University of Aberdeen, School of Biological Sciences, Lighthouse Field Station, Aberdeen, Scotland

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The Lighthouse Field Station

Celebrating 25 years of Cromarty based teaching and research
on the ecology of seals, dolphins and fulmars

Since 1990 the Lighthouse Field Station has provided a Highland base for marine biologists from the University of Aberdeen. Our research on the ecology and conservation of marine top predators has built upon field studies in Scottish waters, and underpinned work with a wide range of UK and overseas collaborators. 25 years on, our findings have been reported in over 130 scientific publications and had important impacts on the way we understand and manage our marine ecosystems.

The following pages provide an overview of how our research has developed over the years, and highlight the teaching and public engagement activities that have been integrated into our work. These achievements have only been possible with the support of many colleagues, students, collaborators, friends and funding bodies, and we'd like to take this opportunity to thank you all.



1990

A research contract from the Scottish Office Agriculture and Fisheries Department allowed the University to expand studies of harbour seal population and foraging ecology that we'd initiated in 1987. Alongside this work, we began a programme of regular photo-ID surveys for bottlenose dolphins in collaboration with the Sea Mammal Research Unit (SMRU), initially using the Zoology Department's boat *Talitrus*. This was expanded later in 1990 with funding from the Greenpeace Environmental Trust, and we secured a 3-year lease for the Lighthouse Keeper's Cottage in Cromarty as a base for this work.



1991

Much of the year was dominated by our harbour seal field studies, using our new boat *Tursiops* to capture seals at different haulout sites with a seine net for tagging and health screening. Subsequent VHF tracking studies were used to identify key foraging areas within the Moray Firth, as well as providing new data on diving behaviour and reproductive strategies. *Tursiops* also allowed us to make monthly photo-ID surveys to identify seasonal patterns in the distribution of bottlenose dolphins in the inner Moray Firth. The Lighthouse Field Station was officially opened by Tom Kelly of the Scottish Office in June.



1992

Our seal tracking was extended through comparative studies that used SMRU satellite tags to follow Moray Firth grey seals as far as Orkney and the Farn Islands. In March, we hosted our first international meeting, when 50 colleagues met in Cromarty for a European Seal Group conference. The national profile of the Moray Firth bottlenose dolphins and our research programme was raised through a leading article in BBC Wildlife. Later in the year, photo-ID surveys were extended to the outer Moray Firth through collaboration with IFAW's boat *Song of the Whale*.



1993

In March, we hosted the Annual Conference of the European Cetacean Society at the Eden Court Theatre in Inverness, attracting over 300 participants from across the world. A grant from NERC allowed us to collaborate with colleagues at the University of Cambridge to develop molecular techniques to study individual and sex differences in seal diet. A new partnership with the Whale and Dolphin Conservation Society provided additional funding for our dolphin photo-ID studies and our results supported their Adopt-a-Dolphin scheme. Honours students from Aberdeen started using the Field Station as a base for summer projects.



1994

Another contract from the Scottish Office Agriculture and Fisheries Department focussed our studies towards harbour seal diet. Ongoing health screening with the Scottish Agricultural College's Veterinary Investigation Centre highlighted that annual variation in prey stocks influenced seal parasite burdens and condition. Collaboration with the Scottish Agricultural College also revealed that bottlenose dolphins were the cause of the traumatic injuries found in many stranded harbour porpoises. These findings were included in two network TV programmes that focussed on our dolphin research, resulting in international press coverage.



UNDER THE SEA
Revealing the secrets of the sea using modern technology

18 March - 15 April 1994
Monday to Saturday 9am - 5pm
Inverness Museum & Art Gallery
Admission Free

Equipment and research for the exhibition kindly loaned by Mediterranean, Aberdeen. The Exhibition is open 10am-5pm. Inverness Museum & Art Gallery, Inverness, 14 Inverness Quay, Inverness, Morayshire. Hours: 10am-5pm. Inverness Museum & Art Gallery, Inverness, 14 Inverness Quay, Inverness, Morayshire. Hours: 10am-5pm. Inverness Museum & Art Gallery, Inverness, 14 Inverness Quay, Inverness, Morayshire. Hours: 10am-5pm.



EVENING / LATE NIGHT
CHANNEL 4

7.00 Equinox
The Private Lives of Dolphins

A look at the lives and social behaviour of the bottle-nosed dolphin, as studied by researchers on three continents: Randy Wells in Florida, Richard Connor in Australia's Shark Bay, and Ben Wilson and his team on the Moray Firth in Scotland. While dolphins are perceived to be friendly creatures, the researchers' observations suggest that they can behave like brutal predators.

See today's choices.
Director Mack J Davis; Producer Frances Benigan. Subtitled8295
◆ Friend or foe? See feature: page 31

7.00pm Dolphins may seem docile but they are capable of surprising aggression, according to research

Su
Sunday 30 October

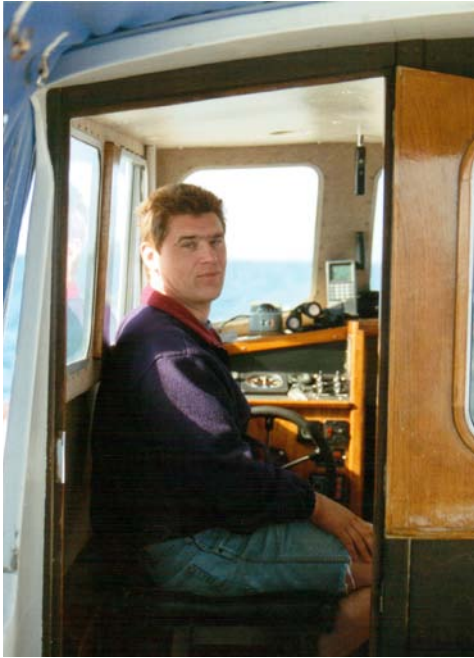


What the nation watched

	BBC1	Millions	BBC2	Millions	ITV	Millions	C4	Millions
1	EastEnders (Thu/Sun)	25.30	Have I Got News for You	6.36	Coronation St (Mon/Wed)	20.27	Brookside (Wed/Sat)	5.63
2	Neighbours (Mon)	15.44	Red Dwarf VI	4.89	Heartbeat	16.31	Fifteen-to-One (Thu)	3.62
3	Casualty	13.37	The X-Files	4.73	Soldier, Soldier	15.74	Drop the Dead Donkey	3.59
4	Noel's House Party	11.23	Top Gear	4.12	You've Been Framed!	15.72	Forbidden Planet	3.28
5	Les Dawson: the Entertainer	11.14	Star Trek: the Next Generation	3.96	London's Burning	14.66	Equinox	3.22

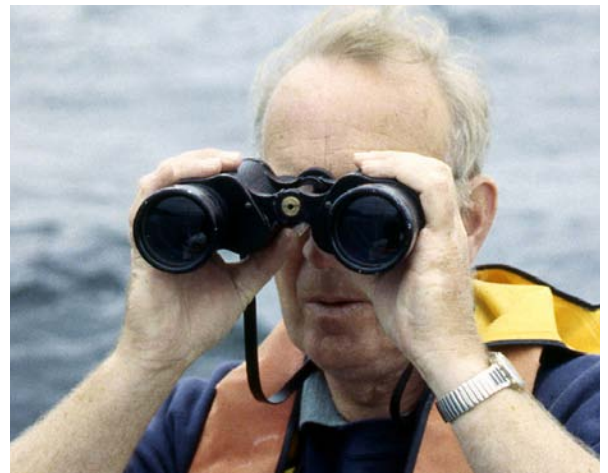
1995

Bioacoustics became an increasingly important component of our research. A new research vessel *Bella Jane* was purchased with funding from the Wills Trust to support passive acoustic studies of both seals and dolphins. In partnership with the Highland Council we built upon collaborative studies with the University of St Andrews to integrate a permanent hydrophone array into a new visitors centre overlooking Inverness and the Kessock Channel. In Cromarty, we organised the first of what became a long series of annual training workshops for Aberdeen postgraduate students and the Field Station's first PhD student graduated.



1996

A UK government contract from MAFF and DETR allowed us to continue with a summer programme of bottlenose dolphin surveys, primarily aimed at understanding the causes of the high levels of skin lesions we detected. Proposals for the Moray Firth to become a Special Area of Conservation in response to the EU Habitats Directive resulted in the first of a series of contracts from Scottish Natural Heritage to provide scientific support for SAC management and monitoring. The internet and email arrived at the Field Station, albeit only on a single shared PC. The first of our undergraduate Field Courses on Coastal Ecology was held in the Cromarty Old Brewery.



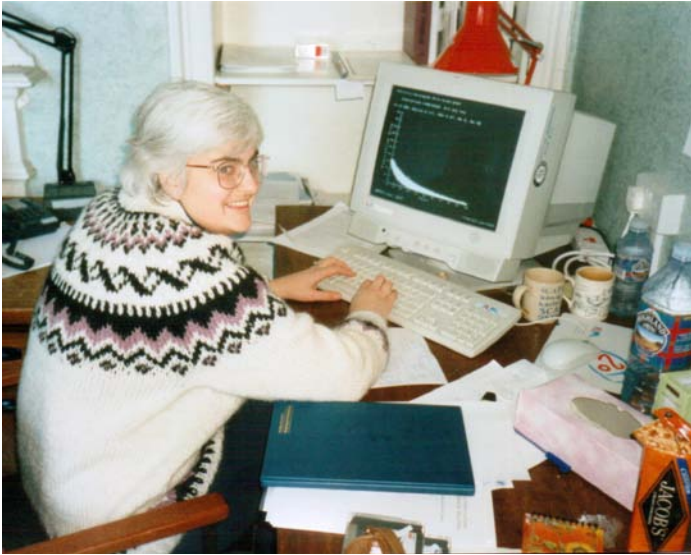
1997

There was increased use of the Field Station as a base for postgraduate studies at overseas study sites, with fieldwork conducted on fur seals and river dolphins in South America and killer whales in Norway. Within the Moray Firth our harbour seal studies focussed on land-based observations. Industry support from the Cromarty Firth Port Authority, Ross and Cromarty Enterprise, and Talisman Energy (UK) Ltd allowed us to develop land based observations and acoustic studies of bottlenose dolphin distribution and behaviour in the Cromarty Firth.



1998

This year saw the first of what became annual field trips to Orkney. A summer project on harbour seal acoustics revealed dramatic declines in adults and pups on Eynhallow. At the same time, the Field Station took over the co-ordination of the Aberdeen University study of northern fulmars that had started in 1950. Bottlenose dolphins got mixed press. Concerns over the animals using the candidate Moray Firth SAC resulted in a contract to model population viability. While collaborative studies with the Scottish Agricultural College revealed that bottlenose dolphins engaged in infanticide in addition to their previously reported aggression towards porpoises.



1999

Our involvement in the development of a management plan for the Moray Firth SAC increased interactions with industry stakeholders, resulting in regular support from Talisman Energy (UK) Ltd and Chevron Texaco. Oil and gas related studies were also conducted for the Atlantic Frontier Environmental Network in collaboration with Cornell University and the Joint Nature Conservation Committee. This project used remote acoustic loggers to study the distribution of fin whales in the Shetland-Faroes channel. In the Cromarty Firth, new studies of interactions between seals and salmon were developed with the Fisheries Research Services and the Conon District Fisheries Board.



2000

A series of collaborative papers based upon our passive acoustic studies highlighted how low cost acoustic techniques could provide insights into dolphin foraging behaviour and harbour seal mating strategies. Following pilot studies in 1999, we continued to develop harbour seal photo-ID studies in the Cromarty Firth to support studies of individual movements and survival. Further afield, postgraduate collaborations with the Bahamas Marine Mammal Surveys studied the social behaviour and ecology of bottlenose dolphins in warmer waters. The Management Group for the Moray Firth SAC was launched.



2001

Analysis of the long-term fulmar data set revealed that climate variation influenced reproductive success in this population and underpinned a successful NERC grant to model the impacts of climate on survival. Passive acoustic surveys of sperm whale and oceanic dolphin distribution were made across the Shetland-Faroes Channel with the Fisheries Research Services Marine Laboratory. Similar techniques were used to study bottlenose dolphin distribution during the replacement of Talisman's Beatrice pipeline. *Tursiops* was retired after a grant from International Water Ltd allowed us to purchase *Rona*, extending our capabilities for undertaking coastal surveys.



2002

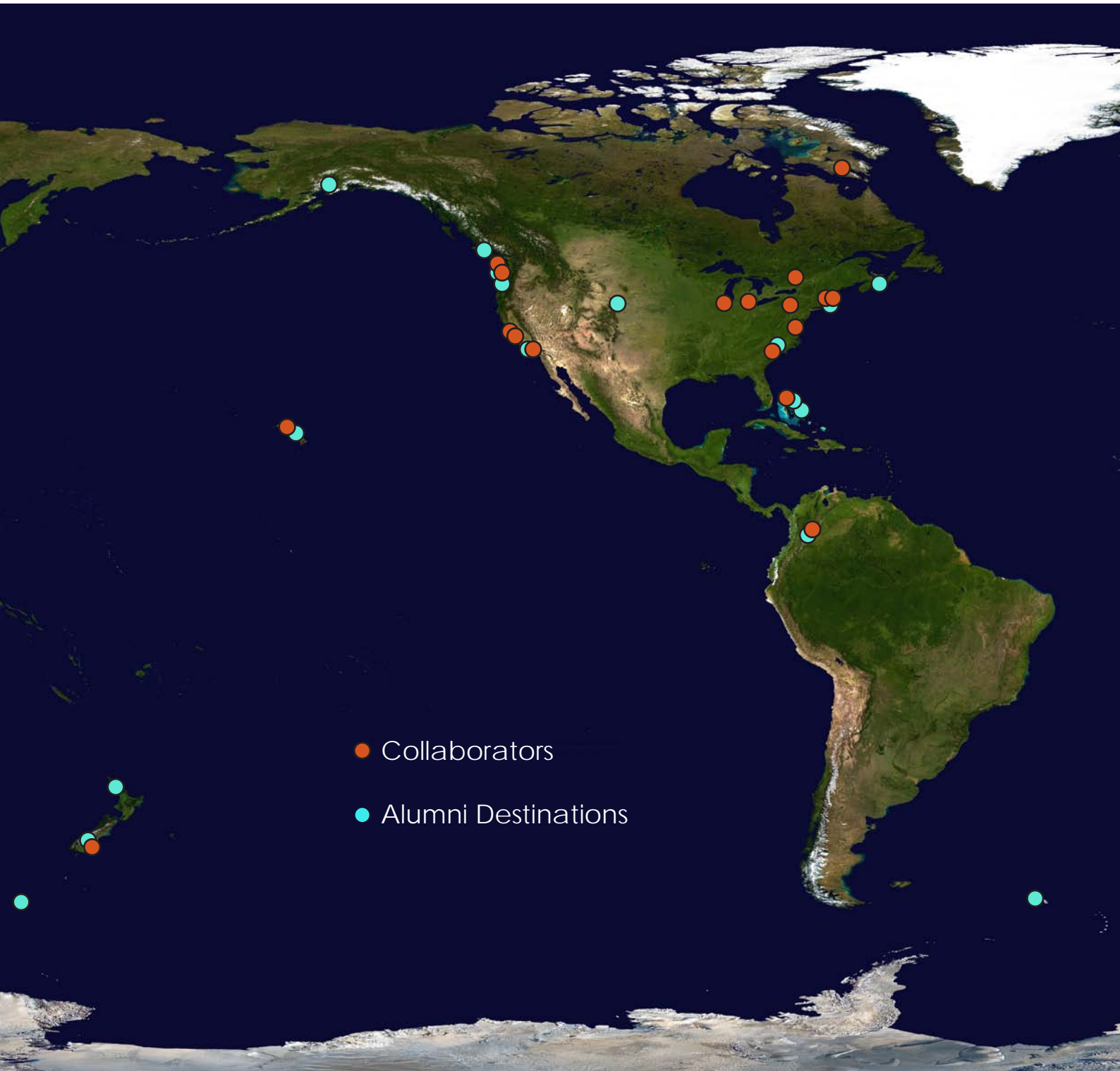
Support from a wide range of funders allowed us to refurbish the Old Buoy Store to provide new teaching and research facilities at the Lighthouse Field Station. Work on the Old Buoy Store grounds and new boat shed continued through the summer and was completed later in the year. The Management Plan for the Moray Firth SAC was launched. Several different aspects of the Field Station's research were featured in a BBC Radio 4 Nature Programme on "*The Moray Firth Bottlenose Dolphins*".



Collaborators

Andenes Whale Centre; Bahamas Marine Mammal Surveys; Bangor University; Biomathematics and Statistics Scotland;

British Antarctic Survey; Canadian Wildlife Service; Centre for Ecology and Hydrology; Cetacean Research and Rescue Unit; Chicago Zoological Society; CNRS; Conon District Fisheries Board; Cornell University; David Cabot; Duke University; Fondation Omache;



Iceland Nature Research Centre; Norwegian Institute for Natural Research; Norwegian Institute of Fisheries and Aquaculture; Norwegian Polar Institute; Ocean Networks Canada; Oceanopolis; Oregon State University; Parque Natural da Arrabida; Plymouth Marine Laboratory; Scottish Agricultural College; Scottish Association for Marine Science; Sea Watch Foundation; Shetland Biological Records Centre; South Iceland Nature Centre; Spey District Salmon Fishery Board; Stanford University; Subacoustech Environmental Ltd;

Fresh Pond Research Institute; FRS Marine & Freshwater Laboratories; Hebridean Whale and Dolphin Trust; IFAW; Imperial London; JNCC; Kongsburg Maritime Ltd; Marine Research Institute; Marine Scotland Science; Moss Landing Marine Laboratory; National Environmental Research Institute; National Marine Fisheries Service; National Marine Mammal Laboratory; National Wildlife Research Centre, Carleton University; Natural Power Consultants; NERC Sea Mammal Research Unit; Netherlands Institute for Forestry & Nature Research; Northeast

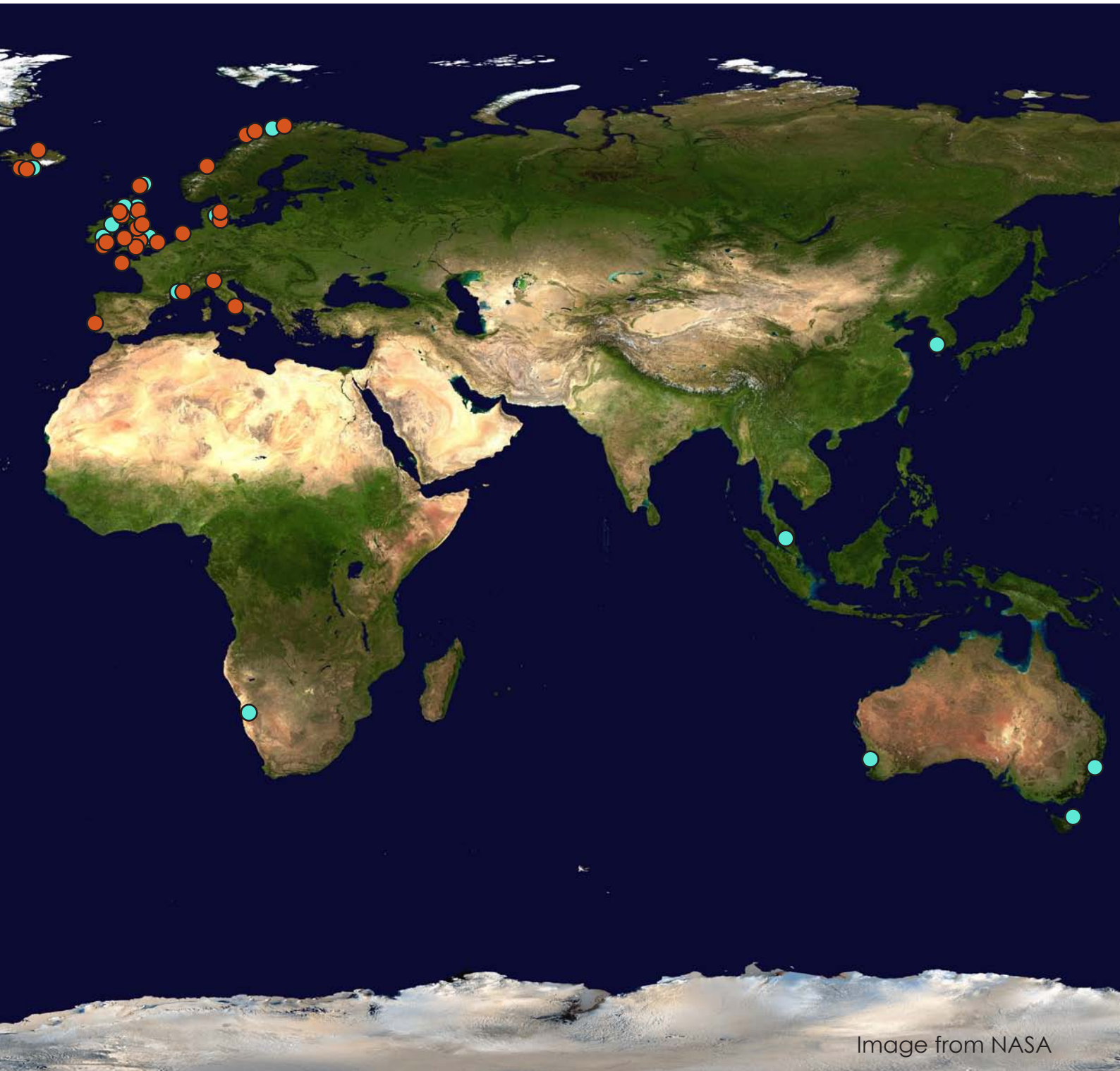


Image from NASA

Swedish Museum of Natural History; Talisman Energy (UK) Ltd; Tethys Research Institute; Universita La Sapienza; University of Bath; University of California; University of Cambridge; University of Copenhagen; University of Cork; University of Durham; University of Edinburgh; University of Glasgow Veterinary School; University of Maryland Centre for Environmental Science; University of Michigan; University of Otago; University of Reading; University of St Andrews; University of Leeds; Whale & Dolphin Conservation; Wild Idea; WWT Consulting.

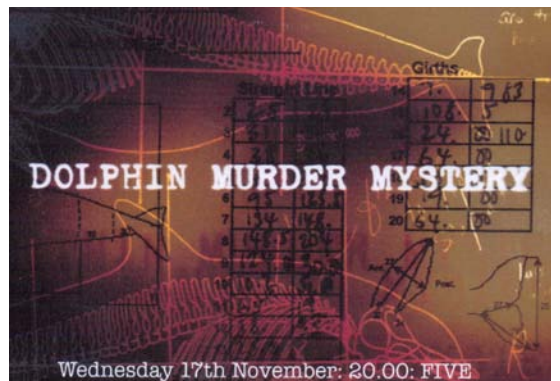
2003

The refurbished Old Buoy Store was officially opened by Charles Kennedy MP, and a series of public Open Days were held through the summer. Honours students carried out projects on fulmars on Eynhallow and dolphins in the Moray Firth, and exchange students and post-docs joined us from Denmark, Ireland, France, New Zealand and Australia. Field Station studies were also presented at international workshops in France, Gran Canaria and the US.



2004

This was the first of two summers in which we conducted a series of acoustic surveys from *Bella Jane* to study the distribution of bottlenose dolphins and harbour porpoises across the Moray Firth SAC. Scottish Natural Heritage started to contribute to our annual photo-ID surveys to monitor the condition of the SAC. Poor prey stocks resulted in the worst breeding season on record for Eynhallow fulmars and other Scottish seabirds. Channel 5 screened *Dolphin Murder Mysteries*, loosely documenting our efforts to identify what had caused traumatic injuries to harbour porpoises.



2005

Our research extended further into the outer Moray Firth through the EU DOWNVIND Project, developing monitoring approaches to support the installation of the Beatrice Offshore Demonstrator Wind Turbines. Offshore projects tracking seabirds with radar were complemented by inshore studies validating the use of T-PODs to detect dolphin and porpoise echolocation clicks using passive acoustics. BBC coverage of our other work for a Radio 4 *Living World on The Fulmars of Eynhallow* and BBC1 *Coasts* were included in Christmas *Pick of the Year* TV and Radio programmes.



2006

Bottlenose dolphin photo-ID studies were extended around the whole Scottish coast through a collaborative contract from the Scottish Executive Environment and Rural Affairs Department (SEERAD) and Scottish Natural Heritage. *Uisge* was purchased to support studies outside the Moray Firth and additional west coast fieldwork was carried out with SAMS and the Hebridean Whale and Dolphin Trust from *Silurian*. Pilot tracking studies of fulmars provided evidence of extensive feeding movements before the breeding season. Pile-driving noise was measured during the installation of the Beatrice Demonstrators and the Field Station purchased a vintage Massey-Ferguson tractor.



2007

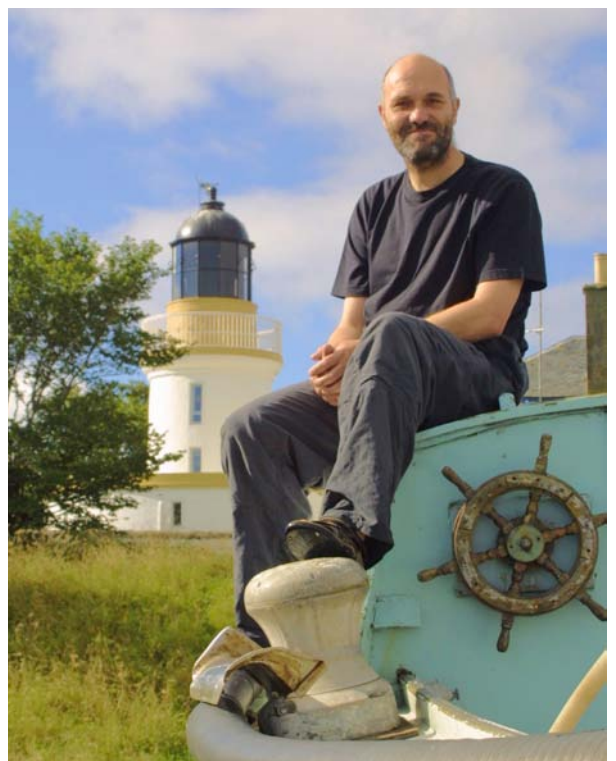
Offshore passive acoustic monitoring using PODs continued through the final stages of the Beatrice turbine installation. Increasing numbers of breeding harbour seals in Loch Fleet opened up new opportunities for photo-ID based studies of phenology and demography. The SEERAD bottlenose dolphin project developed a sightings reporting network to target photo-ID studies that detected wide-scale movements on the west coast of Scotland. Similar approaches were used to study killer whales around the Scottish coast and another student's PhD focused on killer whales in the North Pacific.



Sightings reporting hotline 0800 0858110
www.scottishdolphins.info



Scottish Bottlenose Dolphin Project



2008

Fieldwork on Scottish killer whales was expanded through a Carnegie Trust collaborative grant with the University of St Andrews and *Uisge* was relocated to Shetland for photo-ID and acoustic studies. With funding from the Scottish Government, large samples of miniature geo-location loggers were deployed on Eynhallow fulmars, underpinning two subsequent PhD projects. Concerns over the impacts of further oil and gas exploration resulted in Scottish Government funded passive acoustic monitoring studies in the outer Moray Firth. Dolphin photo-ID protocols were adapted to incorporate routine laser metric measurements of body size and growth.



2009

Studies were developed to assess and monitor the impact of seismic surveys with funding from DECC, Oil & Gas UK, Scottish Government and COWRIE. Visual boat based surveys were made in the outer Moray Firth from chartered fishing vessels, and recently developed CPODs were used to establish an extensive passive acoustic monitoring array across the area. Fieldwork on Eynhallow produced our first fine-scale GPS tracks of fulmar foraging trips and we tracked five of the known Loch Fleet harbour seals over the summer using SMRU GPS mobile phone tags. The University purchased the Lighthouse Tower and the Keeper's Cottage roof was replaced.



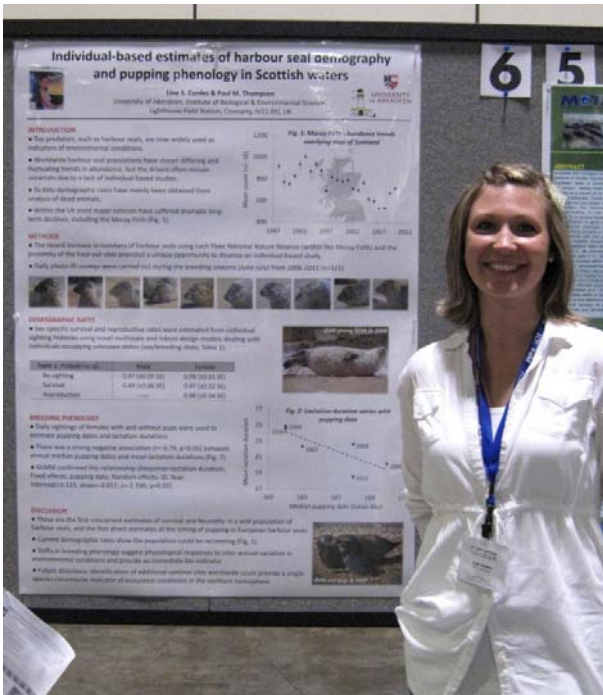
2010

An intensive programme of aerial surveys was used to estimate the density of harbour porpoise in two offshore study blocks, providing baseline for assessing the impacts of seismic survey noise. Parallel CPOD deployments and trials using digital aerial surveys provided data for a later comparison of methods for surveying offshore development sites. These studies were extended under contract to the Moray Firth offshore wind developers to provide baseline for their consent applications. Our annual programme of summer dolphin photo-ID surveys continued, with the latest data indicating that the number of individuals using the Moray Firth SAC was stable.



2011

Comparative studies of fulmars were extended through both GPS tracking of birds breeding on St Kilda and collaborative fieldwork with Irish and Icelandic researchers to deploy geo-location loggers and collect feathers for isotopic analysis. We conducted extensive passive acoustic and digital aerial surveys to assess the responses of harbour porpoises to seismic oil and gas exploration surveys in September. Collaborative work with Kongsberg measured received noise levels at different distances from the seismic vessel. The Keeper's Cottage was given a major refurbishment to upgrade the Field Station's office facilities.



2012

The Field Station hosted a Sublime arts residency in collaboration with IOTA. Supported by Creative Scotland, Highland Council, Inverness Common Good Fund and HIE, the works were first presented during a week of arts and science events in Cromarty and subsequently in Inverness Cathedral. GPS tracking recorded a male fulmar's record-breaking 6200 km 15 day round trip to the mid-Atlantic Ridge. Working with researchers at the University of Bath our underwater noise recordings from the Cromarty Firth provided some of the first UK data on shipping noise for the Marine Strategy Framework Directive.



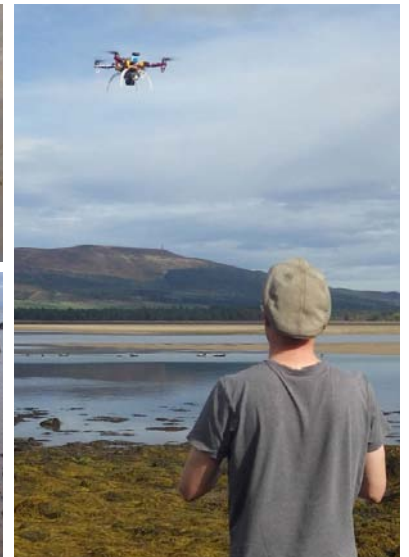
2013

Continued photo-ID studies of bottlenose dolphins recorded the project's first known 4th generation calf. Collaborative studies with other research groups provided data to estimate the abundance of bottlenose dolphins in Scottish waters. Studies of the responses of bottlenose dolphins and harbour porpoises to disturbance from harbour developments and shipping were funded through the DECC Strategic Environmental Assessment and MASTS. The ongoing Loch Fleet harbour seal photo-ID study allowed us to use individual based data to investigate changes in pupping phenology.



2014

Our individual based studies were integrated into a strategic Marine Mammal Monitoring Programme to assess the population consequences of disturbance from Moray Firth windfarm developments. Pre-construction monitoring was initiated with partnership funding from BOWL, MORL, Marine Scotland, The Crown Estate and HIE. Collaborative studies with St Andrews University used UAVs to estimate seal condition and we deployed GPS mobile phone tags to collect baseline movement data for harbour seals from our Loch Fleet study population. The year ended with the submission of the Field Station's 20th PhD thesis.



2015

Additional harbour seal tracking revealed links between the Moray Firth and breeding sites in Orkney, with one female we'd caught in Loch Fleet visiting Eynhallow while we were checking fulmar nests on the island. Collaboration with the Norwegian Polar Institute extended our work on the winter distribution of fulmars through a multi-species comparison of seabirds at sites from Scotland to the arctic. Photogrammetric methods for estimating dolphin body condition were successfully trialled. Inter-disciplinary approaches such as this will underpin further studies of the ecological consequences of environmental change, and support measures to mitigate these impacts.



Thankyou...

to the following organisations and individuals for their support.

Association for the Study of Animal Behaviour; Atlantic Frontier Environmental Network; Beatrice Offshore Wind Ltd; BP Amoco; British Ecological Society; British Council; Caledonian Society of Sheffield; Carnegie Trust; Chevron-Texaco; COLCIENCIAS; Countryside Council for Wales; Creative Scotland; Cromarty Firth Port Authority; Cromarty Arts Trust; Daily Mail Newspapers; Department of Energy & Climate Change; Department for Environment Transport and the Regions; Department for Environment Food and Rural Affairs; Earthkind;



Earthwatch; EDPR; European Union; Fisheries Research Service; Friends of the Environment; Greencard Trust; Greenpeace Environmental Trust; Hebridean Whale and Dolphin Trust; HDH Wills Trust; Highland Regional Council; Highlands & Islands Enterprise; Imagining Natural Scotland; International Water Ltd; International Fund for Animal Welfare; IOTA; J&D Wotton; Leverhulme Trust; Mammals Trust UK; Ministry of Agriculture Fisheries & Food;



Marine Scotland; Marine Alliance for Science & Technology Scotland; MarCRF; Moray Offshore Renewables Ltd; National Marine Fisheries Service; Natural Environment Research Council; Natural Sciences and Engineering Research Council of Canada; Nuffield Foundation; US Office of Naval Research; Oil & Gas UK; RAF Kinloss; Repsol; Ross & Cromarty Enterprise; Royal Society; Scottish Association for Marine Studies; Scottish Funding Council;



Scottish Executive Environment and Rural Affairs Department; Scottish Natural Heritage; Scottish Government; Shell UK; Shetland Wildlife Fund; Scottish Office Agriculture Environment and Fisheries Department; Scottish Water Solutions; Scottish & Southern Energy; Spey District Salmon Fisheries Board; Talisman Energy (UK) Ltd; The Crown Estate; University of Aberdeen Development Trust; Whale & Dolphin Conservation Society.

Deep-Sea Research II
Tracking a northern fulmar from a Scottish nesting site to the Charlie-Gibbs Fracture Zone: Evidence of linkage between coastal breeding seabirds and Mid-Atlantic Ridge feeding sites
Ewan W. Thompson

Brucella species infection in North Sea seal and cetacean populations
M. M. Ross, K. L. Johnson, A. P. Mackintosh, R. J. Reid, P. M. Thompson, G. MacInnes

Global Ecology and Conservation
Long-term trends in the use of a protected area by small cetaceans in relation to changes in population status
Barbara Cheney¹, Ross Corcoran¹, John W. Durban², Kate Grenfell³, Philip S. Hammond⁴, Cristina Llanos-Villaverde⁵, Vincent M. Janik⁶, Susan M. Lancaster⁷, Kim M. Parsons⁸, Nicola J. Quick⁹, Ben Wilson¹⁰, Paul M. Thompson¹

Evidence for infanticide in bottlenose dolphins: an explanation for violent interactions with harbour porpoises?
I. A. P. Thompson¹, R. J. Reid¹, B. Wilson¹, K. Grenfell¹, and P. M. Thompson¹

Prey selection by harbour seals, *Phoca vitulina*, in relation to variations in prey abundance
Dominic J. Tollit, Simon P.R. Greenstreet, and Paul M. Thompson

Animal Conservation
Estimating spatial, temporal and individual variability in dolphin cumulative exposure to boat traffic using spatially explicit capture-recapture methods
E. Prota¹, P. M. Thompson², B. Cheney³, C. R. Donovon⁴, & D. Lusseau⁵

EVALUATION OF CLOSED CAPTURE-RECAPTURE METHODS TO ESTIMATE ABUNDANCE OF HAWAIIAN MONK SEALS
ALAN D. BAKER

Patterns in the vocalizations of male harbor seals
Sofia M. Van Parijs¹

Environmental Impact Assessment Review
Framework for assessing impacts of pile-driving noise from offshore wind farm construction on a harbour seal population
Paul M. Thompson¹, Gordon D. Hastie², Jeremy Newell³, Richard Barham⁴, Kate L. Brookes⁵, Liam S. Cordeiro⁶, Helen Bailey⁷, Nancy McLeod⁸

Spatial and social connectivity of fish-eating "Resident" killer whales (*Orcinus orca*) in the northern North Pacific
Holly Fenwick¹, John W. Durban², Charles K. Ebbett³, Megan J. Peterson⁴, Jay Rucke⁵, David R. Wade⁶

USE OF T-PODS TO ASSESS VARIATIONS IN THE OCCURRENCE OF COASTAL BOTTLENOSE DOLPHINS AND HARBOUR PORPOISES
HELEN BAILEY¹, GEMMA CLAY¹, ELIZABETH A. COATES², DAVID LUSSEAU³, BRIDGET SENIOR⁴

Genetic isolation of a new extant population of bottlenose dolphins (*Tursiops truncatus*)
Courtney Nichols¹, Jerry Herman², Oscar E. Guagnoli³, Keith M. Dobney⁴, Kim Parsons⁵, and A. Rus Hoelzel⁶

Analysis of fatty acids and fatty alcohols reveals seasonal and sex-specific changes in the diets of seabirds

Ellie Owen · Francis Daunt · Colin Moffat · David A. Elton · Sarah Wanless · Paul Thompson

Received: 10 April 2013 / Accepted: 14 December 2012 / Published online: 23 January 2013
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Abstract A key challenge in ecology is to find ways to obtain precise and accurate information about the diets of animals. To respond to this challenge in seabirds, traditional methods of prey analysis, including content analysis or indirect methods of molecular trophic indicators, these investigations have the potential to extend the period of analysis. Here, we use a novel method of fatty acid (FA) and fatty alcohol (FAA) analysis to provide significant insights into the diets of male and female

common guillemots (*Uria aegialis*), black-legged kittiwakes (*Rissa tridactyla*) and northern fulmars (*Fulmarus glacialis*) collected during the breeding period. We found that the composition of the diet of both sexes of all three species changed seasonally across the season, but sex differences were apparent only in the diet of fulmars. Our results show that FA/FAA analysis can provide significant insights into the diets of seabirds, in particular periods of the breeding season which are not readily sampled using traditional methods.

Keywords Fatty acids · Fatty alcohols · Diets · Seabirds · Trophic indicators

Communicated by S. A. Pardo.

Electronic supplementary material The online version of this article (doi:10.1007/s00771-012-0111-0) includes supplementary material, which is available to authorized users.

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Flexible incubation rhythm in northern fulmars: a comparison between oceanographic zones

M. L. Mulvey · A. J. Gaston · M. R. Forbes · H. C. Galloway · S. Cleary · S. Lewis · P. M. Thompson

Abstract Variation in the timing and abundance of incubation efforts is known to affect the breeding success of many seabirds, contrasting our understanding of the extent to which behaviours vary in different parts of a species' range. We compared incubation rhythms in Arctic Canada (High Arctic oceanographic zone) and one colony in the UK (Low Arctic oceanographic zone) between 2011 and 2012. Fulmars in Arctic Canada had longer incubation shifts than previously reported, lower costs in terms of energy expenditure, and were particularly long on one colony in years with above-normal sea-ice cover.

Introduction Oceanic experience a variety of natural cycles and anthropogenic changes, which may change the nature of food web structure, and the timing and abundance of food resources available to marine animals. One way to track these changes is to monitor animals, which are often regarded as effective indicators of the condition of marine ecosystems (Cox 1987; Furness and Cuthbert 1991; Frederiksen 2005). Because these birds rely on resources from the sea, changes in marine productivity or specific food supplies may be detected by monitoring seabird reproduction. For example, in response to food reduction in estuarine food webs, breeding seabirds may exhibit lower colony attempt success, fewer breeding attempts, delayed egg laying, reduced clutch or egg size, reduced reproductive success, or altered breeding timing (Levey et al. 2003; Thompson 2005). Even when marine conditions are 'normal', changes in food availability and availability of

every year, the duration of shifts was shorter than reported. At the lowest colony, incubation shifts were much longer than expected, similar to Arctic colonies, and likely shifted in response to the timing of food supplies in the North Sea. In contrast, on one colony in the UK, incubation shifts were shorter than expected. Collectively, our data suggest that fulmars can adjust their incubation rhythm to compensate for poor marine feeding conditions, although this may incur a cost to body condition or reproductive success.

Keywords Incubation rhythm · Food availability · Energy expenditure · Seabirds · Arctic · Oceanographic zones

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Influence of the tidal cycle and a tidal intrusion front on the spatio-temporal distribution of coastal bottlenose dolphins

Sóna Mendes · William Turrell · Thomas Lillo-Caballero · Paul Thompson

Abstract Small scale hydrographic fronts may act as convergence zones and have been used traditionally to explain spatial and temporal distribution of marine organisms. In this paper, we investigate the spatio-temporal distribution of bottlenose dolphins (*Tursiops truncatus*) in relation to the tidal cycle and a tidal intrusion front. We found that the distribution of dolphins was related to the tidal cycle and the position of the frontal zone. In the first stage of the tidal cycle, the distribution of dolphins was related to the tidal cycle and the position of the frontal zone. In the second stage of the tidal cycle, the distribution of dolphins was related to the tidal cycle and the position of the frontal zone. In the third stage of the tidal cycle, the distribution of dolphins was related to the tidal cycle and the position of the frontal zone.

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Mark-resight estimates of seasonal variation in harbor seal abundance and site fidelity

Lise S. Cordeiro · Paul M. Thompson

Abstract Monitoring trends in abundance of pinnipeds typically involves counting seals at terrestrial haul-out sites throughout the breeding season. Counts of seals made at other times of the year are typically lower, however, it is often times when these counts simply reflect a reduction in haul-out probability. Here we illustrate how photo-identification can be used to estimate seasonal variation in abundance and site fidelity. Monthly data collected over a two-year period were analyzed using a mark-resight population model to estimate seasonal variation in abundance and site fidelity. Monthly data collected over a two-year period were analyzed using a mark-resight population model to estimate seasonal variation in abundance and site fidelity.

Introduction Monitoring trends in population abundance plays an important role in conservation efforts (Pocco et al. 2001; Taylor et al. 2007). For pinnipeds species, this typically involves counting seals at terrestrial haul-out sites throughout the breeding season or at other times when seals are present in large numbers (Baker and Johnson 2005). However, it is often times when these counts simply reflect a reduction in haul-out probability. Here we illustrate how photo-identification can be used to estimate seasonal variation in abundance and site fidelity. Monthly data collected over a two-year period were analyzed using a mark-resight population model to estimate seasonal variation in abundance and site fidelity.

Keywords Haul-out probability · Individual-based · Mark-resight · Photo-identification · Population dynamics

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Parallel influence of climate on the behaviour of Pacific killer whales and Atlantic bottlenose dolphins

David Williams · Bob Williams · Ian Stewart · Lisa M. Berman · Philip M. Thompson · Paul M. Thompson

Abstract The grouping behaviour of animals is governed by intrinsic and extrinsic factors which may interact. We investigated the influence of ocean climate variation on the grouping behaviour of two widely ranging cetacean species: the Pacific killer whale (*Orcinus orca*) and Atlantic bottlenose dolphin (*Tursiops truncatus*). We found that the grouping behaviour of both species was influenced by ocean climate variation, with killer whales showing a stronger response to climate variation than bottlenose dolphins.

Keywords Bottlenose dolphin, climate, grouping, killer whale, ocean-field model, North Atlantic Oscillation, Pacific Decadal Oscillation, sociality

Communicated by S. A. Pardo.

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Effects of extrinsic and intrinsic factors on breeding success in a long lived seabird

Sue Lewis, David A. Elton, Francis Daunt, Barbara Cheney and Paul M. Thompson

Abstract There is growing concern about the ecological effects of climate change (IPCC 2007; Walker et al. 2002). Population dynamics of animal species are likely to be affected by changes in the timing and abundance of food resources available to marine animals. One way to track these changes is to monitor animals, which are often regarded as effective indicators of the condition of marine ecosystems (Cox 1987; Furness and Cuthbert 1991; Frederiksen 2005). Because these birds rely on resources from the sea, changes in marine productivity or specific food supplies may be detected by monitoring seabird reproduction. For example, in response to food reduction in estuarine food webs, breeding seabirds may exhibit lower colony attempt success, fewer breeding attempts, delayed egg laying, reduced clutch or egg size, reduced reproductive success, or altered breeding timing (Levey et al. 2003; Thompson 2005). Even when marine conditions are 'normal', changes in food availability and availability of

every year, the duration of shifts was shorter than reported. At the lowest colony, incubation shifts were much longer than expected, similar to Arctic colonies, and likely shifted in response to the timing of food supplies in the North Sea. In contrast, on one colony in the UK, incubation shifts were shorter than expected. Collectively, our data suggest that fulmars can adjust their incubation rhythm to compensate for poor marine feeding conditions, although this may incur a cost to body condition or reproductive success.

Keywords Incubation rhythm · Food availability · Energy expenditure · Seabirds · Arctic · Oceanographic zones

Communicated by S. A. Pardo.

S. Lewis · D. A. Elton · F. Daunt · B. Cheney · P. M. Thompson
Department of Biology, Durham University, Leazes Road, Durham, UK

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Use of photo-identification data to quantify mother-calf association patterns in bottlenose dolphins

Kate Grellett, Philip S. Hammond, Ben Wilson, Carol A. Sanders-Reed, and Paul M. Thompson

Abstract For social animals living in fission-fusion societies, the mother-calf bond is long and usually beyond the scope of direct observation. We used photo-identification data to quantify mother-calf associations in a population of bottlenose dolphins (*Tursiops truncatus*) in the North Sea. We found that mother-calf associations were long and stable, with mothers spending a significant proportion of their time with their calves. This suggests that mother-calf associations are important for the survival and development of calves in this population.

Keywords Bottlenose dolphin, climate, grouping, killer whale, ocean-field model, North Atlantic Oscillation, Pacific Decadal Oscillation, sociality

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Review of the 1988 and 2002 phocine distemper virus epidemics in European harbour seals

Tero Härkönen · Rune Dietz · Peter Reijnders · Jonas Teilmann · Karin Harding · Halvor S. Øien · Thomas Das Rasmusen · Paul Thompson

Abstract We present new and revised data for the phocine distemper virus (PDV) epidemics that resulted in the deaths of more than 23000 harbour seals (*Phoca vitulina*) in 1988 and 2002 in Europe. We found that the epidemics were caused by a single strain of PDV, which was introduced to Europe from the North Atlantic. The epidemics were caused by a single strain of PDV, which was introduced to Europe from the North Atlantic. The epidemics were caused by a single strain of PDV, which was introduced to Europe from the North Atlantic.

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Senescence rates are determined by ranking on the fast-slow life-history continuum

Diana K. Jones · Sean M. Schrad · Jennifer L. Schrad · Robert M. May · Paul M. Thompson

Abstract Comparative analysis of survival senescence by using life table methods has identified general patterns in the relationship between senescence and life history. We found that senescence rates were determined by ranking on the fast-slow life-history continuum. Species with a fast life history (high fecundity, short lifespan) had higher senescence rates, while species with a slow life history (low fecundity, long lifespan) had lower senescence rates.

Keywords Senescence, life history, survival, mortality, population dynamics

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Ecological, morphological and genetic divergence of sympatric North Atlantic killer whale populations

Andrew D. Poot · Jason Newton · Stuart B. Piertney · ESKA Willerslev · Paul M. Thompson

Abstract Biological divergence has a central role in speciation and is therefore an important source of biodiversity. We investigated the ecological, morphological and genetic divergence of sympatric North Atlantic killer whale populations. We found that there was significant divergence in morphology and genetics, but not in ecology. This suggests that ecological factors may be important in driving divergence in these populations.

Keywords Bottlenose dolphin, climate, grouping, killer whale, ocean-field model, North Atlantic Oscillation, Pacific Decadal Oscillation, sociality

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Mark-resight estimates of seasonal variation in harbor seal abundance and site fidelity

Lise S. Cordeiro · Paul M. Thompson

Abstract Monitoring trends in abundance of pinnipeds typically involves counting seals at terrestrial haul-out sites throughout the breeding season. Counts of seals made at other times of the year are typically lower, however, it is often times when these counts simply reflect a reduction in haul-out probability. Here we illustrate how photo-identification can be used to estimate seasonal variation in abundance and site fidelity. Monthly data collected over a two-year period were analyzed using a mark-resight population model to estimate seasonal variation in abundance and site fidelity. Monthly data collected over a two-year period were analyzed using a mark-resight population model to estimate seasonal variation in abundance and site fidelity.

Introduction Monitoring trends in population abundance plays an important role in conservation efforts (Pocco et al. 2001; Taylor et al. 2007). For pinnipeds species, this typically involves counting seals at terrestrial haul-out sites throughout the breeding season or at other times when seals are present in large numbers (Baker and Johnson 2005). However, it is often times when these counts simply reflect a reduction in haul-out probability. Here we illustrate how photo-identification can be used to estimate seasonal variation in abundance and site fidelity. Monthly data collected over a two-year period were analyzed using a mark-resight population model to estimate seasonal variation in abundance and site fidelity.

Keywords Haul-out probability · Individual-based · Mark-resight · Photo-identification · Population dynamics

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Long-term patterns in harbour seal site-use and the consequences for managing protected areas

L. S. Cordeiro · C. D. Duck · B. L. Mackey · A. J. Hoff · P. M. Thompson

Abstract There have been marked declines of UK harbor seals and populations over at least the last decade. Protected areas, such as Special Areas of Conservation (SACs), are designed to protect important natural features. We investigated the long-term patterns in harbor seal site-use and the consequences for managing protected areas. We found that harbor seals showed a strong preference for certain sites, and that the use of these sites was related to the quality of the habitat. This suggests that the management of protected areas should focus on maintaining the quality of the habitat.

Keywords Long-term patterns, harbor seal, site-use, protected areas

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Senescence rates are determined by ranking on the fast-slow life-history continuum

Diana K. Jones · Sean M. Schrad · Jennifer L. Schrad · Robert M. May · Paul M. Thompson

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