Institution: Bournemouth University
Unit of Assessment: UOA17
Title of case study: Striking the right balance between coastal bird conservation and the needs of society.

1. Summary of the impact (indicative maximum 100 words)

Human activities and manmade structures can negatively affect bird populations, but previously there was no robust method to quantify the impact. Bournemouth University (BU) researchers have applied extensive behavioural research to develop unique computer modelling techniques to predict how human activities affect coastal birds. These models have provided the evidence-base for coastal management schemes in 35 sites in Europe and one in Australia and include shellfisheries, wind farms, bridges, tidal barrages and nuclear power stations. In England specifically the technique has been applied to 812 km^2 (29%) of protected coastal habitat.

With no other alternatives to quantify the risk to birds, this research is truly innovative. The method gives coastal managers the evidence to make informed decisions that weigh up the cost to birds with the benefits to society. This avoids the precautionary principle of banning human activities that are not in fact harming the birds.

2. Underpinning research (indicative maximum 500 words)

Human activity, such as port development, dredging, tidal barrages, wind farms, recreation and fishing can lead to loss of habitat and biodiversity. There is a long history of environmental conflicts between the needs of the birds and human activity, which has been fuelled by a lack of evidence of how the changes affect the birds. Coastal managers need to balance the requirements of the birds with those of society and to do this they need evidence. This has not been available until now, but BU researchers Stillman (2007 to present) and Clarke (2007 to present) identified this knowledge gap and created a system to provide timely advice on predicted impacts before change happens.

The method combines behavioural research within a computer model. The results quantify the effect of environmental change on the coastal birds, providing the evidence for an informed debate between different interest groups. BU is in a unique position to provide this advice as no comparable approaches are available (P1).

The first component of the process has been extensive behavioural research into how individual species, such as waders and wildfowl, respond to environmental change (P1). This includes how they interact with their competitors, prey, humans and the environment. The BU research has made significant advances in ecologists' understanding of how food supply, competitors and disturbance from humans can affect the rates at which birds consume their food. This has allowed BU researchers to build up extensive knowledge of how real birds respond to changes within their environment.

The second component is the use of applied research to predict the effect of environmental change within a site. Information on the site's environment and the number and species is fed into a computer model, MORPH, programmed by BU researchers (P2) to predict how the birds will respond to a certain change. MORPH is based on the principal that animals will attempt to maximise their chances of survival and reproduction, regardless of how much the environment changes. The model predictions are compared with real conditions to confirm accuracy (P1). By integrating the responses of individual birds, the model can predict the population response to the change. These responses relate to bird behaviour and foraging success, and their interaction with competitors, prey, potential predators and the environment. The output is a prediction of the change in mortality rate and distribution of the population in response to the environmental change.

For example, by inputting accurate data about the food supply available in an environment, the user can see how the model birds would feed. The user can then reduce the amount of food available and see how many birds would die. A real-life application here would be in setting shellfishing quotas. The user could vary the food supply in the computer model to find a level that fulfils the needs of the fisherman with minimal impact on the birds.

Grant G1 brought together coastal stakeholders (Natural England, Scottish Natural Heritage, Countryside Council for Wales, Shellfishery regulators, Royal Society for the Protection of Birds and Associated British Ports) to transfer understanding of the approach and make the outputs of the research more accessible. This took place through a series of workshops and the development of a simplified model (P3). Grant G2 funded the international dissemination of the research and its application to conservationists and government bodies in France, Spain, Portugal and the USA.

Application of the model takes the form of commissioned research addressing coastal bird conservation issues or as responses to case-specific or general policy enquiries. BU's role is evidenced through the £75,000 to £100,000 funding per year to apply the approach since 2008, commissioned research reports and letters of support from the coastal managers or policy makers (see section 5). The computer model predicts the amount of environmental change beyond which coastal birds are adversely affected (P4 and P5). Predicting how environmental change affects coastal birds can reliably inform conservation management and policy.

3. References to the research (indicative maximum of six references)

Papers

P1. Stillman, R.A. and Goss-Custard, J.D. (2010) Individual-based ecology of coastal birds. *Biological Reviews*, 85(3), 413–434. DOI:10.1111/j.1469-185X.2009.00106.x.
P2. Stillman, R.A. (2008) MORPH – An individual-based model to predict the effect of environmental change on animal populations. *Ecological Modelling*, 216(3–4), 265–276. DOI:10.1016/j.ecolmodel.2008.04.014.
P3. West, A.D., Stillman, R.A., Drewitt, A., Frost, N.J., Mander, M., Miles, C., Langston, R., Sanderson, W.G. and Willis, J. (2011) WaderMORPH: A user-friendly model to advise shorebird policy and management. *Methods in Ecology and Evolution*, 2(1), 95–98. DOI:10.1111/j.2041-210X.2010.00049.x.
P4. Durell, S.E.A. Le V. dit, Stillman, R.A., Triplet, P., Desprez, M., Fagot, C., Loquet, N., Sueur, F. and Goss-Custard, J.D. (2008) Using an individual-based model to inform estuary management in the Baie de Somme, France. *Oryx*, 42, 265–277. DOI: 10.1017/s003060530800625x.
P5. Stillman, R.A., Moore, J.J., Woolmer, A.P., Murphy, M.D, Walker, P., Vanstaen, K.R., Palmer, D. and Sanderson, W.G. (2010) Assessing waterbird bird conservation objectives: An example for the Burry Inlet, UK. *Biological Conservation*, 143(11), 2617–2630. DOI:10.1016/j.biocon.2010.07.004.

Grants

G1. 2008–2010. Natural Environment Research Council. Building a user-friendly model to assist wildlife policy and management. Project code: NE/F009305/1. PI: Richard Stillman. £153,000.
G2. 2010–2011. Higher Education Innovation Fund. Coastal Bird Enterprise. PI: Richard Stillman. £20,362.

4. Details of the impact (indicative maximum 750 words)

BU's research has had a significant impact on protecting biodiversity, with fewer birds dying through loss of food and habitat. It also benefits society by identifying human activities that do not negatively impact on the birds. Historically, the precautionary principle would be applied in the absence of evidence, assuming any activity would adversely affect the birds. This has led to banning human activities that would not affect wildlife. This wastes conservation resources in opposing non-harming activities instead of focusing efforts on damaging ones, and also restricts human activities and development even if they would be non-damaging.

The computer modelling technique has been applied to 35 sites in Europe and one in Australia. In England specifically it has been used on 812 km^2 (29%) of Special Protection Areas identified by DEFRA (Humber Estuary, Wash, North Norfolk, Chichester Harbour, Southampton Water, Poole Harbour, Exe Estuary, Severn Estuary, Dee Estuary, Morecambe Bay and Solway Firth). Since 2007, the computer modelling technique has been used in the following conservation scenarios:

Barrages and bridges

Evidence was provided to the UK Government on the impact of proposed tidal power barrages within the Severn Estuary in 2010 contributed to the decision to abandon funding of the scheme on environmental grounds (R1). Evidence was provided to the Danish government in 2011 on the effect a proposed bridge over the Fehmarn Belt between Germany and Denmark would have on sea ducks.

Housing

Evidence was provided to regulatory bodies and conservation and industrial organisations on the potential impact of human disturbance resulting from increased housing in the Solent region (2010-present; R2 and R3).

Harbour development

Evidence was provided for the assessment of the impact of harbour development on a rare wading bird, the Pied Oystercatcher, in Tasmania (2008; R4).

Sea level rise

Evidence has shown the impact of sea level rise on bird populations in Poole Harbour (2008), Exe Estuary (2008) and Baie de Somme, France (2008-present). Manager of the Nature Syndicat Mixte Nature Reserve in France said: “The results of the model gave the opportunity and the arguments to change the opening of the cockle fishing season. This now starts one month earlier than before, in order to increase the cockle harvest” (R5).

Nuclear power

The UK nuclear power industry was advised on the impact warm-water outflow from a proposed nuclear power station on Bridgwater Bay would have on birds and their food source (2010, R6).

Shellfishing

The BU model is applied to annual quotas in Baie de Somme, France (2008-present; R5) and all shellfishing sites in Wales. This is evidenced in the minutes from the Welsh Government meeting, ‘Bird Food Model’, which took place in Aberystwyth on 3 October 2012 (R7).

In England, evidence of the effects of shellfishing has been provided to coastal managers of 27% (881 km^2) of coastal and brackish waters classified as shellfish surface water by DEFRA. This includes Solway Firth (2008; R8); Morecambe Bay (2010; R9) and The Wash (2007-present; R9). Referring to a protected wading bird, Senior Advisor for Natural England said: “The modelling work has determined the amount of shellfish food required to ensure minimum mortality in the over-wintering oystercatcher population” (R9).

Using financial information from the Marine Management Organisation, the English shellfisheries regulated by BU research and modelling, produce between 4,401 and 10,394 tonnes of shellfish per annum (2010 figures) with an estimated annual value of between £8.35 million and £17.43 million. This constitutes 53% of the total income generated by shellfishing in English waters.

The Wash specifically produces between 1,100 and 2,298 tonnes of shellfish per annum (2010 figures) with an estimated annual value between £1.7 and £4.38 million. This constitutes 13% of the total annual income generated by shellfish farming in English waters. A precautionary approach of banning shellfishing in the Wash would result in an annual loss of income of between £1.7 and £4.38 million. In contrast, lack of evidence may mean that use of the coast is unregulated. The Wash shellfishery was unregulated during the 1990s and extensive shellfishing reduced the food supplies of a protected species, the oystercatcher, leading to up to 25% overwinter mortality of these birds (5,000 birds), whereas only 1-2% died when overfishing did not occur. BU's modelling technique has allowed shellfishing quotas to be set to maximise economic potential, while ensuring adequate food supply is left for the birds.

The environmental conflicts that BU's models are designed to address occur world-wide and are not restricted to coastal birds. The modelling technique allows coastal managers to weigh up the environmental damage of human activity and, where this is minimal and the benefit to society is significant, proceed with the activity. The evidence quells environmental arguments and allows informed decision making that strikes a balance between protecting biodiversity and doing what is right for society.

Since 2010 these models have been used by 21 researchers (PhD students, post-doctorate researchers and academics) around the world to further conservation research, including 12 in the UK, 7 elsewhere in Europe, 1 in the USA and 1 in South Korea. This demonstrates the increasing reach of the work.

5. Sources to corroborate the impact (indicative maximum of 10 references)

R1. Stillman, R. A. (2010) *Severn Tidal Power – SEA Topic Paper. Waterbirds. Annex 3 – Waterbird Individual-based Modelling*. Report to Department of Energy and Climate Change, p.59.
R2. Letter explaining how BU models have been used to assess the impact of disturbance on birds throughout the Solent region, 31 May 2013 2012 (available on request).
R3. Stillman, R.A., West, A.D., Clarke, R.T. and Liley, D. (2012) *Solent Disturbance and Mitigation Project Phase II: Predicting the impact of human disturbance on overwintering birds in the Solent.* Report to the Solent Forum, p.119.
R4. Atkinson, P.W. and Stillman, R.A. (2008) Carrying capacity modelling for the Pied Oystercatcher at Lauderdale and surrounding sites. Lauderdale Quay Proposal. *British Trust for Ornithology Research Report*, No.515, p.55.
R5. Letter from Syndicat Mixte Baie de Somme explaining how BU's research has been used in the management of the Baie de Somme, France, for coastal birds, 11 September 2012 (available on request).
R6. Garcia, C., Stillman, R.A., Forster, R. and Bremner, J. (2011) *Investigations of the links between intertidal macrofauna and their avian predators in Bridgwater Bay with an individual-based model.* Centre for Environment, Fisheries & Aquaculture Science Report TR161, p.65.
R7. Minutes from Welsh Government meeting, 'Bird Food Model', 3.30pm, 3 October 2012, Aberystwyth.
R8. Stillman, R.A. (2008) *Predicted effect of shellfishing on the oystercatcher and knot populations of the Solway Firth. Final report.* Solway Shellfish Management Association, p.23.
R9. Letter from Natural England explaining how the BU models have been used to set shellfishing quotas in the Wash and North Norfolk, Morecambe Bay and Ribble Estuary Special Protection Areas, 25 October 2013 (available on request).