

# Impact assessment and management

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## Impact assessment and management

### Impact assessment and management 2016

Duan, H., H. Zhang, Q. Huang, Y. Zhang, M. Hu, Y. Niu, and J. Zhu. 2016. Characterization and environmental impact analysis of sea land reclamation activities in China. *Ocean & Coastal Management* **130**:128-137.

(Abstract)

With rapid urbanization and soaring land prices, many coastal cities in China have turned their eyes to the ocean and built airports or factories on reclaimed land. However, sea land reclamation activities have brought about serious environmental impacts. This study therefore combines qualitative and quantitative information to focus on reclamation activities in China and to highlight the major impacts: ecosystem damage and geological disasters, and the deterioration of marine environmental quality resulting from polluted air, water, soil, and sediment. The realized and potential environmental damages are substantial. A resultant policy recommendation is for local Chinese governments to limit land reclamation and to strengthen environmental assessment systems, especially in fragile coastal regions containing important oceanic resources such as mangroves and protected wildlife. Our study can also serve as a reference for the better management of land reclamation in densely populated coastal regions of the world.

Shimeta, J., L. Saint, E. R. Verspaandonk, D. Nugegoda, and S. Howe. 2016. Long-term ecological consequences of herbicide treatment to control the invasive grass, *Spartina anglica*, in an Australian saltmarsh. *Estuarine, Coastal and Shelf Science* **176**:58-66.

(Abstract)

Invasive plants acting as habitat modifiers in coastal wetlands can have extensive ecological impacts. Control of invasive plants often relies on herbicides, although little is known about subsequent environmental impacts. Studying effects of herbicides on non-target species and long-term cascading consequences may yield insights into the ecology of invasive species by revealing interactions with native species. We conducted a long-term field experiment measuring effects of treating the invasive saltmarsh grass, *Spartina anglica*, with the herbicide Fusilade Forte®. No changes in sedimentary macrofaunal abundances or species richness, diversity, or assemblages were detected 1-2 months after spraying, despite known toxicity of Fusilade Forte® to fauna. This lack of impact may have been due to low exposure, since the herbicide was taken up primarily by plant leaves, with the small amount that reached the sediment hydrolyzing rapidly. Six months after spraying, however, total macrofauna in treated plots was more than four times more abundant than in unsprayed control plots, due to a fifteen-fold increase in annelids. This population growth correlated with increased sedimentary organic matter in treated plots, likely due to decomposition of dead *S. anglica* leaves serving

as food for annelids. After another year, no differences in macrofauna or organic matter remained between treatments. The indirect effect on annelid populations from herbicide treatment could benefit management efforts by providing greater food resources for wading birds, in addition to improving birds' access to sediments by reducing plant cover. This study shows that an invasive grass can have a significant impact on native fauna through food-web interactions, influenced by herbicide usage.

Stillman, R. A., K. A. Wood, and J. D. Goss-Custard. 2016. Deriving simple predictions from complex models to support environmental decision-making. *Ecological Modelling* **326**:134–141.

(Abstract)

Recent decades have seen great advances in ecological modelling and computing power, enabling ecologists to build increasingly detailed models to more accurately represent ecological systems. To better inform environmental decision-making, it is important that the predictions of these models are expressed in simple ways that are straightforward for stakeholders to comprehend and use. One way to achieve this is to predict threshold values for environmental perturbations (e.g. climate change, habitat modification, food loss, sea level rise) associated with negative impacts on individuals, populations, communities or ecosystems. These thresholds can be used by stakeholders to inform management and policy. In this paper we demonstrate how this approach can use individual-based models of birds, their prey and habitats, to provide the evidence-base for coastal bird conservation and shellfishery management. In particular, we show how such models can be used to identify threshold values for perturbations of food abundance that can impact negatively on bird populations. We highlight how environmental thresholds could be used more widely to inform management of species and habitats under environmental change.

Li, S., B. Cui, T. Xie, and K. Zhang. 2016. Diversity Pattern of Macrobenthos Associated with Different Stages of Wetland Restoration in the Yellow River Delta. *Wetlands* **36**:S57–S67.

(Abstract)

Because wetland restoration projects are becoming more common and are expensive, it is important to evaluate their success. Evaluation studies commonly use measurements of soils, vegetation, hydrology and wildlife to evaluate the success of wetland restoration. In contrast, the diversity of macrobenthos and their relationships with environmental factors are often neglected. To better understand the success of wetland restoration, we examined the abundance and diversity of macrobenthos in different stages of a freshwater wetland restoration project in the Yellow River Delta in China, with reference to environmental factors

that might explain macrobenthic patterns. Macrobenthic species richness and density were greater in the oldest restoration area versus the younger and no-treatment areas. Macrobenthic biomass, however, was greatest in the no-treatment area. The oldest restoration area had deeper water levels, lower salinities, softer and wetter soils, and higher soil organic, nitrogen and carbon contents, and these variables largely distinguished the macrobenthic samples in a CCA analysis. A combination of landscape position and recovery time (time since the restoration was implemented) likely explains the abiotic differences among restoration areas. We recommend an adaptive management strategy, guided by long-term monitoring and experiments, to improve the success of this and other wetland restoration projects.

Sesser, K. A., M. E. Reiter, D. A. Skalos, K. M. Strum, and C. M. Hickey. 2016. Waterbird response to management practices in rice fields intended to reduce greenhouse gas emissions. *Biological Conservation* **197**:69–79.

(Abstract)

There are many benefits of agricultural landscapes for wildlife. In California's Central Valley, post-harvest flooding of rice fields increases the decomposition of rice stubble and provides habitat for over 50 species of waterbirds. These fields are also flooded during planting, providing habitat for spring migrants and locally breeding birds. Because California has lost over 90% of its historic wetlands, flooded rice is critical wildlife habitat, providing 80% of the total flooded habitat in the Sacramento Valley. Flooding rice fields, however, contributes to greenhouse gas (GHG) emissions. Several rice field management practices may reduce methane emissions including reduced flooding in winter, removal of rice straw after harvest (baling), and drill seeding during planting. During the winters of 2011–2012 and 2012–2013, we compared waterbird use in four combinations of post-harvest practices: baled/flooded, baled/non-flooded, non-baled/flooded, and non-baled/non-flooded. We found significantly higher dabbling duck and shorebird densities in the non-baled/flooded practice compared to the other three practices. During the spring of 2012 and 2013, we compared waterbird use of drill-seeded fields (reduced GHG) with flooded fly-on seeded fields (status quo GHG). We found no significant differences in mean density between the two seeding practices for waterbirds. Our study found evidence that some post-harvest practices (reduced winter flooding, baling) that reduce GHG emissions from rice also reduce use by waterbirds. While reducing GHG is globally necessary to minimizing the impacts of climate change, doing so in an area of hemispheric importance for waterbirds should be done with caution.

Żmihorski M, Pärt T, Gustafsson T, Berg A. 2016. Effects of water level and grassland management on alpha and beta diversity of birds in restored wetlands. *Journal of Applied Ecology* **53**:587–595.

(Abstract)

1. Nearly 60% of European wetlands have been lost to drainage or to the cessation of grassland management. Large amounts of resources are put into wetland restoration with the aim to recover biodiversity. However, few studies have simultaneously evaluated effects of management, wetness and flooding dynamics on biodiversity of restored wetlands such as seasonally flooded wet grasslands.

2. We inventoried bird communities over 4 years at 137 sites (each 3.1 ha) within five restored wet grassland areas in Sweden to investigate whether species richness and occurrence of 12 common wet grassland species were related to (i) local conditions such as management (grazing, mowing and unmanaged areas), basic wetness and spring flooding dynamics. Further, we investigated whether (ii) the composition of the adjacent landscape (20 ha) related to local bird diversity and (iii) species turnover (i.e. beta diversity) differed between sites characterized by their basic wetness, degree of flooding and predominant management regime.

3. Local species richness was positively linked to degree of flooding and basic wetness of grasslands but not to type of grassland management. Species richness tended also to be negatively linked to proportion of forest at the landscape scale. Although variable, the same results were also true concerning the probability of the occurrence of a single species at the local scale.

4. Species turnover between sites, and thus total species richness, was distinctly higher in (i) grazed as compared to mowed grasslands except in dry non-flooded grasslands and (ii) flooded as compared to non-flooded sites. Similar patterns held for the subset of 12 red-listed species. We suggest that the high beta diversity in grazed and flooded grasslands is driven by the heterogeneous vegetation structure, resulting in good conditions for foraging and nesting for several wet grassland bird species.

5. Synthesis and applications. The selection of wetlands for conserving wet grassland birds should prioritize temporary flooded grasslands of moderate wetness, preferably far from forest edges. Restoration and management of wet grasslands should include water level management, removal of shrubs and trees, and low-intensity grazing, whereas mowing could be used in non-flooded grasslands of low basic wetness.

Zhang C, Yuan Y, Zeng G, Liang J, Guo S, Huang L, Hua S, Wu H, Zhu Y, An H, Zhang L. 2016. Influence of hydrological regime and climatic factor on waterbird abundance in Dongting Lake Wetland, China: Implications for biological conservation. *Ecological Engineering* **90**:473–481.

(Abstract)

Understanding how migratory waterbirds respond to hydrology and climate is of great importance for providing valuable insight into conservation in wetland system. Dongting Lake Wetland is an important wintering habitat in the East Asian-Australasian Flyway. However, little

is known about the effects of hydrology and climate on wintering waterbirds. Therefore, it is urgent to analyze the relationship between them. To better interpret the ecological significance, we divided the bird species into five functional groups on the basis of their typical feeding habits. Redundancy analysis (RDA) combined with forward selection procedure was applied to select the hydrological and climatic variables with significant influences. Then, response surface methodology (RSM) was carried out to identify the thresholds of the variables. The results showed that inflow and water level were probably the two critical variables accounting for 52.13% and 47.87% of the variation in the bird species, respectively. However, other variables did not reach a significant level in this study. As for the group-level, different functional bird groups had different reflections to inflow and water level. Minimal guaranteed values of the two variables were identified as 3518.82–3736.28 m<sup>3</sup>/s and 22.61–23.49 m respectively based on the hydrological requirements and the weights of all groups. The results highlighted that the minimal requirements of inflow and water level should be satisfied to provide appropriate habitats for waterbirds. Besides, the regulatory authorities and environmental protection agencies should develop relevant law or regulation to protect waterbird habitats from human destruction especially the activities which could change the hydrological regime.

Liu C-Y, Jiang H-X, Zhang S-q, Li C-r, Pan X, Lu J, Hou Y-Q. 2016. Expansion and Management Implications of Invasive Alien *Spartina alterniflora* in Yancheng Salt Marshes, China. *Open Journal of Ecology* 6:113-128.

(Abstract)

Improved understanding of the spatial dynamics of invasive plant species is critical for effective land management and control of future invasion. The Yancheng National Nature Reserve (YNNR), an internationally important wetland, has the largest distribution of alien *Spartina alterniflora* in China. This alien plant was intentionally introduced for erosion prevention and dike protection in China. However, it became an aggressive competitor with native salt marsh plants in the coastal regions in China. High resolution imagery, SPOT-5, was used to map plant communities including invasive species in the south core zone of YNNR with the natural ecosystem of salt marshes in 2003, 2005 and 2008. The fuzzy set assessment method significantly improved the classification accuracies over the conventional error matrix, i.e., from 73.8%, 73.5% and 81.4% to 91.5%, 91.6% and 93.4% in 2003, 2005 and 2008, respectively. It shows a great potential for mapping invasive plant species. *Phragmites australis* and *S. alterniflora* were the most accurately mapped classes, and sparse and dense *Suaeda glauca* were the least accurately mapped. From 2003 to 2008, *S. alterniflora* increased 28.8% from 1664.1 to 2142.6 ha in area size, and more than 2.5 times from 742 to 2608 patches. The highest increase in patch number occurred within the interval between 2001 and 3000 m from the eastern baseline. This increase was dominated by small patches with area less than 200 m<sup>2</sup>. During the study period, the mean spread width was 405 ± 80.7 m in the original large patch of area over 200 ha. The eastward/seaward spread was distinctively larger than the westward/landward. The results enhance the understanding of

alien plant's invasion patterns and help improve conservation efforts.

Casazza ML, Overton CT, Bui T-VD, Hull JM, Albertson JD, Bloom VK, Bobzien S, McBroom J, Latta M, Olofson P, Rohmer TM, Schwarzbach S, Strong DR, Grijalva E, Wood JK, Skalos SM, Takekawa JY. 2016. Endangered species management and ecosystem restoration: finding the common ground. *Ecology and Society* **21** (1):19.

(Abstract)

Management actions to protect endangered species and conserve ecosystem function may not always be in precise alignment. Efforts to recover the California Ridgway's Rail (*Rallus obsoletus obsoletus*; hereafter, California rail), a federally and state-listed species, and restoration of tidal marsh ecosystems in the San Francisco Bay estuary provide a prime example of habitat restoration that has conflicted with species conservation. On the brink of extinction from habitat loss and degradation, and non-native predators in the 1990s, California rail populations responded positively to introduction of a non-native plant, Atlantic cordgrass (*Spartina alterniflora*). California rail populations were in substantial decline when the non-native *Spartina* was initially introduced as part of efforts to recover tidal marshes. Subsequent hybridization with the native Pacific cordgrass (*Spartina foliosa*) boosted California rail populations by providing greater cover and increased habitat area. The hybrid cordgrass (*S. alterniflora* × *S. foliosa*) readily invaded tidal mudflats and channels, and both crowded out native tidal marsh plants and increased sediment accretion in the marsh plain. This resulted in modification of tidal marsh geomorphology, hydrology, productivity, and species composition. Our results show that denser California rail populations occur in invasive *Spartina* than in native *Spartina* in San Francisco Bay. Herbicide treatment between 2005 and 2012 removed invasive *Spartina* from open intertidal mud and preserved foraging habitat for shorebirds. However, removal of invasive *Spartina* caused substantial decreases in California rail populations. Unknown facets of California rail ecology, undesirable interim stages of tidal marsh restoration, and competing management objectives among stakeholders resulted in management planning for endangered species or ecosystem restoration that favored one goal over the other. We have examined this perceived conflict and propose strategies for moderating harmful effects of restoration while meeting the needs of both endangered species and the imperiled native marsh ecosystem.

Lu Q, Kang L, Shao H, Zhao Z, Chen Q, Bi X, Shi P. 2016. Investigating marsh sediment dynamics and its driving factors in Yellow River delta for wetland restoration. *Ecological Engineering* **90**:307–313.

(Abstract)

The wetlands of the Yellow River delta play important roles for Asian and west Pacific birds during migration. Marshes are the main component of wetlands in the delta, and their coverage area has experienced a decreasing trend for the last few decades. Wetland changes in the Yellow River delta have been analyzed in previous studies; however, those studies only partially analyzed the causes of the decline. Using statistical and spatial analysis based on observational data and remote sensing imagery for the period of 1986–2005, we found that the annual mean temperature and annual precipitation tended to increase, and the evapotranspiration and the moisture index tended to decrease. Consequently, these climate factors led to a significant decrease in river runoff, which resulted in decreased water supply for the marshes in the delta. A Wetland Restoration Project was launched in 1992, and it successfully conserved marshes within a relatively small area. However, the inadequate water supply still resulted in an overall decrease in marsh area over the entire study area. These results provide more insights into managing wetlands eco-restoration.

Puente-Rodriguez, D., E. van Slobbe, I. A. C. Al, and D. E. Lindenbergh. 2016. Knowledge co-production in practice: Enabling environmental management systems for ports through participatory research in the Dutch Wadden Sea. *Environmental Science and Policy* **55**:456-466.

(Abstract)

Coastal zone management is inconceivable without the mobilization and integration of different types of knowledge – that is, without knowledge co-production practices. This article applies the concept of knowledge co-production to analyze the process of emergence, standardization, and enculturation of environmental management systems (EMSs) within port communities in the Dutch Wadden Sea. Moreover, it is a report from the field in which we reflect on the participatory practices conducted to facilitate the knowledge arrangements required to develop EMSs for a group of ports. The article concludes that this type of knowledge arrangement and co-production practices (involving different types of actors and knowledge) might become mandatory in the near future to stabilize the EMS phenomenon in the practices of ports.

#### Impact assessment and management 2015

Zhang B, Yin L, Zhang S, Liang K. 2015. Estimation on wetland loss and its restoration potential in Modern Yellow River Delta, Shandong Province of China. *Chinese Journal of Population Resources and Environment* **13** (4):365-372.



(Abstract)

Wetland is one of the most important ecosystems with varied functions and structures, and its loss has been a major issue. Wetland loss in Modern Yellow River Delta (MYRD) becomes a serious environmental problem, so its restoration attracts a great deal of attention from academia and governments. This article proposes a GIS-based multi-criteria comprehensive evaluation methodology for potential estimation of wetland restoration, using MYRD as an example. The model uses four kinds of data (hydrology, terrain, soil, and land use) and could be adapted by planners for use in identifying the suitability of locations as wetland mitigation sites at any site or region. In the application of the model in the MYRD, the research developed a lost wetland distributed map taking the better wetland situation of 1995 as the reference, and elevated the overall distribution trends of wetland restoration potential based on wetland polygon. The results indicated that the total area of wetland loss from 1995 to 2014 was 568.12 km<sup>2</sup>, which includes 188.83 km<sup>2</sup> natural wetland and 21.80 km<sup>2</sup> artificial wetland, respectively. The areas of lost wetland with low, middle, and high resilience ability are 126.82 km<sup>2</sup>, 259.92 km<sup>2</sup>, and 119.59 km<sup>2</sup>, occupying 25.05%, 51.33%, and 23.62%, respectively. The high-restoration-potential wetland included 98.47 km<sup>2</sup> of natural wetland and 21.12 km<sup>2</sup> of artificial wetland, which are mainly bush, reed, and ponds. The high restoration-potential wetland is mainly distributed in the vicinity of Gudong oil field, the Yellow River Delta protected areas, and the eastern sides of Kenli county and Dongying city.

Reiter, M. E., M. A. Wolder, J. E. Isola, D. Jongsomjit, C. M. Hickey, M. Carpenter, and J. G. Silveira. 2015. Local and Landscape Habitat Associations of Shorebirds in Wetlands of the Sacramento Valley of California. *Journal of Fish and Wildlife Management* 6:29-43.

(Abstract)

The Sacramento Valley of California is a site of international importance for shorebirds despite having lost >90% of its historic wetlands. Currently both managed wetlands and flooded agriculture are important habitats for shorebird populations, but the extent of flooded agriculture may be declining in early winter when shorebirds need to acquire resources postmigration to survive winter. We employed long-term shorebird monitoring data to evaluate factors influencing abundance and species richness of shorebirds using the Sacramento National Wildlife Refuge Complex in early winter (November–December) between 2000 and 2009. We quantified the effect of local attributes of the wetland management unit (wetland type, size, and topography) as well as factors in the surrounding landscape (proportion of surface water and housing density) using generalized linear mixed models. We assessed a local-scale model, including covariates representing the area of six wetland types within the management unit, an index to the proportion of the management unit that had a tapered-edge (i.e., topography where flooded areas grade to exposed shoreline then upland), and a year effect. In this local-scale model, shorebird abundance had a significant positive association with the area of seasonally flooded marsh (SFM) and summer water. Topographical variation, characterized by the amount of tapered-edge, also had a significant positive effect on the abundance of shorebirds and species richness. Because >70% of the shorebirds were

counted in SFM, we removed all wetland types except SFM to evaluate landscape covariates. Using only SFM-dominated units, there was a significant nonlinear association with the area of SFM within a management unit, with 40–95-ha wetlands having the highest shorebird abundance and species richness. On a landscape scale, the amount of flooding within a 10-km buffer was the best supported model of shorebird abundance and suggested the highest shorebird abundance in a management unit to be expected when 15–45% of the surrounding landscape was flooded. Species richness was positively associated with the proportion of surface water within 2- and 5-km buffers. We identified zones with a predicted high shorebird response to SFM, and assessed that only 6% of potential wetland areas in those zones have permanent conservation status. Our analyses suggest that shorebird abundance and species richness vary nonlinearly as a function of both local and landscape factors, and thus both spatial scales should be considered when developing conservation and management strategies.

Iftekhar, M. S., and D. J. Pannell. 2015. “Biases” in Adaptive Natural Resource Management. *Conservation Letters* 8:388–396.

(Abstract)

Uncertainties about the consequences of natural resource management mean that managers are required to make difficult judgments. However, research in behavioral economics, psychology, and behavioral decision theory has shown that people, including managers, are subject to a range of biases in their perceptions and judgments. Based on an interpretative survey of these literatures, we identify particular biases that are likely to impinge on the operation and success of natural resource management. We discuss these in the particular context of adaptive management, an approach that emphasizes learning from practical experience to reduce uncertainties. The biases discussed include action bias, the planning fallacy, reliance on limited information, limited reliance on systematic learning, framing effects, and reference-point bias. Agencies should be aware of the influence of biases when adaptive management decisions are undertaken. We propose several ways to reduce these biases.

Rogers, D. I., K. Stamation, R. H. Loyn, and P. Menkhorst. 2015. Literature Review: Management of Non-Tidal Ponds for Shorebirds. Arthur Rylah Institute for Environmental Research Technical Report Series No. 264, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

(Abstract)

Melbourne Water manages the Western Treatment Plant (WTP), a very large sewage treatment complex on the western shores of Port Phillip Bay with internationally important

populations of migratory shorebirds. In addition to the core purpose of treating wastewater, Melbourne Water has obligations to maintain the shorebird populations of the WTP. Part of the adaptive management framework adopted to accomplish this has been to manage a network of constructed, non-tidal ponds for migratory shorebirds. Many wetland sites around the world are managed for waterbirds, or specifically for shorebirds, and much applied research has been carried out to guide the management of such sites. This report reviews that literature, with a focus on two management questions of particular importance to the WTP:

1. What water management regimes are required in order to maximise the amount of accessible, edible benthic fauna in artificial wetlands?
2. What methods are used to control vegetation encroachment in artificial wetlands, and what are the advantages and disadvantages of each?

Relevant literature located using two bibliographic search tools (Thomson Reuters Web of Science, and Scopus), supplemented by personal collections of shorebird and wetland literature acquired opportunistically over many years. The literature located was extensive but diffuse, and needs to be interpreted with some caution, as authors often advocated management practices that were well suited to their particular study sites and objectives, but not universally applicable. For example, extensive research on manipulating water levels for waterbirds has been carried out in North America, but often the objective there was to enhance habitat for wildfowl, which benefit from accelerated growth of water plants. In contrast, shorebirds forage when wading in shallow wetlands with little or no vegetation, and often abandon wetlands when they become too thickly vegetated. The following points from the literature review were considered of particular relevance to habitat management at the WTP:

1. Habitat studies in non-tidal ponds consistently identified water depth as the habitat attribute of greatest importance to shorebirds: non-tidal ponds can only be used by foraging shorebirds if they are within a narrow range of water depths (these depths vary according to the leg length of the various species).
2. Prey abundance also has a profound effect on numbers of foraging shorebirds. Other factors that have been found to influence shorebird abundance on non-tidal ponds include wetland size, disturbance levels and salinity.
3. Melbourne Water's broad management strategy for managing 'shorebird ponds' at the WTP is to keep selected non-tidal ponds deeply flooded during winter to prevent them becoming choked by vegetation, and to draw water levels down during the austral summer so that the waters become shallow enough for foraging shorebirds at the time of year when numbers and energetic demands of migratory shorebirds are highest. Pond drawdowns are staggered to extend the period in which non-tidal ponds can be used by foraging shorebirds. This general approach is consistent with practices recommended in seminal references on the management of shorebird habitat in non-tidal ponds.
4. The management approach at the WTP is particularly well suited to increasing the abundance of chironomid (midge) larvae, which dominate shorebird diets in most non-tidal wetlands worldwide wherever foraging studies have been carried out. Attributes of chironomid larvae enabling them to occur in high abundance in the shallow open habitats preferred by shorebirds include: tolerance of a wide range of salinities, temperatures and depths; the

capacity to rapidly colonise 'new' wetlands through oviposition by flying adults from nearby wetlands; and the capacity for larvae to grow rapidly on a diet of detritus and algae. Moreover, chironomid larvae are excellent prey for shorebirds, being sluggish, easily captured and of high energy content.

5. The effects of nutrient levels on shorebird abundance are not particularly well known in non-tidal ponds. However, the organic content of sediments has been shown to be correlated with the abundance of benthic invertebrates in non-tidal ponds, and there is an extensive literature on the release of phosphorus in readily available inorganic forms from benthic sediments that have been completely dried out before reflooding. Phosphorus release prompts a surge of productivity in most freshwater wetlands that are alternately dried out and reflooded. For this reason, it is likely that food stocks in wetlands for shorebirds will be higher if managers periodically completely dry out ponds before refilling them (rather than partially draining them and then topping them up).

6. The time taken for invertebrate fauna to recolonise a wetland after it has been refilled is of great importance in determining the draining and refilling schedules of managed wetlands. This duration varies seasonally, is faster in warmer months, and is somewhat stochastic, as the speed with which a 'new' benthic fauna develops is influenced by chance colonisation events. Direct measurement of recolonisation speeds by chironomids on the Western Plains of Victoria was ~1–2 months. Worldwide, published estimates or direct measurements of the duration required for recolonisation by a full chironomid fauna ranged from 2–3 weeks to 4–5 months. At the WTP, a recent study indicated that shorebirds took >4 weeks to recolonise dry or drying ponds after they had been topped up to water levels suitable for shorebirds, consistent with relatively slow recolonisation rates by benthic fauna.

7. Vegetation encroachment is a problem wetland managers face worldwide when managing ponds for shorebirds, as the conditions in which ponds are suitable for shorebirds essentially occur during an early successional stage of vegetation. Deep flooding is a widely preferred method for controlling vegetation in ponds managed for shorebirds. However, the literature emphasises that flooding alone is often not sufficient for controlling vegetation in non-tidal ponds, and that in such cases more active management interventions are preferable to inaction.

8. Methods that have been used effectively to control vegetation in a variety of settings include grazing, burning, disk tilling and herbicides. The preferred method will vary from site to site depending on management targets and budget constraints. At the WTP, for example, grazing is likely to be the most suitable option (and light or pulse grazing has also been advocated in the management of Growling Grass Frog (*Litoria raniformis*) habitat).

9. Although we found no references on the introduction of salt water specifically to control vegetation in shorebird habitat, there is abundant literature showing that vegetation is less dense in saline water, and that shorebird prey (and shorebirds) can occur in abundance in saline ponds.

Van Wesenbeeck, B. K., T. Balke, P. van Eijk, F. Tonneijck, H. Y. Siry, M. E. Rudianto, and J. C. Winterwerp. 2015. Aquaculture induced erosion of tropical coastlines throws coastal communities back into poverty. *Ocean & Coastal Management* **116**:466-469.

(Abstract)

Shallow tropical coastlines harbour unique mangrove ecosystems, which support livelihoods and provide a natural barrier against coastal flooding. Non-sustainable land-use practices, such as large-scale clear cutting of mangroves for aquaculture, ground water withdrawal and alteration of river flows, result in rapid subsidence. The collapse of aquaculture production, due to pollution and disease, is followed by coastal erosion, damage to infrastructure, intrusion of salt water and coastal flooding. Standard engineered interventions for protection often fail or are extremely expensive in these soft muddy environments. Subsidence and erosion render re-planting of mangroves in front of retreating coastlines impossible. Short-term solutions should focus on restoration of abiotic conditions, such as hydrology and sediment fluxes, to facilitate rapid establishment of protective mangrove belts. However, to ensure longterm sustainability, improved governance frameworks are required that put in place criteria for sustainable aquaculture, guide coastal infrastructure designs and limit ground water extraction.

Feaga, J. S., F. J. Vilella, R. M. Kaminski, and J. B. Davis. 2015. Waterbird Use of Catfish Ponds and Migratory Bird Habitat Initiative Wetlands in Mississippi. *Waterbirds* **38**:269-281.

(Abstract)

Aquaculture can provide important surrogate habitats for waterbirds. In response to the 2010 Deepwater Horizon oil spill, the National Resource Conservation Service enacted the Migratory Bird Habitat Initiative through which incentivized landowners provided wetland habitats for migrating waterbirds. Diversity and abundance of waterbirds in six production and four idled aquaculture facilities in the Mississippi Alluvial Valley were estimated during the winters of 2011-2013. Wintering waterbirds exhibited similar densities on production (i.e., ~22 birds/ha) and idled (i.e., ~20 birds/ha) sites. A total of 42 species were found using both types of aquaculture wetlands combined, but there was considerable departure in bird guilds occupying the two wetland types. The primary users of production ponds were diving and dabbling ducks and American coots. However, idled ponds, with varying water depths (e.g., mudflats to 20 cm) and diverse emergent vegetation-water interspersion, attracted over 30 species of waterbirds and, on average, had more species of waterbirds from fall through early spring than catfish production ponds. Conservation through the Migratory Bird Habitat Initiative was likely responsible for this difference. Our results suggest production and idled Migratory Bird Habitat Initiative aquaculture impoundments produced suitable conditions for various waterbird species and highlight the importance of conservation programs on private lands that promote diversity in vegetation structure and water depths to enhance waterbird diversity.

Marco-Méndez, C., P. Prado, L. M. Ferrero-Vicente, C. Ibáñez, and J. L. Sánchez-Lizaso. 2015. Rice Fields Used as Feeding Habitats for Waterfowl throughout the Growing Season. *Waterbirds* **38**:238-251.

(Abstract)

The role of rice fields as feeding habitats for the two main waterfowl herbivores, Eurasian Coot (*Fulica atra*) and Mallard (*Anas platyrhynchos*), in the Ebro Delta, a Mediterranean wetland in northeastern Spain, was investigated. Exclusion cages and tethering experiments were deployed within a rice field at the beginning of the growing season (summer 2010) and before harvest (autumn 2010). In summer, waterfowl abundances were low, but cage experiments detected rice field damage by waterfowl grazing through a significant reduction in plant biomass (although consumption was undetectable using tethers). In autumn, waterfowl abundance increased and tethering experiments detected consumption of rice plants with developed seeds, whereas cage experiments did not show grazing effects. Gut content analyses indicate that Mallards are mainly granivorous, feeding mostly on seeds of spiral ditch grass (*Ruppia cirrhosa*) and rice (*Oryza sativa*), while Eurasian Coots are herbivorous, feeding mainly on macrophyte leaves. However, stable isotope analyses and mixing model results showed that in the long term both species seem to acquire most of their dietary needs from rice plants and sago pondweed (*Potamogeton pectinatus*). Dietary analyses confirm the importance of rice in both species' diets but also suggest that waterfowl may undergo seasonal dietary variations. These are mostly influenced by changes in the availability of food resources in the area rather than by their nutritional quality. This study confirms the ecological importance of rice fields as a complementary feeding habitat for waterfowl during the growing season in Mediterranean areas. It also highlights the importance of including these habitats in wetland management for waterfowl conservation.

Mandema, F. S., J. M. Tinbergen, B. J. Ens, K. Koffijberg, K. S. Dijkema, and J. P. Bakker. 2015. Moderate livestock grazing of salt, and brackish marshes benefits breeding birds along the mainland coast of the Wadden Sea. *The Wilson Journal of Ornithology* **127**:467-476.

(Abstract)

Our study investigated how bird species richness and abundance was related to livestock grazing on salt, and brackish marshes, with an emphasis on songbirds, and shorebirds. Survey areas with a high percentage cover of tall vegetation were assumed to have experienced lower livestock grazing intensities than survey areas with a low percentage cover of tall vegetation. This relationship was verified for the tall grass *Elytrigia atherica*. The species richness, and abundance of birds was related to the percentage cover of tall vegetation on the survey areas. We found that total bird species richness was positively related to the percentage cover of tall vegetation. We also found that all of the investigated species, except Pied Avocet (*Recurvirostra avosetta*), showed a positive relation to the percentage cover of tall vegetation up to a specific percentage of cover. The abundance of investigated songbird

species increased up to an intermediate percentage cover of tall vegetation, and decreased at higher percentage cover of tall vegetation, suggesting that moderate grazing of marshes may maximize the abundance of the investigated songbirds. Abundances of Common Redshank (*Tringa totanus*) and Eurasian Oystercatcher (*Haematopus ostralegus*) were positively related to the percentage cover of tall vegetation on salt marshes, but negatively related to the percentage cover of tall vegetation on brackish marshes. With intermediate livestock grazing species number, and abundance of most breeding birds can be maintained in coastal marshes. However, specific goals for management should be set before applying a grazing regime to a marsh.

Végvári, Z., S. Borza, and K. Juhász. 2015. The role of phylogeny and life history of migratory waterbirds in designing fishpond management plans. *Ecological Engineering* **85**:288–295.

(Abstract)

The acceleration of wetland loss on a global scale has frequently been reported in the past decades which is in correspondence with serious declines of migratory waterbirds. Indeed, the spatial distribution of waterbirds during migration has been shown to be associated with various predictors, ranging from feeding behaviours and migratory strategies to physical attributes of wetlands and spatial effects related to human disturbance. These results demonstrate that different constraints of ecology and life history may shape the effects of human disturbance on migratory water bird populations. In this work we analyse the role of ecological predictors and life history traits in shaping avian responsiveness to spatial attributes of artificial constructions in a phylogenetic context, using an extensive dataset of migratory water birds in Hortobágy, one of the most important stop-over sites in a major Afro-Eurasian flyway. Our study revealed that response to human disturbance factors such as the density and distance of public roads on larger spatial scales is predominantly related to life-history predictors such as the age of maturity, migration strategy and constrained by phylogenetic relatedness. Therefore, we recommend that phylogenetic relatedness and life-history traits are considered when designing management plans for larger water bodies used by staging waterbirds.

Tian, K., G. Liu, D. Xiao, J. Sun, M. Lu, Y. Huang, and P. Lin. 2015. Ecological Effects of Dam Impoundment on Closed and Half-Closed Wetlands in China. *Wetlands* **35**:889–898.

(Abstract)

Whether dam impoundment for water resource purposes improves wetland ecosystems is heavily disputed. In this study, we investigated the effects of dam impoundment from 2006 to 2011 on wetland plant communities and wintering water birds in Lashi Lake, a typical closed

wetland in Northwest Yunnan, China. The surface area of the water body increased from 933 hm<sup>2</sup> before impoundment to 1262 hm<sup>2</sup> after impoundment; the area of meadows and emergent, submerged and floating vegetation increased from 1006 to 1149 hm<sup>2</sup>. After the dam impoundment and with the rising water level, formerly dominant plant communities, such as Com. *Phragmites australis*, Com. *Potamogeton pectinatus* and Com. *Nymphoides peltatum*, disappeared. New communities, such as Com. *Polygonum hydropiper*, Com. *Acorus calamus* and Com. *Leersia hexandra*, rapidly expanded into the newly formed lakeside. During these changes, the species and number of wintering water birds slightly increased, but the populations and distributions of birds were altered. Some birds chose the newly formed lakeside as habitat, while others disappeared or decreased greatly. Notably, the major protected birds, such as species of *Ciconia nigra*, did not appear in the new area, and the species number of *Grus grus* decreased. The results showed that damming impacted wetland ecosystems. Given the importance and complexity of dam impoundment in alpine wetlands, the effects of food-chain modifications on plants, water birds, aquatic organisms, and humans could be extensive.

Jiang, T.-t., J.-f. Pan, X.-M. Pu, B. Wang, and J.-J. Pan. 2015. Current status of coastal wetlands in China: Degradation, restoration, and future management. *Estuarine, Coastal and Shelf Science* **164**:265-275.

(Abstract)

China's coastal wetlands have been under considerable stress and have been severely damaged as a result of continuing population growth, large-scale infrastructural developments, extensive land reclamation projects, and the ineffective control of various types of pollution. The restoration of coastal wetlands in China has consequently become urgent. In this study, we analyze the degradation status of coastal wetlands, also review progress made towards their restoration. We further discuss the weaknesses of policy and institutional frameworks in tackling environmental problems in coastal wetlands. These perspectives on comprehensive and integrated policy requirements for wetland restoration, management, and future development will help ensure better management of coastal wetlands.

Glisson, W. J., R. S. Brady, A. T. Paulios, S. K. Jacobi, and D. J. Larkin. 2015. Sensitivity of Secretive Marsh Birds to Vegetation Condition in Natural and Restored Wetlands in Wisconsin. *The Journal of Wildlife Management* **79**:1101–1116.

(Abstract)

Wetland loss, biological invasions, and ecological restoration are major factors altering wetland resources in the Midwestern United States. Large-scale plant-community change



associated with these factors is an under-investigated, potentially strong driver of habitat suitability for wetland-dependent wildlife, such as secretive marsh birds (SMBs), which are of widespread conservation concern. We employed multi-year, hierarchical Bayesian occupancy modeling to investigate sensitivity of 3 SMB species (American bittern, sora, and Virginia rail) to habitat and vegetation characteristics in Wisconsin, USA. We contrasted habitat characteristics and SMB occupancy in natural wetlands with those restored under the federally funded Wetlands Reserve Program (WRP). We also examined the extent to which SMB occupancy was explained by 3 levels of habitat assessment that encompassed different spatial scales and levels of sampling effort (landscape, rapid, and intensive). All species were significantly associated with variables derived from intensive assessment, and showed high sensitivity to differences in plant-community composition and vegetation quality. Both American bittern and Virginia rail were negatively associated with abundance of the invasive wetland grass, *Phalaris arundinacea* (reed canarygrass), and were positively associated with an indicator of plant-community quality (mean coefficient of conservatism, or C-value). Sora occupancy was positively associated with *Typha* (cattail) abundance. For all 3 species, occupancy was greater in natural sites than in restored sites, which were characterized by greater *Phalaris* abundance and lower mean C-values. Our results show broad agreement between botanical and avian indicators of wetland quality, suggesting that enhancing the condition of wetland vegetation can yield ancillary benefits for SMBs. In this region, efforts to control *Phalaris* and restore diverse, native-dominated plant communities are likely to increase wetlands' capacity to support SMBs.

Kerschbaumer, L., J. F. Köbbing, K. Ott, S. Zerbe, and N. Thevs. 2015. Development scenarios on Hetao irrigation area (China): a qualitative analysis from social, economic and ecological perspectives. *Environ Earth Sci* **73**:815-834.

(Abstract)

Lakes are threatened ecosystems in drylands of Central Asia. The Wuliangsu Lake ("W-Lake") is a case in point. Located in the Hetao Irrigation Area ("HIA"), W-Lake is a rare multifunctional inland lake in arid North China. It provides a wide range of ecosystem services, including provision of products, regulation of water and climate, water purification, biodiversity conservation and cultural services. The lake's major water input is the drainage water from HIA's farmlands. Those farmlands divert water directly from the Yellow River for irrigation. Unsustainable agricultural practice in HIA has gravely impacted on W-Lake in terms of reduced water quantity and degraded water quality. However, the linkage between agricultural practice in HIA and the environmental changes of W-Lake has been rarely investigated. Existing data focus mainly either on W-Lake or on HIA's farmlands with overwhelmingly technical and end-of-the-pipe solutions. In view of the above, this paper develops four qualitative scenarios on HIA from social, economic and ecological perspectives. The four scenarios are: (a) green growth; (b) strong sustainability; (c) shift to swamp; and (d) worst case. The main aims of this paper are (1) to assist local decision makers of HIA in policy-making and (2) to develop concepts and strategies within the larger framework of integrated water management that shall

inspire conservation efforts in other Central Asian regions.

Navedo, J. G., G. Fernández, J. Fonseca, and M. C. Drever. 2015. A Potential Role of Shrimp Farms for the Conservation of Nearctic Shorebird Populations. *Estuaries and Coasts* **38**:836–845.

(Abstract)

Shrimp aquaculture farms have greatly expanded at tropical areas worldwide, especially during the past three decades. One of the main core areas of this expansion was the northwestern coast of Mexico, prompting conservation concern for the shorebird populations that spend the nonbreeding period (October to March) in the region. We conducted a series of counts and behavioral observations to evaluate the importance of a shrimp farm as foraging habitat for shorebirds, relative to adjacent intertidal areas, during and after the shrimp harvest period at a tropical wetland in Sinaloa, Mexico, 2012 and 2013. Overall, low-tide counts within the entire wetland had an average of  $3,168 \pm 605$  (SE) shorebirds during the shrimp harvest period (October–November) and subsequently dropped to  $1,408 \pm 373$  birds following harvest (December to January), when shrimp ponds were emptied and foraging opportunities were reduced. The proportion of counts at the shrimp farm relative to total counts over the entire wetland ranged from 10 to 80% for different shorebird species and dropped to 0 to 10% in the postharvest period. During the harvesting period, black-necked stilt, American avocet, willet, and whimbrel selected shrimp ponds over intertidal areas to forage during low tide, while marbled godwit, western sandpiper, and dowitchers did not. The proportion of shorebirds observed feeding at the shrimp farm ranged between 60 and 90% for most species and did not differ between low- and high-tide counts. These results suggest that shrimp farms can provide ephemeral but important complementary foraging areas for shorebirds, and appropriate management of existing farms may aid in conservation efforts for these species.

Nam, H.-K., Y.-S. Choi, S.-H. Choi, and J.-C. Yoo. 2015. Distribution of Waterbirds in Rice Fields and Their Use of Foraging Habitats. *Waterbirds* **38**:173-183.

(Abstract)

Over the course of a year, rice fields display spatial and temporal differences according to farming management practices, providing a succession of habitats throughout the crop-growing cycle for various waterbird species. However, few studies have assessed the influence of the spatial and temporal differences produced by rice field farming management practices on waterbird species during a year. The present study investigated spatial and temporal patterns of species distribution and examined the factors that affect waterbird selection of foraging habitats in the rice fields located in the midwestern part of South Korea

from April 2009 to March 2010 and from April 2011 to March 2012. Waterbird species represented strong seasonality and selectively used different field types at a fine spatial scale. The selection of field type depended more on field structures that were related to the vulnerability of prey items than on prey abundance in rice fields. Water level was an important factor that affected shorebird selection of foraging habitat, and they chose habitats with different water levels according to their body size. The density of rice plants was a critical factor affecting the selection of habitats by herons, because densely planted fields inhibited their access to food. The presence of rolled straw in rice fields affected the distribution of waterfowl. These results demonstrate that farming management practices, which determine prey accessibility, strongly affect the use of rice field habitats by waterbirds. Our knowledge of these relationships should be incorporated into conservation practices protecting the various waterbird species that use rice fields.

Walton, M. E. M., C. Vilas, J. P. Cañavate, E. Gonzalez-Ortegon, A. Prieto, S. A. van Bergeijk, A. J. Green, M. Librero, N. Mazuelos, and L. Le Vay. 2015. A model for the future: Ecosystem services provided by the aquaculture activities of Veta la Palma, Southern Spain. *Aquaculture* **448**:382-390.

(Abstract)

The lack of space and opportunity for development has been identified as key reasons behind the stagnation of the European aquaculture industry. With the historical loss and degradation of current European wetlands there is an opportunity for harnessing the commercial investment of the aquaculture industry in construction of dual purpose wetlands that incorporate both conservation and extensive aquaculture activities. These wetlands can be used to expand the area available to suitable aquaculture into ecologically sensitive areas, such as Natura 2000 sites. Veta la Palma (VLP) situated in the Doñana Natural Park (and a Natura 2000 site) is an example of such an aquaculture development and a possible model for future opportunities. In the current study some of the important ecosystem services that are provided by VLP are assessed. The provisioning services of VLP were the economic rationale for the investment and more than 820 tonnes/yr of fish and shrimp is produced, through a mixture of semi-extensive and extensive aquaculture. The regulating services include nutrient absorption, and the flow of river water through VLP and high primary production results in the absorption of 377 tonnes of dissolved inorganic nitrogen/yr, and 516 tonnes of C/yr. Supporting services include the provision of habitat for more than 94 bird and 21 fish species. The primary production that supports the birds, extensive and semi-extensive aquaculture production was also estimated to be 167,000 tonnes, 50,000 tonnes and 133,000 tonnes/yr, respectively. The losses to birds are substantial and these estimates indicate that almost half of the primary production supports the wetland birds which directly consume 249 tonnes of fish and 2578 tonnes of invertebrates per annum. However, it is the ecological credentials of the farm that enable premium prices and hence ensure the economic viability of the farm. The study demonstrates the possibility of using aquaculture to mitigate the historical loss of wetlands, provide significant ecosystem services and contribute to achievement of the

European environmental legislative goals, and furthers the opportunity for the expansion of aquaculture into sensitive but impacted habitats.

Walton, M. E. M., C. Vilas, C. Coccia, A. J. Green, J. P. Cañavate, A. Prieto, S. A. van Bergeijk, J. M. Medialdea, H. Kennedy, J. King, and L. Le Vay. 2015. The effect of water management on extensive aquaculture food webs in the reconstructed wetlands of the Doñana Natural Park, Southern Spain. *Aquaculture* **448**:451–463.

(Abstract)

Extensive aquaculture in coastal and estuarine wetlands can support both increased food production and wider ecosystem services when underpinned by effective management to promote productivity and hence food webs that support both commercial species and biodiversity. Changing hydrology, specifically water movement, within wetlands significantly impacts the physico-chemical properties of the water body and hence can be employed to manipulate productivity and alter patterns of recruitment of commercial species and may also transfer nonnative species from the supplying water bodies. The reconstructed wetlands of Veta la Palma in the Doñana Natural Park are subjected to either a 1% or 5% per day water exchange with water drawn from the adjacent Guadalquivir estuary. This site provides an excellent opportunity for examining the effect of water management on the food webs that support both the birdlife and aquaculture activities for which this habitat is managed. Stable isotopes were used to examine food webs in three replicate lagoons under each water management scheme. In lagoons receiving higher water exchange, phytoplankton productivity appeared to be more important than benthic production in supporting food webs. Increased water exchange also changed the shape of the food webs, facilitated the colonisation of at least one non-native species and increased the importance of non-native species in the diets of large commercially harvested fish (>60% of seabass diet). Lagoons with high water flows also had between three and four times greater shrimp biomass than those of low flow lagoons. Non-native fauna were opportunistic omnivores, eating marginally more non-natives in lagoons with greater water exchange. Overall non-native cordgrass *Spartina densiflora* contributed only slightly more to food webs compared with the native reed *Phragmites australis*, despite the lagoon edge occupancy ratio of 9:1, respectively. Non-natives also appear to enhance food provision for large predators and wetland birds, by increasing biomass, without competing for resources with native species, supporting the dual management objectives of aquaculture and waterbird conservation. Statement of relevance: Extensive aquaculture productivity appears to be positively correlated with water exchange rates.

Sheehan, M. R., and J. C. Ellison. 2015. Tidal marsh erosion and accretion trends following

invasive species removal, Tamar Estuary, Tasmania. *Estuarine, Coastal and Shelf Science* **164**:46-55.

(Abstract)

The introduction of *Spartina* to intertidal marshes last century in many areas of the world transformed estuarine geomorphology, threatened native species and habitats, and impeded coastal access and use. This study investigated erosion/accretion trends of marsh surfaces following removal of invasive *Spartina* across a substantial intertidal marsh area. Marsh surface changes were monitored within a 0.6 ha experimental site where *Spartina anglica* cover was removed, and compared with surface changes at a comparable control site. Erosion/accretion rates were measured for over two years using a grid transect network, creek cross sectional profiles, and seaward edge delineation. Results showed that a significant erosion of the marsh surface occurred at the experimental site relative to the control site, using two different statistical analyses. Analysis of mean monthly change found erosion rates at the experimental site to be 13.2 mm/a relative to 2.0 mm/a at the control site, a rate that was six times greater. Analysis of overall change from the beginning to the end of the study showed that erosion was significantly more pronounced at the experimental site relative to the control site, and increased from the landward edge to the seaward edge at both sites. This study demonstrates the need for consideration of geomorphic processes when managing invasive plants in dynamic environments, and indicates that large scale *Spartina* removal will cause coastal erosion, bringing potential consequences to adjacent near shore waters and ecosystems.

Hu, Z.-J., Z.-M. Ge, Q. Ma, Z.-T. Zhang, C.-D. Tang, H.-B. Cao, T.-Y. Zhang, B. Li, and L.-Q. Zhang. 2015. Revegetation of a native species in a newly formed tidal marsh under varying hydrological conditions and planting densities in the Yangtze Estuary. *Ecological Engineering* **83**:354–363.

(Abstract)

The extent of the Chinese endemic salt marsh community characterized by the sedge, *Scirpus mariqueter*, which is identified as the most favorable habitat for local biodiversity, has been shrunk due to the rapid expansion of exotic *Spartina alterniflora*. Based on an ecological engineering aimed at annihilating this invasive species, the increases in newly formed tidal mudflats have made the revegetation of native *S. mariqueter* possible. In this study, the experiments of *S. mariqueter* revegetation were examined to assess strategies of site selection in terms of the importance of hydrological regimes. Also, three levels of planting density were also conducted in order to assess their cost-effectiveness. To mitigate the impacts of strong hydrological disturbance on the tidal mudflat, soil microcosms consisting of corms of *S. mariqueter* were used for planting. The results indicated that the differences in sedimentary rates and tidal wave energy during the initial establishment period significantly influenced the outcome of succession. A moderate sedimentary rate was shown to help the persistence of planting materials, which, in turn, benefitted the colonization of *S. mariqueter*.

seedlings by vegetative tillering and rhizome growth underground. However, a heavy sedimentary rate during the early growing season failed to support the establishment of *S. mariqueter* and destroyed the adaptive mechanism of plants to burial stress, further resulting in the failure of revegetation practices. Regardless of the planting density, a burial depth of approximately 15–20 cm represents a tolerant threshold for the survival of *S. mariqueter* seedlings. At the same time, a medium planting density appears to a cost-effective way to establish the native species in the newly formed mudflats, because the high-level shoot density was achieved with the medium planting density relative to the high planting density. We suggested that restoration ecologists should take these findings in relation to site selection and cost-effectiveness into careful consideration when planning further large-scale revegetation in the Yangtze estuary.

Neckles, H. A., J. E. Lyons, G. R. Guntenspergen, W. G. Shriver, and S. C. Adamowicz. 2015. Use of Structured Decision Making to Identify Monitoring Variables and Management Priorities for Salt Marsh Ecosystems. *Estuaries and Coasts* **38**:1215–1232.

(Abstract)

Most salt marshes in the USA have been degraded by human activities, and coastal managers are faced with complex choices among possible actions to restore or enhance ecosystem integrity. We applied structured decision making (SDM) to guide selection of monitoring variables and management priorities for salt marshes within the National Wildlife Refuge System in the northeastern USA. In general, SDM is a systematic process for decomposing a decision into its essential elements. We first engaged stakeholders in clarifying regional salt marsh decision problems, defining objectives and attributes to evaluate whether objectives are achieved, and developing a pool of alternative management actions for achieving objectives. Through this process, we identified salt marsh attributes that were applicable to monitoring National Wildlife Refuges on a regional scale and that targeted management needs. We then analyzed management decisions within three salt marsh units at Prime Hook National Wildlife Refuge, coastal Delaware, as a case example of prioritizing management alternatives. Values for saltmarsh attributes were estimated from 2 years of baseline monitoring data and expert opinion. We used linear value modeling to aggregate multiple attributes into a single performance score for each alternative, constrained optimization to identify alternatives that maximized total management benefits subject to refuge-wide cost constraints, and used graphical analysis to identify the optimal set of alternatives for the refuge. SDM offers an efficient, transparent approach for integrating monitoring into management practice and improving the quality of management decisions.

Ancog, R., and C. Ruzol. 2015. Urbanization adjacent to a wetland of international importance:

The case of Olango Island Wildlife Sanctuary, Metro Cebu, Philippines. *Habitat International* **49**:325-332.

(Abstract)

The concentration of human population and development in wetland margins necessitated the identification and establishment of areas for conservation. However, change in the socio-economic and builtup environment particularly in urbanizing municipalities continue to impact the state of the protected wetland. This study highlights this phenomenon and focuses on the relation between urbanization and a wetland of international importance in Metro Cebu, Philippines. Urbanization adjacent to the Olango Island Wildlife Sanctuary (OIWS), the first Ramsar Site of the Philippines, is analyzed in terms of land cover change and population growth before and after the declaration of the protected area in 1992. The results show that percent change in urban cover intensified from 1973 to 1992 (1.29%) to 1992-2007 (18.53%). This can be attributed to the prioritization of the expansion of urban space in Metro Cebu. On the other hand, percent population growth is much higher in 1970-1980 (47.14%) and 1980-1990 (34.00%) before the proclamation of OIWS. Shift in the availability and accessibility of the types of primary and alternative sources of income in fishing communities indicate the influence of urbanization. Perceived problems in fishing reflect the environmental effects of urbanization such as oil spill, solid waste mismanagement, and reclamation projects that relate to the decrease in fish stock. Upon empirical evidence of the impact of OIWS to the restrained rate of urban cover expansion and population growth, education of surrounding urban population on the benefits of conservation should be enhanced. The geographical position of OIWS relative to areas of active urbanization requires a regional level evaluation of environmental quality of the protected ecosystem. This study recommends that conservation policies should take into account the historical urbanization phenomenon within the region of protected areas.

Semeraro, T., C. Giannuzzi, L. Beccarisi, R. Aretano, A. De Marco, M. R. Pasimeni, G. Zurlini, and I. Petrosillo. 2015. A constructed treatment wetland as an opportunity to enhance biodiversity and ecosystem services. *Ecological Engineering* **82**:517–526.

(Abstract)

Today we have to face new challenges about decreasing water resources, wastewater treatment, limited spaces and ecological preservation. This problem must be solved in a sustainable way using innovative water management strategies that combine technology with landscape design by enhancing ecosystem services provision. An effective way of tackling this problem is to use Constructed Treatment Wetlands (CTW) as low-cost alternative to conventional secondary or tertiary wastewater treatment. The aim of this paper is to evaluate their multifunctional role in terms of biodiversity and ecosystem services' enhancement by taking into account a case study in southern Italy. For this purpose an annual monitoring of fauna and vegetation has been carried out in order to identify species of national and international interest strongly related to the new habitats availability. Results have shown the

ability of CTW in providing ancillary benefits, well beyond the primary aim of water purification, such as sustaining wildlife habitats and biodiversity at local and global scales, as well as its potential role in terms of recreational and educational opportunities.

Nicol, S., R. A. Fuller, T. Iwamura, and I. Chadès. 2015. Adapting environmental management to uncertain but inevitable change. *Proceedings of the Royal Society of London B: Biological Sciences* **282**:20142984.

(Abstract)

Implementation of adaptation actions to protect biodiversity is limited by uncertainty about the future. One reason for this is the fear of making the wrong decisions caused by the myriad future scenarios presented to decision-makers. We propose an adaptive management (AM) method for optimally managing a population under uncertain and changing habitat conditions. Our approach incorporates multiple future scenarios and continually learns the best management strategy from observations, even as conditions change. We demonstrate the performance of our AM approach by applying it to the spatial management of migratory shorebird habitats on the East Asian–Australasian flyway, predicted to be severely impacted by future sea-level rise. By accounting for non-stationary dynamics, our solution protects 25 000 more birds per year than the current best stationary approach. Our approach can be applied to many ecological systems that require efficient adaptation strategies for an uncertain future.

Cohen-Shacham, E., T. Dayan, R. de Groot, C. Beltrame, F. Guillet, and E. Feitelson. 2015. Using the ecosystem services concept to analyse stakeholder involvement in wetland management. *Wetlands Ecol Manage* **23**:241–256.

(Abstract)

Wetland management usually involves multiple stakeholders. This paper describes how the use of the ecosystem services (ES) concept can help to identify the main stakeholders associated with wetland conservation, using the Hula Wetland in the Sea of Galilee's watershed as a case study. We conducted a stakeholder analysis based on semi-structured interviews. We focused on the management of two seminatural areas within the larger Hula Wetland area (Hula Nature Reserve and Agamon), in which different management regimes are used and which provide different bundles of ES to different stakeholders. Using the ES concept in the stakeholder analysis, we were able to present the Hula Wetland management in a comprehensive manner. The approach also revealed a lack of coordination between the managing organisations which might lead to competition favouring cultural services (in particular tourism) at the expense of habitat services (i.e. biodiversity conservation) in the



future. To test our method we also conducted a stakeholder analysis in the Camargue Wetland in France. The two wetlands have similar characteristics but are embedded in different institutional contexts. The Camargue Regional Park has a multi-stakeholder platform which could serve as an example for the Hula Wetland to improve its management and lead to better coordination and complementarity of ES provided by the two sub-sites. Our study showed that applying the ES concept helps to quickly identify relevant stakeholders and analyse wetland management in a more holistic way and to point towards sustainable solutions for conflicting stakeholder interests.

Bezuijen, M. R. 2015. Rapid assessment of management effectiveness of the Zhangye National Wetland Park, Gansu province, People's Republic of China. *Parks* **21**:43-50.

(Abstract)

A rapid assessment of management effectiveness was undertaken for the Zhangye National Wetland Park, a small, remote protected area in Gansu Province, the People's Republic of China (PRC). During site visits and a workshop with park personnel in 2011, park management activities were documented and the first baseline score of management effectiveness was derived. The park exhibits similar trends to many other protected areas in the PRC and globally, with legal establishment, design and objectives, and economic benefits reported as management strengths, and budget security, monitoring and evaluation, and law enforcement reported as management weaknesses. Specific challenges for the park include a need to balance the development of tourism infrastructure with biodiversity conservation, and to develop quantitative management targets linked to conservation objectives.

Pernollet, C. A., A. Guelmami, A. J. Green, A. Curcó Masip, B. Dies, G. Bogliani, F. Tesio, A. Brogi, M. Gauthier-Clerc, and M. Guillemain. 2015. A comparison of wintering duck numbers among European rice production areas with contrasting flooding regimes. *Biological Conservation* **186**:214–224.

(Abstract)

Agricultural lands can provide suitable habitat for birds under some conditions. In particular, waterfowl sometimes rely on ricefields as nocturnal foraging habitat during winter if post-harvest practices make food accessible. To assess whether the winter flooding of ricefields could be a major driver of duck regional abundance in Europe, we relied on a combination of spatial and temporal analyses. In the former, five of the most important western European rice growing regions in Spain, Italy and France were compared in terms of habitat composition over the 2002–2012 period. The relative importance of natural wetlands and ricefields (either dry or flooded) in determining the abundance of wintering ducks was then established. In the

second approach, the trends in duck numbers before and after implementation of winter-flooding Agri-Environment Schemes (AES) were compared in two of the study regions. Both approaches highlighted the role of winter ricefield flooding in explaining wintering duck numbers and complementing the natural wetlands; flooding harvested ricefields improves habitat attractiveness by enhancing food resource accessibility. In Europe, the proportion of ricefields flooded during winter varies considerably between countries (0.17–62%), owing to differences in policy initiatives such as Agri-Environment Schemes. Promoting such schemes more widely across the European rice production area could make a big difference in terms of waterfowl habitat quality at the scale of their wintering range.

Tavares, D. C., D. L. Guadagnin, J. F. de Moura, S. Siciliano, and A. Merico. 2015. Environmental and anthropogenic factors structuring waterbird habitats of tropical coastal lagoons: Implications for management. *Biological Conservation* **186**:12–21.

(Abstract)

Tropical coastal lagoons are among the most threatened ecosystems on Earth due to multiple factors. The loss and degradation of coastal lagoons can adversely affect waterbirds, which depend crucially on wetland habitats. This study investigates the effects of a number of environmental variables on waterbird habitat use. Specifically, we assessed the abundances of six waterbird guilds in relation to hydrochemical, structural, and anthropogenic factors in 351 survey blocks of 22 tropical coastal lagoons of southeastern Brazil. Patterns of habitat use were analyzed using generalized mixed models. We found that water depth was the most important variable influencing the waterbird assemblage. Increasing water depth reduced the abundance of small and large wading birds, dabbling ducks, and diving birds. Extreme values of salinity negatively affected diving birds and large wading birds. Vegetation height influenced shorebirds negatively, while it influenced vegetation gleaners positively. Anthropogenic factors played an important role in structuring the habitat of small wading birds, dabbling ducks, diving birds and fishing birds. Our study indicates that the various guilds showed specific responses to different habitat variables. We conclude that the maintenance of water depths in the range of 0–20 cm, the preservation of a mosaic of vegetation heights, and the reduction of livestock grazing pressure are among the most important aspects for supporting high avian abundance and biodiversity in tropical coastal lagoons. Management strategies should therefore address a specific number of structural and hydrochemical attributes of coastal lagoons and should carefully consider the effects of land use practices.

Lopez-Pomares, A. L., G. M. Lopez-Iborra, and C. Martín-Cantarino. 2015. Irrigation canals in a semi-arid agricultural landscape surrounded by wetlands: Their role as a habitat for birds during the breeding season. *Journal of Arid Environments* **118**:28-36.

(Abstract)

Traditional water supply systems in semi-arid agrarian ecosystems, mainly irrigation canals, contribute to the diversity of the landscape and influence the composition of species. To evaluate their effect on bird communities in the breeding season, we selected a rural area in southeastern Spain, where an intricate and extensive network of irrigation canals and cultivated areas is located between two wetlands declared as Natural Parks. Birds were counted at representative points distributed throughout the canal network at which we recorded several variables related to the physical features, the vertical and horizontal structure of associated vegetation, reed development (*Phragmites australis*) and land use in the neighboring areas. We detected 37 bird species, most of which were also breeding in the wetlands nearby. We used Hierarchical Partitioning analyses to identify the variables most strongly related to the probability of the presence of selected species and species richness. Vegetation cover and height close to the canals, together with reed development, were the most important types of variables explaining species presence and richness. We found that current management practices for reeds in canals are not well-suited for biodiversity conservation. We therefore propose alternatives that could be implemented in the area in cooperation with stakeholders.

#### Impact assessment and management 2014

Dicks, L. V., J. C. Walsh, and W. J. Sutherland. 2014. Organising evidence for environmental management decisions: a '4S' hierarchy. *Trends in Ecology & Evolution* **29**:607-613.

(Abstract)

Making decisions informed by the best-available science is an objective for many organisations managing the environment or natural resources. Yet, available science is still not widely used in environmental policy and practice. We describe a '4S' hierarchy for organising relevant science to inform decisions. This hierarchy has already revolutionised clinical practice. It is beginning to emerge for environmental management, although all four levels need substantial development before environmental decision-makers can reliably and efficiently find the evidence they need. We expose common bypass routes that currently lead to poor or biased representation of scientific knowledge. We argue that the least developed level of the hierarchy is that closest to decision-makers, placing synthesised scientific knowledge into environmental decision support systems.

Lee, C.-H., B.-Y. Lee, W. K. Chang, S. Hong, S. J. Song, J. Park, B.-O. Kwon, and J. S. Khim.

2014. Environmental and ecological effects of Lake Shihwa reclamation project in South Korea: A review. *Ocean & Coastal Management* **102**:545-558.

(Abstract)

The Shihwa Coastal Reservoir (SCR) was created to supply agricultural water during the construction of dikes for land reclamation, with this project representing a striking example of policy failure regarding tidal flat reclamation in Korea. After the completion of dike construction in 1994, the water quality inside the SCR drastically deteriorated. As a result, in 1996, the sluice gates were opened to dilute water pollution levels through the physical mixing of seawater from outside and freshwater from inside. Over the last 20 years, the Korean government has invested more than US \$ 1.5 billion to recover SCR water quality by improving public sewage treatment systems, which is 2.7 times the cost of the original dike construction. Yet, within the reservoir, water quality has minimally improved, sediment pollution continues to be detected, and anoxic layers have been observed, due to stratification in summer. Severe sedimentary pollution caused by heavy metals and trace organic pollutants originating from the upstream regions of the watershed was evident during the SCR project; however, pollution levels appeared to decrease after seawater circulation. In parallel, the pelagic and benthic communities have also been affected by the deterioration of multiple water and sediment quality indices. While the recent construction of the tidal power plant has significantly increased the volume of seawater circulation, it has not been enough to improve the water quality of the upstream region of the SCR, where the water remains polluted. The SCR project presents a clear example that how incorrect policy leads to the mishandling of both coastal ecosystems and substantial governmental budgets.

Loyn, R. H., J. Potts, D. Duncan, K. Stamation, and P. Menkhorst. 2014. Relationships between waterfowl numbers and the water chemistry of ponds at the Western Treatment Plant, Victoria., Arthur Rylah Institute for Environmental Research Technical Report Series No. 260. Department of Environment and Primary Industries, Heidelberg, Victoria.

(Abstract)

The Western Treatment Plant (WTP) treats about half of the wastewater produced in Melbourne, Victoria, a city of over 4 million people. It also provides valuable habitat for waterfowl and is a wetland of international importance listed under the Ramsar Convention. Hence, WTP managers need to consider waterfowl conservation as well as wastewater treatment, re-use and disposal. This study was undertaken to determine the relationships between the density of waterfowl (in seven guilds) on 26 selected treatment ponds and five key water variables measured in those ponds. The five variables were Cumulative Retention Time (CRT), Chlorophyll A concentration, Carbon Biological Oxygen Demand (CBOD5), Total Kjeldahn Nitrogen (TKN) and pH. The data had been collected from regular monitoring on behalf of Melbourne Water (the WTP's manager) during 2000–2011. Waterfowl guilds responded to the variables in different ways. Coots and diving ducks favoured ponds with low CRT, while dabbling ducks and filter-feeding ducks favoured ponds with high CRT. Diving

ducks, grazing ducks and swans favoured ponds with high levels of Chlorophyll A (an index of algal growth). Three guilds that feed from deep water (diving ducks, grebes and swans) avoided ponds with high levels of CBOD5 (an index of bacterial activity and organic carbon), whereas filter-feeding ducks favoured such ponds. TKN had a negative influence on all guilds except diving ducks, and they responded positively. Increasing pH had a positive, but generally small, impact on coots, dabbling ducks, diving ducks and grazing ducks, and a negative impact on grebes. These results are discussed in relation to previous studies of the relationships between waterfowl use of treatment ponds at the WTP and water characteristics in those ponds. The current study produced results at variance with some outcomes of previous work. Some of these differences may be due to changed relationships as a result of changes to sewage treatment during the data collection period (Loyn et al. 2014). Others may be due to statistical issues and the difficulty of untangling the effects and interactions of numerous variables (including many water chemistry variables that were not assessed at enough ponds to be reliably included in this analysis). A unifying theme is that waterfowl favour bodies of water with intermediate levels of nutrients—not too high and not too low. The challenge for Melbourne Water is to continue to maintain such conditions while meeting its obligations to treat wastewater.

Ryu, J., J. Nam, J. Park, B.-O. Kwon, J.-H. Lee, S. J. Song, S. Hong, W. K. Chang, and J. S. Khim. 2014. The Saemangeum tidal flat: Long-term environmental and ecological changes in marine benthic flora and fauna in relation to the embankment. *Ocean & Coastal Management* **102**:559-571.

(Abstract)

The present article presents a historical overview of the Saemangeum reclamation projects and key findings from the ecological studies of the Saemangeum tidal flat, highlighting the ecological impact against the grand reclamation project, as a model example, in Korea. First, the scientific efforts given to the area of interest, mainly the inner part of the dikes, during the construction periods of series of four dikes (1991-2006) were summarized in terms of the change of environmental condition followed by the ecological responses over the past 20 years. As part of review, we selected and reanalyzed our series of the Saemangeum data including the current works relating to the microphytobenthos and macrozoobenthos, where the spatio-temporal variations cross the benthos in association with dike effects were carefully discussed in detail. The species composition in the upper intertidal zone, situated relatively far from the dikes, have been lesser changed between the periods of before (1988) and during the dike construction (2003-05). However, the benthic assemblages appeared to be changed in the mid to the lower intertidal zones of several transects and such phenomenon strengthened for the locations near the completed dike, e.g., Sandong transect near the dike of sector IV. Meanwhile, changes of the representative zoning in benthic assemblages during the dike construction were much clearly observed for the faunal species rather than flora. Such long-term ecological impacts including the timely increase of the opportunistic species during the dike construction were further evidenced the compositional change of the dominant

benthos spanning two decades or so. In general, a long-term change in benthic community structure clearly reflected the community level impact apparently due to the attenuation of tidal energy by the embankment, varying the degree of impacts depending on the geographical location. Interdisciplinary monitoring and modeling studies are highly recommended to track natural variations in water quality and ecosystem health. Overall a long-term ecological monitoring should be applied to direct sound policy toward conservation of tidal wetlands, by emphasizing the significant biodiversity decline and coastal landscape depreciation.

Ryu J-H, Choi J-K, Lee Y-K. 2014. Potential of remote sensing in management of tidal flats: A case study of thematic mapping in the Korean tidal flats. *Ocean & Coastal Management* **102**:458-470.

(Abstract)

Tidal flats in Korea are increasingly being changed by various construction projects. This report reviews the remote sensing techniques used to monitor tidal flats and suggests appropriate techniques for meeting monitoring targets for the effective management of tidal flats. The application of remote sensing to studies of tidal flats and the characteristics of the preferred satellite data for a particular monitoring target were examined from a statistical analysis of peer-reviewed journals and case studies of Korean tidal flats. Specifically, three different monitoring targets were examined: topography, sedimentary facies, and biofacies. To date, the Landsat thematic mapper (TM) and the enhanced thematic mapper (ETM<sub>p</sub>) have been most widely used for this purpose due to the large amount of archived data, the convenience of time-series analysis, and the minimal or no-cost data acquisition. Sedimentary facies of the tidal flats can be classified into the three categories mud, mixed, and sand, at a spatial resolution of 30 m. A potential map for macrobenthos was generated with high accuracy based on the spatial variables. High-resolution, space-borne, and X-band synthetic aperture radar (SAR) systems such as TerraSAR-X and Cosmo-SkyMed were used to improve the accuracy of tidal flat digital elevation model (DEM) generation and halophyte distribution mapping. The details of those data can be further enhanced by the use of a high-spatial-resolution image. The legislation regarding the monitoring of tidal flats in Korea and Germany was compared to the potential application of remote sensing to the monitoring of tidal flats. Thematic maps based on remote sensing can help improve policy decisions from a management perspective.

Steele, W. K., and S. Harrow. 2014. Overview of adaptive management for multiple biodiversity values at the Western Treatment Plant, Werribee, leading to a pilot nutrient addition study. *The Victorian Naturalist* **131**:128–146.

(Abstract)

Across south-eastern Australia the loss of natural wetlands since European settlement has been substantial such that even constructed waterbodies that provide a measure of habitat for waterbirds can assume importance for their conservation. Melbourne Water operates the Western Treatment Plant (WTP), occupying 10 500 ha near Werribee, primarily for the treatment of some 54% of Melbourne's industrial and domestic wastewater. During 1982 the site was included as a component of the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site in recognition of its great importance for waterfowl (Anseriformes and Podicipediformes), shorebirds (Charadriiformes) and wading birds (Ciconiiformes and Gruiformes). The WTP supports other biodiversity values, with a significant population of the nationally Vulnerable Growling Grass Frog *Litoria raniformis*; a number of threatened species of plant, including the Spiny Rice-flower *Pimelea spinescens* subsp. *spinescens*; and two listed vegetation communities: Natural Temperate Grassland of the Victorian Volcanic Plain (Critically Endangered), and Subtropical and Temperate Coastal Saltmarsh (Vulnerable). This paper describes how site managers have endeavoured since 2002 to implement adaptive management to protect and promote the WTP's recognised biodiversity values during necessary sewage treatment upgrades. Results of management on waterfowl populations are obscured by the effects of the 1997–2009 drought across south-eastern Australia and species' inherent variability in distribution across this vast area. A trial addition of straw to promote waterfowl food in one wetland showed no clear benefits. However, after 12 years of close monitoring of target populations our knowledge is much improved and we believe the site retains the biodiversity values that led to it being listed as a wetland of international importance.

Pérez-García, J. M., E. Sebastián-González, K. L. Alexander, J. A. Sánchez-Zapata, and F. Botella. 2014. Effect of landscape configuration and habitat quality on the community structure of waterbirds using a man-made habitat. *European Journal of Wildlife Research* **60**:875–883.

(Abstract)

Species occurrence and community structure are strongly influenced by multiple factors like habitat selection, species movement capabilities, competition, or conspecific and heterospecific attractions. More specifically, in waterbird communities, previous studies have identified the importance of environmental and structural characteristics of wetlands for their occupation and use. However, the effect of the surrounding landscape configuration remains unknown. In this article, we use a large network of artificial irrigation ponds to evaluate the importance of pond features in comparison to the effect of landscape and spatial configuration on the community at three different spatial scales. Our results show that landscape configuration has relatively little influence on structure of the waterbird community. Pond features were by far the most important variables to describe waterbird abundance and richness. At the species level, we detected differences in habitat preferences relating to species-specific ecological requirements. Our results highlight the importance of using a multiscale approach to understand and predict richness and abundance in waterbird communities. Our findings emphasize the need to maintain high-quality ponds to enhance their suitability for use as breeding and foraging sites.

Lai, X., D. Shankman, C. Huber, H. Yesou, Q. Huang, and J. Jiang. 2014. Sand mining and increasing Poyang Lake's discharge ability: A reassessment of causes for lake decline in China. *Journal of Hydrology* **519**:1698–1706.

(Abstract)

A recent dramatic decline in China's largest freshwater lake, Poyang Lake, has caused particular concerns because of its significant influence on water availability and lake ecology. To better understand the causes of lake decline, especially the abnormal low water levels in the dry season, we investigated channel changes using surveyed and remote sensing data and hence the increasing lake discharge ability and the resulting drop of water level of the lake. The results show that intensive sand mining resulted in a wider and deeper outflow channel for Poyang Lake. The discharge ability of Poyang Lake into the Yangtze River at low water levels has increased to 1.5–2 times the values before the initiation of extensive sand mining. This allows the lake to drain quickly and reach a lower water level than would otherwise have occurred. Higher discharge potential increases drought risk in Poyang Lake, particularly under the superimposed effects of regional rainfall anomalies and the water storage of dams. In response to potential low lake levels, the prohibition of sand mining should be given priority in lake management planning as opposed to damming the lake.

Davidson, N. C. 2014. How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research* **65**:934–941.

(Abstract)

It has been frequently stated, but without provision of supporting evidence, that the world has lost 50% of its wetlands (or 50% since 1900 AD). This review of 189 reports of change in wetland area finds that the reported long-term loss of natural wetlands averages between 54–57% but loss may have been as high as 87% since 1700 AD. There has been a much (3.7 times) faster rate of wetland loss during the 20th and early 21st centuries, with a loss of 64–71% of wetlands since 1900 AD. Losses have been larger and faster for inland than coastal natural wetlands. Although the rate of wetland loss in Europe has slowed, and in North America has remained low since the 1980s, the rate has remained high in Asia, where large-scale and rapid conversion of coastal and inland natural wetlands is continuing. It is unclear whether the investment by national governments in the Ramsar Convention on Wetlands has influenced these rates of loss. There is a need to improve the knowledge of change in wetland areas worldwide, particularly for Africa, the Neotropics and Oceania, and to improve the consistency of data on change in wetland areas in published papers and reports.



Sebastian-Gonzales E, Green AJ. 2014. Habitat Use by Waterbirds in Relation to Pond Size, Water Depth, and Isolation: Lessons from a Restoration in Southern Spain. *Restoration Ecology* **22**, 311–318.

(Abstract)

Wetland restoration is increasingly important to reverse habitat degradation, recover ecosystem services, and maintain biodiversity. To aid project design, more information is required on the influence of wetland size, depth of water, and isolation on the waterbird communities that become established. During a restoration project in Donana, one of the Europe's most important wetland complexes, an experimental network of 96 temporary ponds with standard shape but variable size, water depth, and isolation was created. We surveyed the waterbird community in spring from 2006 to 2008 and related species abundance and richness to abiotic pond characteristics. We also performed analyses pooling species by foraging guilds or body size. Waterbird abundance and species richness were highest in 2007, the wettest year when the ponds had longer hydroperiods. Larger ponds had consistently higher abundance and species richness for the entire community and for different guilds and body sizes. Moreover, the density of birds per hectare was higher in large ponds than in the smaller ones. Pond isolation and excavated depth did not affect overall abundance and richness, although opposing effects of depth were observed on some size classes, and ducks and large birds preferred isolated ponds. Some bird groups preferred ponds at a particular location. This is the first waterbird study to address the importance of pond size, depth, and isolation independently of confounding variables such as pond shape. It illustrates the varied responses from different bird groups and demonstrates the importance of varying depth, location, and isolation to enhance community abundance and diversity.

### **Implications for Practice**

- Ponds designed with non-wintering waterbirds in mind should be of least 1–3 ha.
- Some degree of isolation (up to 1 km from the nearest pond) can be favorable for waterbirds and some isolated ponds should be included when designing wetland complexes.
- Restoration projects should aim to vary depths even within the shallow 0–60 cm range, so as to diversify the waterbird community.
- As reported for other aquatic organisms, creating a diverse and heterogeneous complex of ponds will support more waterbird species than a single lake of the same total surface area.

Nicol S, Griffith B, Austin J, Hunter CM. 2014. Optimal water depth management on river-fed National Wildlife Refuges in a changing climate. *Climatic Change* **124**, 271–284.

(Abstract)

The prairie pothole region (PPR) in the north-central United States and south-central Canada

constitutes the most important waterfowl breeding area in North America. Projected longterm changes in precipitation and temperature may alter the drivers of waterfowl abundance: wetland availability and emergent vegetation cover. Previous studies have focused on isolated wetland dynamics, but the implications of changing precipitation on managed, river-fed wetlands have not been addressed. Using a structured decision making (SDM) approach, we derived optimal water management actions for 20 years at four river-fed National Wildlife Refuges (NWRs) in North and South Dakota under contrasting increasing/decreasing ( $\pm 0.4$  %/year) inflow scenarios derived from empirical trends. Refuge pool depth is manipulated by control structures. Optimal management involves setting control structure heights that have the highest probability of providing a desired mix of waterfowl habitat, given refuge capacities and inflows. We found optimal seasonal control structure heights for each refuge were essentially the same under increasing and decreasing inflow trends of 0.4 %/year over the next 20 years. Results suggest managed pools in the NWRs receive large inflows relative to their capacities. Hence, water availability does not constrain management; pool bathymetry and management tactics can be greater constraints on attaining management objectives than climate-mediated inflow. We present time-dependent optimal seasonal control structure heights for each refuge, which are resilient to the non-stationary precipitation scenarios we examined. Managers can use this information to provide a desired mixture of wildlife habitats, and to re-assess management objectives in reserves where pool bathymetry prevents attaining the currently stated objectives.

Zou Y, Liu J, Yang X, Zhang M, Tang C, Wang T. 2014. Impact of coastal wetland restoration strategies in the Chongming Dongtan wetlands, China: Waterbird community composition as an indicator. *Acta Zoologica Academiae Scientiarum Hungaricae* **60**, 185-198.

(Abstract)

This paper aims to evaluate the success of coastal wetland restoration by quantifying the waterbird community composition at three restored sites and on one natural coastal wetland, which served as a reference site, from September 2011 to May 2012 in the Chongming Dongtan wetlands in China. The Shannon–Wiener diversity index was calculated to describe habitat diversity in the four study sites. Significant differences in habitat heterogeneity and species group diversity, richness, and waterbird density were observed in the sites, but a significant difference among three seasons was observed only in the waterbird density. Significant interactions between site and season were noted for species group diversity, richness, and waterbird density. The densities of four dominant waterbird groups exhibited significant differences in the four sites, and the density of Anatidae and Ardeidae exhibited significant differences among three seasons. Significant interactions were noted between site and season for the densities of Charadriidae, Anatidae, and Ardeidae. In conclusion, the restored coastal wetlands served as a suitable habitat for waterbirds to some extent, although not all restored wetlands were used equally by waterbirds. The restored wetlands with higher habitat heterogeneity supported a greater abundance of waterbirds. However, the same restored wetland was not used equally by waterbirds among different seasons. Multi-functional

restored wetlands could be created for different seasons to attract a diverse group of waterbirds to forage and roost in the coastal wetlands of Yangtze River during their migration from Australia to Siberia.

Cheek MD, Williams GE, Bousquin SG, Colee J, Melvin SL. 2014. Interim Response of Wading Birds (Pelecaniformes and Ciconiiformes) and Waterfowl (Anseriformes) to the Kissimmee River Restoration Project, Florida, U.S.A. *Restoration Ecology* **22**, 426–434.

(Abstract)

Success of the Kissimmee River Restoration Project will be evaluated in part by monitoring populations of wading birds (Pelecaniformes and Ciconiiformes) and waterfowl (Anseriformes). These two waterbird guilds were integral components of the pre-channelization river–floodplain ecosystem, and both declined substantially following channelization. Restoration is expected to attract wading birds and waterfowl by reintroducing naturally fluctuating water levels, seasonal hydroperiods, and historic vegetation communities. Post-construction aerial surveys (November 2001 to May 2008) within the Phase I restoration area indicate that the abundance and species richness of both wading birds and waterfowl have shown a positive restoration response thus far. Dry season abundance of aquatic wading birds and waterfowl has exceeded restoration expectations ( $\geq 30.6$  birds/km<sup>2</sup> and  $\geq 3.9$  birds/km<sup>2</sup>, respectively) each year since the completion of restoration Phase I in 2001. While there has been a significant positive restoration effect on waterfowl abundance, waterfowl species richness ( $n = 6$ ) has not yet reached the restoration expectation of  $\geq 13$  species. Abundance of the terrestrial cattle egret (*Bubulcus ibis*), which increased dramatically after the majority of floodplain wetlands were converted to cattle pastures in the channelized system, has shown a significant negative response to restoration. It is anticipated that completion of the remaining phases of restoration (II/III), and implementation of the Kissimmee River Headwaters Revitalization water regulation schedule by 2019, will further increase and improve habitat for wading birds and waterfowl by reestablishing floodplain hydrology that more closely mimics historical conditions.

### **Implications for Practice**

- Evaluating wetland restoration success by monitoring wading birds and waterfowl relative to historical conditions is a practical means to measure the return of ecological integrity to a system if historical (reference) data are available.
- When monitoring species or species guilds to evaluate the success of a restoration project, choosing species that are of great interest to the public can be beneficial for communicating restoration goals and measures of success.
- Restoration expectation targets should be formulated with multi-year running averages appropriate to the study site and study species to help buffer against climatic or other stochastic events that can significantly affect monitoring data among years/seasons.

Monfils MJ, Brown PW, Hayes DB, Soulliere GJ, Kafcas EN. 2014. Breeding Bird Use and Wetland Characteristics of Diked and Undiked Coastal Marshes in Michigan. *The Journal of Wildlife Management* **78**, 79–92.

(Abstract)

Dikes were built on Great Lakes coastal wetlands to enable water level management for wetland wildlife, particularly waterfowl, but few studies have compared bird use of these areas to undiked sites. During 2005–2007, we evaluated 9 diked and 7 undiked coastal wetlands at the St. Clair Flats (Lake St. Clair) and Saginaw Bay (Lake Huron) of Michigan, USA. We compared bird use of diked and undiked wetlands via 605 10-minute point counts at randomly selected locations of emergent marsh and 287 45-minute surveys of randomly selected open water areas. We also measured wetland characteristics in 1,521 randomly selected 0.25-m<sup>2</sup> quadrats to compare vegetation and physical conditions between diked and undiked wetlands. Diked wetlands had greater coverage and density of cattail (*Typha* spp.), coverage of floating-leaved plants, water depth, and organic sediment depth compared to nearby undiked sites, whereas undiked wetlands had greater coverage and density of common reed (*Phragmites australis*) and bulrush (*Schoenoplectus* spp.) than diked wetlands. Bird species richness and similarity indices indicated comparable breeding bird communities. We observed greater abundances of Canada goose (*Branta canadensis*), wood duck (*Aix sponsa*), American bittern (*Botaurus lentiginosus*), least bittern (*Ixobrychus exilis*), and common gallinule (*Gallinula galeata*) in diked wetlands. These species likely responded to the deep-water cattail marsh and aquatic bed dominating most diked sites. American coot (*Fulica americana*), Forster's tern (*Sterna forsteri*), ring-billed gull (*Larus delawarensis*), and herring gull (*Larus argentatus*) abundance indices were greater in undiked wetlands, likely related to nesting and foraging habitat provided by the shallower, more open wetlands and connecting lakes. Diked wetlands did not benefit the bird community to the degree expected and conditions in diked areas were indicative of deep marshes with stabilized water levels. Periodic late-summer drawdowns could encourage growth of plants we found associated with greater abundance of some priority bird species and reduction of floating vegetation negatively associated with abundance of several species. However, effective control of invasive common reed is needed to reduce risk of expansion during impoundment dewatering.

Brand LA, Takekawa JY, Shinn JM, Graham T, Buffington K, Gustafson KB, Smith LM, Spring SE, Miles AK. 2014. Effects of Wetland Management on Carrying Capacity of Diving Ducks and Shorebirds in a Coastal Estuary. *Waterbirds* **37**, 52-67.

(Abstract)

With global loss of natural wetlands, managed wetlands increasingly support energy requirements for wintering shorebirds and waterfowl. Despite numerous studies of avian bioenergetics in freshwater systems, less is known of the energetic capacity of estuarine systems. In San Francisco Bay, managed saline ponds converted from former commercial salt

evaporation ponds form part of the largest wetland restoration project on the Pacific coast of North America. A daily-ration model was applied to assess carrying capacity for diving ducks and shorebirds during four winter seasons (2007-2010) in seasonal and circulation ponds, each in two salinity classes. Diving ducks comprised an estimated  $35,450 \pm 1,559$  (mean  $\pm$  SE) in average years and  $45,458 \pm 1,653$  in peak years with  $> 95\%$  in circulation ponds. Shorebirds comprised  $64,253 \pm 14,838$  (mean  $\pm$  SE) in average years and  $108,171 \pm 4,854$  in peak years with  $> 64\%$  in seasonal ponds. Macroinvertebrate energy density was highest in mesohaline (5-30 ppt) circulation ponds and lowest in seasonal ponds for both guilds. Energy requirements for diving ducks in mesohaline followed by low-hyperhaline (30-80 ppt) circulation ponds were mostly met by available prey energy. Available energy for shorebirds was substantially less than they required in seasonal ponds but exceeded their needs in mesohaline circulation ponds. Mesohaline circulation ponds supported  $9,443 \pm 1,649$  (mean  $\pm$  SE) shorebird use-days $\cdot$ ha $^{-1}$  of accessible habitat and  $2,297 \pm 402$  diving duck use-days/ha of accessible habitat, twice the capacity of low-hyperhaline circulation ponds and greater than five times that of seasonal ponds for both guilds. Our results indicated that reducing salinity to mesohaline levels and altering water depth to increase accessibility substantially increased energy available for these species in estuarine managed ponds.

Kajtoch Ł, Zmihorski M, Piestrzynska-Kajtoch A. 2014. The Goosander as potential indicator of naturalness and biodiversity in submontane river valleys of northern Carpathians. *Ecological Indicators* **45**, 83–92.

(Abstract)

Riparian habitats are biodiversity hotspots, however, despite their protection (e.g. in Natura 2000 sites) they are drastically transformed, particularly in more developed countries. The least inventoried, monitored and protected are submontane drainages composed of lowland and mountain habitats and species. Effective evaluation and monitoring of riparian habitat quality and species richness in submontane valleys is difficult and time consuming, but could be overcome by using indicator species. In this work, we verify if Goosander *Mergus merganser* could be considered as indicators of submontane valleys' naturalness and biodiversity. Data about Goosander occurrence in the Raba drainage (Polish Carpathians) were compared with several environmental variables and information about species richness of selected riparian animals. Goosander distribution and abundance depended on "naturalness" variables (high share of alluvia and scarps in river channels and forests on river banks), but association with hydrogeomorphology and the vicinity of humans was not found. Goosander abundance was found to be significantly correlated with bird species richness (both forest- and river-dwellers) and the presence of aquatic mammals (beavers and otters), but not with a richness of fish. Moreover, Goosander allows a high prediction accuracy to be achieved for the presence of aquatic animals (otters, beavers, woodpeckers and river-dwelling birds), among others, species annexed in EU directives. The correlation of Goosander abundance with the richness of riparian vertebrates, as well as with natural riparian habitats makes this bird a good candidate for an umbrella and flagship species. Moreover, using

Goosanders as indicators would be a valuable method for preliminary valorization and further monitoring of habitats and species in Natura 2000 sites of Polish Carpathians. The utility of this species as bioindicator in other parts of the Carpathians should be verified after saturation of available areas by its populations.

Vaissière A-C, Levrel H, Pioch S, Carlier A. 2014. Biodiversity offsets for offshore windfarm projects: The current situation in Europe. *Marine Policy* **48**, 172-183.

(Abstract)

The European Union's energy policy aims to increase the proportion of energy derived from renewable sources in Europe. Marine renewable energy, offshore wind energy especially, contributes to the renewable energy mix. Offshore windfarms appear to be clean, and are supported by governments and NGOs as a way to reduce the use of conventional energy resources and thus decrease greenhouse gas emissions. However, developing infrastructure in marine areas can impact marine ecosystems. European directives ask offshore windfarm developers to carry out an Environmental Impact Assessment (EIA) including mitigation hierarchy, i.e. envisaging measures that would avoid, reduce, and if possible offset significant adverse effects on ecosystems and human activities. This paper reviews EIA reports from seven European countries and is focused on impacts on the open water marine environment. According to the reports, measures have been taken for avoiding and reducing impacts, so there should be no significant negative residual impacts and hence no need of offsets. But the mitigation hierarchy for ecological impacts seems to have been incompletely implemented, because it is unlikely that there are no significant residual impacts. The paper proposes some technical and ecological explanations, followed by some governance and social explanations, for the absence of biodiversity offsets.

Van Rees CB, Reed JM. 2014. Wetland Loss in Hawai'i since Human Settlement. *Wetlands* **34**, 335–350.

(Abstract)

Wetland inventories are essential to understanding human effects on wetland distributions, estimating rates of wetland loss and setting recovery goals for endangered species. Wetlands in the Hawaiian archipelago (U.S.A.) support human water demands for agriculture, a rapidly expanding urban population, and 222 federally listed threatened or endangered plants and animals. The only published assessment of wetland loss for Hawai'i was done in 1990, before significant advances in Geographic Information Systems (GIS) and computing technology. We estimated wetland loss on the 5 main Hawaiian Islands since human settlement using the National Wetlands Inventory, hydric soil maps, rainfall, and topographic data. We used the

Topographic Wetness Index (TWI) to estimate pre-settlement wetlands in sites where hydric soil evidence was unavailable or unreliable. We found that TWI makes a useful complement to hydric soil evidence in estimating wetland loss in highly developed areas. We estimate statewide wetland loss at 15 %, compared to 12 % from the 1990 estimate, ranging from 6 to 8 % loss on Maui, Moloka`i, Hawai`i, and Kaua`i to 65%loss on Oahu, the most developed of the islands. The majority of wetland losses occurred in coastal areas where 44 % of wetlands have been lost, while only 3 % were lost at higher elevations.

Ruiz L, Parikh N, Heintzman LJ, Collins SD, Starr SM, Wright CK, Henebry GM, van Gestel N, McIntyre NE. 2014. Dynamic connectivity of temporary wetlands in the southern Great Plains. *Landscape Ecology* **29**, 507–516.

(Abstract)

We quantified fluctuations in the status of individual patches (wetlands) in supporting connectivity within a network of playas, temporary wetlands of the southern Great Plains of North America that are loci for regional biodiversity. We used remote sensing imagery to delineate the location of surface waters in [8,000 playa basins in a ~31,900 km<sup>2</sup> portion of Texas and quantified connectivity in this region from 2007 to 2011. We ranked playas as stepping-stones, cutpoints, and hubs at different levels of environmental conditions (regionally wet, dry, and average periods of precipitation) for dispersal distances ranging from 0.5 to 34 km, representing a range of species' vagilities, to provide baseline dynamics within an area likely to experience disrupted connectivity due to anthropogenic activities. An individual playa's status as a stepping-stone, cutpoint, or hub was highly variable over time (only a single playa was a top 20 stepping-stone, cutpoint, or hub in >50 % of all of the dates examined). Coalescence of the inundated playa network usually occurred at >=10 km dispersal distance and depended on wetland density, indicating that critical thresholds in connectivity arose from synergistic effects of dispersal ability (spatial scale) and wet playa occurrence (a function of precipitation). Organisms with dispersal capabilities limited to <10 km routinely experienced effective isolation during our study. Connectivity is thus a dynamic emergent landscape property, so management to maintain connectivity for wildlife within ephemeral habitats like inundated playas will need to move beyond a patch-based focus to a network focus by including connectivity as a dynamic landscape property.

Downard R, Endter-Wada J, Kettenring KM. 2014. Adaptive wetland management in an uncertain and changing arid environment. *Ecology and Society* **19**, 23.

(Abstract)

Wetlands in the arid western United States provide rare and critical migratory bird habitat and

constitute a critical nexus within larger social-ecological systems (SES) where multiple changing land-use and water-use patterns meet. The Bear River Migratory Bird Refuge in Utah, USA, presents a case study of the ways that wetland managers have created adaptive management strategies that are responsive to the social and hydrological conditions of the agriculture-dominated SES within which they are located. Managers have acquired water rights and constructed infrastructure while cultivating collaborative relationships with other water users to increase the adaptive capacity of the region and decrease conflict. Historically, water management involved diversion and impoundment of water within wetland units timed around patterns of agricultural water needs. In the last 20 years, managers have learned from flood and drought events and developed a long-term adaptive management plan that specifies alternative management actions managers can choose each year based on habitat needs and projected water supply. Each alternative includes habitat goals and target wetland water depth. However, wetland management adapted to agricultural return-flow availability may prove insufficient as population growth and climate change alter patterns of land and water use. Future management will likely depend more on negotiation, collaboration, and learning from social developments within the SES than strictly focusing on water management within refuge boundaries. To face this problem, managers have worked to be included in negotiations with regional water users, a strategy that may prove instructive for other wetland managers in agriculture-dominated watersheds.

Dias MP, Lecoq M, Moniz F, Rabaca J. 2014. Can Human-made Saltpans Represent an Alternative Habitat for Shorebirds? Implications for a Predictable Loss of Estuarine Sediment Flats. *Environmental Management* **53**, 163–171.

(Abstract)

Estuarine areas worldwide are under intense pressure due to human activities such as upstream dam building. Shorebirds strongly depend on estuarine intertidal flats during migration and wintering periods and so are particularly vulnerable to such impacts, whose magnitude will depend on the availability of alternative feeding habitats. In this study we analyze if man-made saltpans can represent an alternative habitat for wintering and migrating shorebirds in the Guadiana estuary, a wetland that is already experiencing environmental changes due to the building of the Alqueva reservoir, the largest in Western Europe. We compared the use of mudflats and saltpans as feeding areas by several shorebird species before the construction of the dam. A dataset with 26 years of counts data was also analyzed in order to detect any long-term trend in shorebirds abundance. We concluded that saltpans, in particular the fully mechanized, can be used as an alternative habitat by larger species during winter and southward migration, thus playing a major role in minimizing the possible effects of sediment loss due to dam building. In contrast, smaller species were particularly dependent on mudflats to feed. A significant change in population trends, from positive to negative, was detected for two species. Although we still have no evidence that this is directly linked to dam building, this result and documented changes that limit primary productivity justifies the implementation of a long-term monitoring scheme of shorebird populations in this



estuary. We also reinforce the need to manage the saltpans as key habitats for shorebirds.

Zhang H, Gorelick SM. 2014. Coupled impacts of sea-level rise and tidal marsh restoration on endangered California clapper rail. *Biological Conservation* **172**, 89-100.

(Abstract)

We develop a predictive multi-process framework to quantitatively assess the spatially variable, interlinked dynamics of sea-level rise, wetland transition, habitat suitability and connectivity, and shorebird distribution and abundance. Bird behavior is represented in a spatially explicit agent-based model that tracks responses of individuals to predicted changes in local habitat quantity and quality. We apply this framework to the endangered California clapper rail (*Rallus longirostris obsoletus*) in the San Francisco Estuary, US, under a range of sea-level rise and conservation scenarios aimed at clapper rail recovery. The framework enables quantification of the relationship between critical habitat destruction and clapper rail population decline. The most influential factors that characterize the quality of tidal marsh habitat are salinity, which is a proxy for higher quality nesting environment and abundance of macroinvertebrates, and tidal conditions, which affect flood and predation threats. Results suggest that clapper rail viability should remain at the present level for moderate sea level rise. However, for a rise of 1.66 m, extinction risk increases from 0.01 to 0.36. The framework enables quantitative evaluation of proposed conservation efforts, and should complement existing theory and empirical inferences. Compared with sub-regional efforts, estuary-wide conservation is more effective in improving reproduction and dispersal success and accommodates a sea-level rise of an additional ~10 cm before population falls below criticality. Should sea level rise to the predicted maximum, proposed conservation efforts are likely to be ineffective in preventing California clapper rail extinction by 2100.

Miller ML, Ringelman KM, Schank JC, Eadie JM. 2014. SWAMP: an agent-based model for wetland and waterfowl conservation management. *Simulation: Transactions of the Society for Modeling and Simulation International* **90**, 52-68.

(Abstract)

The management of North American waterfowl is widely recognized as a premier example of a successful conservation program. Conservation managers on the wintering grounds typically use simple estimates of food availability and population-wide cumulative energy demand to determine how many birds can be supported on a given landscape. When attempting to plan for future needs due to land reallocation, climate change, and other large-scale environmental changes, simple bioenergetic models may not capture important impacts on individual behavior, such as changes in metabolic costs due to increased travel-time and reduced food

accessibility leading to non-linear declines in forager success. We describe the development of an agent-based model of foraging waterfowl that uses explicit individual behavior to generate more detailed and potentially more accurate insights into the impact of environmental changes on forager success and survival. While there is growing recognition of the potential utility of agent-based models in conservation planning, there has yet to be an attempt to formulate, validate, and communicate such a model for use as a decision support tool to guide habitat management conservation for wetlands in North America. Our model seeks to provide the foundational framework for such an effort. We predict that this model will be a useful tool for stakeholders making conservation management decisions.

### Impact assessment and management 2013

Fox AD, Meng F, Shen X, Yang X, Yang W, Cao L. 2013. Effects of shading on *Vallisneria natans* (Lour.) H. Hara growth. *Knowledge and Management of Aquatic Ecosystems* **410**, 7.

(Abstract)

Effects of surface shading were measured on above- and below-ground biomass and fruit production of *Vallisneria natans* (Lour.) H. Hara plants grown from seed in replicated microcosm experiments, based on a control (no shading) and four treatments (25%, 50%, 75% and 90% shading). Above- and below-ground biomass was significantly reduced at treatments above 50% shading and first pistillate and staminate florescence dates were significantly delayed above 75% and 50% shading, respectively. Ratios of mature to unripe fruits produced (both in number or dry weight) did not differ between shading treatments, but dry weight fruit production was significantly reduced at 90% shading. We conclude that above 50% surface shading, *V. natans* plants suffer reductions in accumulated biomass and investment in sexual reproduction. We contend that recent expansions in the extent of the native floating water chestnut *Trapa* spp. at seasonally inundated wetlands in the Yangtze River floodplain could, by shading, have contributed to the reduction in annual biomass and seed production of *V. natans*, contributing to declines in distribution and abundance.

Rimmer JM, Maguire GS, Weston MA. 2013. Perceptions of effectiveness and preferences for design and position of signage on Victorian beaches for the management of Hooded Plovers *Thinornis rubricollis*. *The Victorian Naturalist* **130**, 75-80.

(Abstract)

Damaging human behaviour, yet, is rarely developed using a scientific approach that involves collecting data from the key target audience in regard to their preferences for signs and

placement of signs. We surveyed members of the beach-going public (n = 684) to document their preferences for desirable features and positioning of signage to protect threatened beach-nesting birds. The results suggest a preference for information relating to education and persuasion over details of regulation. However, preferences differed between recreational user groups, suggesting that target audiences should be identified specifically and prioritised. We also describe clear preferences between four candidate signs, which will facilitate a more informed choice of signage for beach-nesting bird management.

Wang Y, Jia Y, Guan L, Lu C, Lei G, Wen L, Liu G. 2013. Optimising hydrological conditions to sustain wintering waterbird populations in Poyang Lake National Natural Reserve: implications for dam operations. *Freshwater Biology* **58**, 2366-2379.

(Abstract)

1. Poyang Lake is the largest freshwater lake in China and is of global importance for the conservation of migratory waterbirds of the East Asian – Australasian Flyway. Recent dam construction on the Yangtze River and its tributaries for agriculture and hydroelectric power has affected the hydrological regimes in downstream lakes. The Three Gorges Dam changed the hydrological regime of downstream lakes by reducing wet season flooding and expanding water storage in the dry season.
2. Despite the critical role of Poyang Lake in regional and global biodiversity conservation and the potential adverse ecological impacts of the Three Gorges Dam on downstream lakes, there have been few studies of the hydrological requirements of wintering waterbirds in the middle Yangtze floodplains.
3. We assembled a predictor matrix including three hydrological variables (annual inflow, maximum water level in high water season or MaxWL and minimum water level in low water season or MinWL) and two climatic variables (annual rainfall and biological cumulative temperature or BioT). Using the predictor matrix and annual waterbird census, we built group-specific generalised additive models (GAM) to investigate how waterbird population variations were related to climatic and hydrological factors in the Poyang Lake National Natural Reserve. We then used the modelled predictor–response curves to identify the optimal lake water levels for each waterbird group.
4. The community-level model selected group and the group-varying-coefficient term of BioT, Inflow and MaxWL as explanatory variables. At group level, tuber eaters and sedge foragers responded positively to BioT and MinWL. Seed eaters, invertebrate eaters and fish eaters responded positively to Inflow and negatively to MaxWL and MinWL. Based on the modelled predictor–response curves, we propose the following optimal water level ranges for Poyang Lake wintering waterbird conservation: a) maximum high water season level should be less than 17.4 m; and b) minimum low water level should be between 8.2 m and 8.8 m.

Rogers DI, Loyn RH, Greer D. 2013. 'Factors influencing shorebird use of tidal flats adjacent to the Western Treatment Plant.' Department of Sustainability and Environment, Heidelberg, Victoria.

(Abstract)

This report presents some key findings from studies of shorebirds at the Western Treatment Plant (WTP) from 2001 to 2012, and also considers previous counts from 1981. The work was commissioned by Melbourne Water to help manage the WTP to treat half of Melbourne's sewage, reduce nutrient emissions to Port Phillip Bay, and conserve waterbirds. The WTP forms part of a wetland complex listed as internationally significant under the Ramsar Convention. Shorebirds use a range of habitats at and near the WTP, especially the tidal flats along 11 km of coast from the Werribee River to The Spits Nature Reserve (managed by Parks Victoria). Shorebirds also forage and roost on shallow non-tidal wetlands in and near the WTP, but the tidal flats appear to be the main foraging habitat for the most numerous shorebird species, all of which are migrants that nest in Arctic Siberia or Alaska. The shorebirds feed on benthic invertebrates in the tidal flats, and high densities of benthic invertebrates have been attributed to nutrient enrichment from the WTP. An Environment Improvement Program has been implemented to reduce nitrogen emissions to the bay, and a risk was recognised that this could reduce the value of the flats for shorebirds. These studies were initiated to monitor the response of shorebird species and attempt to understand their ecology better so that the response could be managed and mitigating measures implemented where necessary. This report focuses on the tidal flats and the three most numerous migratory shorebird species that forage on them: Red-necked Stint, Curlew Sandpiper and Sharp-tailed Sandpiper. Data were collected through bird counts (several times each summer, at least once each winter), foraging observations, estimates of how many birds were foraging or roosting, photographs of prey species, observations of bird movements (including a radio-tracking study) and standardised collections of benthic invertebrates. Data were also obtained from previous shorebird counts at the WTP, and from similar counts elsewhere in coastal Victoria. Numbers of shorebirds fluctuated seasonally and between years. Red-necked Stint declined in abundance at the WTP during the 2000s, but no more so than at other Victorian sites. Curlew Sandpiper declined greatly in numbers during the decade as part of a global decline in this species. Numbers of both species at the WTP were positively correlated with numbers at other Victorian sites. Sharp-tailed Sandpipers were influenced by availability of water inland, and hardly any visited the WTP in summer 2011 after the breaking of a twelve-year drought. In other years they showed a weak tendency to be more numerous at the WTP in years when they were scarce at other Victorian sites. None of these species showed a stronger decline at the WTP during the 2000s than at other Victorian sites. Studies of benthic invertebrates revealed some striking changes over this short period of time, with a large decline in worms and a corresponding increase in crustaceans (mainly amphipods) in the middle of the decade. This is likely to have implications for some shorebird species, although the net effect was little change in edible biomass. The relationships between numbers of shorebirds and benthic invertebrates are complex. Remote-sensed mapping of tidal flats proved necessary to explore these relationships and we present the first maps of the key intertidal foraging sites for shorebirds of the WTP to show the area exposed and submerged by water at specific water levels. We developed a hierarchical set of models that predicted shorebird numbers at any stretch of

coast. According to these models, shorebird numbers at particular tidal foraging sites depend on the total number of shorebirds in the whole WTP (partly a product of events elsewhere in the flyway), the exposure of those flats at any one time (or the mean exposure over a longer period) and the abundance of benthic invertebrates on those flats. The data allowed us to parameterise these models for the three focal species. Significant positive relationships were found between local foraging abundance of shorebirds and density of benthic invertebrates. Within periods of low tidal range, tide height had a strong influence on the numbers of birds that foraged on tidal flats. The proportion of WTP shorebirds foraging on tidal flats was highest on the lowest spring tides (<0.20 m), and lower on tides of 0.35–0.5m, even though there was still some tidal flat exposure in these conditions. Key areas were identified where shorebirds were able to forage at high tidal levels. These areas could be crucial for conserving shorebirds during neap tides when many areas of tidal flat can remain inundated and inaccessible to shorebirds for many days at a time: non-tidal wetlands on the WTP may perform a similar function.

Linhoss AC, Kiker GA, Aiello-Lammens ME, Chu-Agor ML, Convertino M, Muñoz-Carpena R, Fischer RA, Linkov I. 2013. Decision analysis for species preservation under sea-level rise. *Ecological Modelling* **263**, 264– 272.

(Abstract)

Sea-level rise is expected to dramatically alter low-lying coastal and intertidal areas, which provide important habitat for shoreline-dependent species. The Snowy Plover (*Charadrius alexandrinus*) is an threatened shorebird that relies on Florida Gulf Coast sandy beaches for nesting and breeding. Selecting a management strategy for the conservation of this species under sea-level rise is a complex task that entails the consideration of multiple streams of information, stakeholder preferences, value judgments, and uncertainty. We use a spatially explicit linked modeling process that incorporates geomorphological (SLAMM), habitat (MaxEnt), and metapopulation (RAMAS GIS) models to simulate the effect of sea-level rise on Snowy Plover populations. We then apply multi-criteria decision analysis to identify preferred management strategies for the conservation of the species. Results show that nest enclosures are the most promising conservation strategy followed by predator management, species focused beach nourishment, and no action. Uncertainty in these results remains an important concern, and a better understanding of decision-maker preferences and the Snowy Plover's life history would improve the reliability of the results. This is an innovative method for planning for sea-level rise through pairing a linked modeling system with decision analysis to provide management focused results under an inherently uncertain future.

Niu JY, Zou YA, Yuan X, Zhang B, Wang TH. 2013. Waterbird distribution patterns and

environmentally impacted factors in reclaimed coastal wetlands of the eastern end of Nanhui County, Shanghai, China. *Acta Zoologica Academiae Scientiarum Hungaricae* **59**, 171-185.

(Abstract)

The eastern end of Nanhui County is one of the most important coastal wetlands for waterbirds. It is also the key reclamation site in the Yangtze River Delta. In 2005, a reclamation project was completed here. A part of reclaimed area was converted into three types of artificial wetlands: urban lake wetlands; extensive fish ponds; and abandoned wetlands. To examine the effects of different management of these wetlands on the conservation of waterbirds, a study was conducted from 2009 to 2011. A total of 41,493 waterbirds corresponding to 91 species from 15 families were recorded. Two species, Black-faced Spoonbill *Platalea minor* and Falcated Duck *Anas falcata*, meet the international conservation Ramsar criterion of >1% of global population size. The extensive fish ponds contain the highest species richness and evenness, followed by abandoned wetlands and urban lake wetlands. Non-metric Multi-dimensional Scaling ordination plot revealed partition with four distinct clusters apparent. The first and the second clusters were positively correlated with deep water area, anthropogenic disturbance, distance to the seawall, and mean water level. The third cluster had no direct relationship with any environmental factors. The fourth cluster was correlated with vegetation area, shallow water area, and bare muddy area.

Gayet G, Guillemain M, Mesleard F, Fritz H, Curtet L, Broyer J. 2013. Annual use of man-made wetlands by the mute swan (*Cygnus olor*). *Journal of Environmental Management* **120**, 120-126.

(Abstract)

This is essential to understand habitat selection by wildlife to manage habitats and populations. Studying the annual use of aquatic habitats provides information on how to manage wetlands for waterfowl, and to predict possible detrimental effects associated with extended usage by these birds. This is particularly important for species like the mute swan (*Cygnus olor* Gmelin), given its recent dramatic demographic expansion, causing concern in both Europe and America. We studied the extent of usage (swan.days/ha) of habitat patches by mute swans in a heterogeneous and fluctuating fishpond landscape. We assessed seasonal differences of swan usage of fishponds, annual variation for a given fishpond, and determined which habitat factors drive swan usage over the year. The seasonal use pattern was regular: a similar proportion of fishponds was used heavily, moderately or lightly in all seasons. Flocking throughout the year and breeding during summer were associated with heavy use of fishponds, i.e. large number of swan.days/ha. Flocking on some fishponds during several successive seasons demonstrated that some waterbody provide valuable habitats over time for swans. However, swans did not use individual fishponds to the same extent each season, mostly depending on the fluctuating ecological requirements of swans and variation in habitat properties. Agricultural practices on fishponds drastically affected swan usage during autumn and winter: formerly dried fishponds were used preferentially once reflooded. The specific

agricultural crops used during the drought period had no influence though. The large-sized fishponds and fishponds within a dense network of waterbody were the most heavily used by swans throughout the year. Our results may thus be helpful to predict and prevent possible habitat damage by swans. They also provide information on habitats that are valuable for waterfowl species in general, by using mute swans as a proxy for waterfowl requirements.

Burns F, McCulloch N, Szekely T, Bolton M. 2013. No overall benefit of predator exclosure cages for the endangered St. Helena Plover *Charadrius sanctaehelenae*. *Ibis* **155**, 397–401.

(Abstract)

Predator exclosure cages are designed to increase the clutch survival of ground-nesting birds. Predator exclosures provided for the endangered St. Helena Plover *Charadrius sanctaehelenae*, however, did not result in differences in clutch survival between protected and control nests and may have resulted in elevated adult mortality. Exclosures did not exclude all cats, the dominant nest predator, and it is likely that cats caused the adult mortalities observed close to the exclosures. A population model indicates that even if predator exclosures had excluded all cats, the benefits of increased clutch survival would have been more than negated by the estimated decrease in adult survival. The overall effect of predator exclosures needs to be clarified for other species, taking into consideration annual productivity and adult survival, to understand the circumstances in which predator exclosures are beneficial.

Le Lay Y-F, Piégay H, Rivière-Honegger A. 2013. Perception of braided river landscapes: Implications for public participation and sustainable management. *Journal of Environmental Management* **119**, 1-12.

(Abstract)

Over the past century, the ecologically-diverse, braided Magra River in Italy has narrowed, incised, and lost many gravel bars due to the riparian vegetation encroachment following the decrease in bedload supply and channel degradation. Motivated by the European Water Framework Directive, river scientists and managers are beginning to plan projects to conserve and restore these dynamic mosaics of rare habitats and processes. To support this objective, a study was conducted to assess how braided rivers are perceived by different social groups in the area. In June 2006, 127 people were surveyed using a photo questionnaire consisting of ten photographs that depicted riverscapes with different proportions of water, vegetation, and bed material. Respondents were asked to score each photograph in terms of aesthetic value, beneficial uses, and river management needs. Results showed that the photographs depicting gravel bars were perceived as less aesthetically pleasing, so therefore they need an

active management. However, these perceptions differed amongst groups of participants, reflecting their interests and objectives. This paper identifies a distance between scientific and popular attitudes and discusses implications for public participation, support for braided river restoration policy, and environmental education.

Malpas LR, Smart J, Drewitt A, Sharps E, Garbutt A. 2013. Continued declines of Redshank *Tringa totanus* breeding on saltmarsh in Great Britain: is there a solution to this conservation problem? *Bird Study*.

(Abstract)

Capsule: Over 50% of saltmarsh breeding Common Redshank have been lost since 1985, with current conservation management having only limited success at halting these declines.

Aims: To update population size and trend estimates for saltmarsh-breeding Redshank in Britain, and to determine whether conservation management implemented since 1996 has been successful in influencing grazing intensity and Redshank population trends.

Methods: A repeat national survey of British saltmarsh was conducted in 2011 at sites previously visited in 1985 and 1996. Redshank breeding density and grazing pressure were recorded at all sites; the presence of conservation management was additionally recorded for English sites. Results from all three national surveys were used to update population size and trend estimates, and to investigate changes in grazing pressure and breeding density on sites with and without conservation management.

Results: Of the 21 431 pairs breeding on saltmarsh in 1985, 11 946 pairs remained in 2011, with the highest proportion of this population found in East Anglia. From 1985, British breeding densities declined at a rate of 1 pair km<sup>-2</sup> year<sup>-1</sup>, representing a loss of 52.8% of breeding pairs over 26 years, although regional trends varied across different time periods. Grazing pressures did not change markedly with conservation management. Redshank declines were less severe on conservation-managed sites in East Anglia and the South of England where grazing pressures remained low, though were more severe on conservation-managed sites in the North West where heavy grazing persisted.

Conclusion: Saltmarsh-breeding Redshank declines continue and are likely to be driven by a lack of suitable nesting habitat. Conservation management schemes and site protection implemented since 1996 appear not to be delivering the grazing pressures and associated habitat conditions required by this species, particularly in the North West of England, though habitat changes may not be linked to unsuitable grazing management in all regions. An in-depth understanding of grazing practices, how conservation management guidelines could be improved, and the likely success of more long-term management solutions is needed urgently.



Li D, Chen S, Lloyd H, Zhu S, Shan K, Zhang Z-W. 2013. The importance of artificial habitats to migratory waterbirds within a natural/artificial wetland mosaic, Yellow River Delta, China. *Bird Conservation International* **23**,184-198.

(Abstract)

Anthropogenic conversion of natural wetlands into artificial wetland habitats has produced complex wetland landscapes worldwide. In this study we investigated the responses of migratory and wintering waterbirds to five artificial wetland habitats (aquaculture ponds, paddyfields, irrigation canals, open water reservoirs and salt pans) within a novel natural-artificial wetland landscape, Yellow River Delta (YRD), eastern China from October 2007 to May 2008. The results showed that almost all bird community indicators in the YRD natural wetlands were higher than those in adjacent artificial wetlands. Across the landscape, natural wetlands remained most important for all waterbird guilds, and more than 90% of waterbird populations were dependent on these habitats. Artificial wetlands mainly provided a secondary role, supporting about 70% of waterbird species (including six species that reached 1% of their global or biogeographical flyway populations), but with distinctive functional capacity for specific waterbird guilds in different artificial wetlands. The conservation value of artificial wetlands is often ephemeral, mainly during autumn, for specific migratory waterbirds and complements that of remaining areas of natural wetlands. Therefore, the utilisation patterns of artificial wetlands are highly temporal and the majority of species are dependent on areas of natural wetland. A comprehensive study of the inter-seasonal and inter-annual variations in these different habitats and dependence by the various guilds in the YRD is required to enable the true value of these habitats to be understood. We suggest that the conservation of artificial wetlands should not be at the expense of natural wetlands, which should remain the priority for wetland landscape management. Management to maintain the existing artificial wetlands for migrating and wintering water birds should target habitat features that are absent or limited in natural wetlands thus increasing the carrying capacity of the YRD landscape.

Choi C, Gan X, Hua N, Wang Y, Ma Z. 2013. The Habitat Use and Home Range Analysis of Dunlin (*Calidris alpina*) in Chongming Dongtan, China and their Conservation Implications. *Wetlands*.

(Abstract)

Natural coastal wetlands are important habitats for shorebirds while flooded agricultural croplands, may also be useful habitats. Shorebirds in East Asia utilize an often highly developed coastal landscape, which may be dissected by seawalls with intertidal flats on the seaward side, and aquaculture ponds and agricultural croplands on the landward side. Little is known about the value of aquaculture ponds to shorebirds. We investigated the habitat use, preference and home range of wintering Dunlin (*Calidris alpina*) in Chongming Dongtan, east China, through radio tracking and field observations in 2006–2007. Our results indicated that Dunlins preferred tidal flats, avoided agricultural croplands, and used aquaculture ponds in

proportion to their availability. The probability of Dunlin usage of aquacultural ponds decreased with increasing size of unflooded area in the aquaculture ponds. Durlins foraging in aquaculture ponds had lower feeding success rate than those in tidal flats. Thus, tidal flats may provide important foraging habitats for wintering Durlins, while aquaculture ponds may provide alternative roosting and supplemental foraging habitat. Conserving the natural wetlands on tidal flats is vital for shorebird conservation in East Asia but at the same time, the aquaculture ponds also could play an important role if managed properly.

Korner-Nievergelt F, Brinkmann R, Niermann I, Behr O. 2013. Estimating Bat and Bird Mortality Occurring at Wind Energy Turbines from Covariates and Carcass Searches Using Mixture Models. *PLoS ONE* 8, e67997.

(Abstract)

Environmental impacts of wind energy facilities increasingly cause concern, a central issue being bats and birds killed by rotor blades. Two approaches have been employed to assess collision rates: carcass searches and surveys of animals prone to collisions. Carcass searches can provide an estimate for the actual number of animals being killed but they offer little information on the relation between collision rates and, for example, weather parameters due to the time of death not being precisely known. In contrast, a density index of animals exposed to collision is sufficient to analyse the parameters influencing the collision rate. However, quantification of the collision rate from animal density indices (e.g. acoustic bat activity or bird migration traffic rates) remains difficult. We combine carcass search data with animal density indices in a mixture model to investigate collision rates. In a simulation study we show that the collision rates estimated by our model were at least as precise as conventional estimates based solely on carcass search data. Furthermore, if certain conditions are met, the model can be used to predict the collision rate from density indices alone, without data from carcass searches. This can reduce the time and effort required to estimate collision rates. We applied the model to bat carcass search data obtained at 30 wind turbines in 15 wind facilities in Germany. We used acoustic bat activity and wind speed as predictors for the collision rate. The model estimates correlated well with conventional estimators. Our model can be used to predict the average collision rate. It enables an analysis of the effect of parameters such as rotor diameter or turbine type on the collision rate. The model can also be used in turbine-specific curtailment algorithms that predict the collision rate and reduce this rate with a minimal loss of energy production.

Qiu J. 2013. China's cordgrass plan is 'overkill'. *Nature* 499, 392-393.

(No abstract available)

Ge Z, Cao H, Zhang L. 2013. A process-based grid model for the simulation of range expansion of *Spartina alterniflora* on the coastal saltmarshes in the Yangtze Estuary. *Ecological Engineering* **58**, 105– 112.

(Abstract)

*Spartina alterniflora* has been widely introduced to many coastal and estuarine regions of the world as a species for ecological engineering and this species has been spreading rapidly and widely along the Chinese coastline for the past 30 years. Based on four years of field measurements at the Chongming Dongtan wetland in the Yangtze Estuary, a process-based grid model of spatio-temporal range expansion for *S. alterniflora* was developed. The model incorporated the seasonal patterns of seed bank dynamics, seedling establishment, clonal propagation and vegetative growth, while also considering the effects of hydrodynamic conditions on the range expansion of *S. alterniflora* in the coastal saltmarshes. Modelling of a survey strip over a single year on the Dongtan wetland showed that the simulated spread pattern agreed with the actual pattern recorded during the growing season (March–September) with an accuracy of 90–95%, based on the estimations of seed bank dynamics and seedling establishment. On a wider spatio-temporal scale, an 8 year simulation showed that the patterns of range expansion of *S. alterniflora* are amenable to spatially-explicit modelling that takes spatio-temporal processes into account, mainly due to the aggregation effects of clonal integration in patches. Hydrodynamic conditions and niche availability were the most important factors controlling the expansion rate of *S. alterniflora* on the seaward expansion front. However, the actual expansion rate of *S. alterniflora* has slowed down in recent years due to the reduction in the sediment load of the Yangtze River following the completion of the Three Gorges Dam Project. There remain several uncertain issues relating to the model setup and its predictive capacity in terms of environmental variability and the stochasticity that is inherent in the modelling of the reproduction, dispersal and survival of *S. alterniflora*. Furthermore, an update of the model is needed linked to the sediment dynamics seasonality of hydrodynamic conditions in the Yangtze Estuary. In conclusion, this modelling approach provided valuable insights into the life-cycle mechanisms and range expansion processes of *S. alterniflora* under the current conditions. We suggest the potential application of this model in comparing various control strategies.

Tang L, Gao Y, Wang C-H, Li B, Chen J-K, Zhao B. 2013. Habitat heterogeneity influences restoration efficacy: Implications of a habitat-specific management regime for an invaded marsh. *Estuarine, Coastal and Shelf Science* **125**, 20-26.

(Abstract)

Invasive species have to be managed to prevent adverse consequences. *Spartina*

*alterniflora* has invaded many marshes where salinity and inundation are often key factors affecting vegetation. The former was surface clipped twice and native *Phragmites australis* was planted in invaded zones to examine the effects of habitat properties on the efficacy of invader control and native restoration. The results showed that two clipping treatments almost eliminated *S. alterniflora* in the zones with long inundation periods of 80 h/15 d but stimulated compensatory growth of *S. alterniflora* in the zones with short inundation periods. Transplanted *P. australis* performed better over time in zones with low salinity.

## Impact assessment and management 2012

Li, T. H. Y., S. T. Ng, and M. Skitmore. 2012. Public participation in infrastructure and construction projects in China: From an EIA-based to a whole-cycle process. *Habitat International* **36**:47-56.

(Abstract)

Many governments world-wide are increasingly encouraging the involvement of interested individuals, groups and organisations in their public infrastructure and construction (PIC) projects as a means of improving the openness, transparency and accountability of the decision-making process and help improve the projects' long-term viability and benefits to the community. In China, however, the current participatory mechanism at the project level exists only as part of the environmental impact assessment (EIA) process. With an increasing demand for PIC projects and social equality in China, this suggests a need to bring the participatory process into line with international practice. The aim of this paper, therefore, is to identify the weaknesses of EIA-based public participation in China and the means by which it may be improved for the whole lifecycle of PIC schemes. To do this, the results of a series of interviews with a diverse group of experts is reported which analyse the nature and extent of existing problems of public participation in EIA and suggestions for improvement. These indicate that the current level of participation in PIC projects is quite limited, particularly in the crucial earlier stages, primarily due to traditional culture and values, uneven progress in the adoption of participatory mechanisms, the risk of not meeting targets and lack of confidence in public competence. Finally, a process flowchart is proposed to guide construction practitioners and the community in general.

Huang, S.-C., S.-S. Shih, Y.-S. Ho, C.-P. Chen, and H.-L. Hsieh. 2012. Restoration of Shorebird-Roosting Mudflats by Partial Removal of Estuarine Mangroves in Northern Taiwan. *Restoration Ecology* **20**:76-84.

(Abstract)

Expansion of the monospecific mangrove, *Kandelia obovata*, has converted intertidal mudflats and other habitats into mangrove forests, thus reducing estuarine biodiversity in the Danshuei River estuary, northern Taiwan. Dense mangrove vegetation was removed to create a small patchwork of mudflats and a tidal creek in February 2007. Subsequent changes in sediment properties and biodiversity of the macrobenthos and avian communities were examined. The results showed that the creation of different habitats led to changes in sediment properties and biodiversity. The water content and sorting degree of the sediments differed significantly among the restored mudflat, the tidal creek, and the mangrove control site. Silt/clay, organic carbon content, and chlorophyll a concentrations varied seasonally, but not among sites. The abundance of polychaetes in the creek was greater than that in the mudflat or the mangrove (12.5 vs. 5.3 and 2.2 individuals/m<sup>2</sup>, respectively), suggesting preferential colonization of infaunal polychaetes in habitats with prolonged submersion. Crabs showed seasonal changes in density, with higher densities in summer than in autumn and winter. The species richness of wintering shorebirds on the created mudflat increased dramatically from 2002 to 2007. The transformation of a vegetated area into an open mudflat appeared to benefit shorebirds by providing roosting habitat. Our study demonstrated that controlling the spread of estuarine mangrove forests could increase biodiversity, and could particularly benefit the migratory shorebird community.

Bolduc F, Afton AD. 2012. Interactions of structural marsh management, salinity, and water depth on wintering waterbird communities. In 'Wetlands: Ecology, Management and Conservation.' (Eds A Baranyai and D Benkô) pp. 109-128. (Nova Science Publishers, Inc.: Hauppauge, NY.)

(Abstract)

Substantial hydrologic changes occurred during the last century in coastal marshes of southwestern Louisiana, which provide vital habitats for wintering waterbirds of North America. As a result, structural marsh management (levees, water control structures and impoundment; SMM) has been widely implemented for conservation purposes. Our previous research on marsh ponds in this area indicated that SMM mostly decreased biomass of small nematoda and secondarily increased that of ostracoda. We also found that invertebrate communities of impounded freshwater (IF), oligohaline (IO), and mesohaline (IM) marshes differed primarily in biomass of oligochaeta. However, the above invertebrate taxa are not likely major prey of waterbirds. Consequently, we predicted that waterbird species that differentiate communities (1) of IM and unimpounded mesohaline (UM) marshes, and (2) of IF, IO, and IM marshes would not be invertebrate-feeding species. We tested these two predictions by comparing waterbird densities among marsh types using multivariate analysis of variance (MANOVA). We computed standardized canonical coefficients from MANOVA to evaluate contributions of waterbird species to differences in communities among marsh types. We used corrected bird densities (Bolduc and Afton 2008) to remove the confounding effects of water level variation among sampling periods and sites on our comparisons. In contrast to our first prediction,

several waterbird species that consume invertebrates contributed most to differences in waterbird communities between ponds of IM and UM marshes (American avocets *Recurvirostra americana*, northern shovelers *Anas clypeata*, and willets (*Catoptrophorus semiplamatus*). However, consistent with our second prediction, species that consume vegetation contributed most to differences in waterbird communities among ponds of IF, IO, and IM marsh ponds (common moorhens *Gallinula chloropus*, American coots *Fulica americana*, gadwalls *A. strepera*). Most waterbird species had highest observed densities in IF marshes when water depth was lower than on average, whereas American avocets, northern shovelers, and willets mainly used ponds of UM marshes. We conclude that (1) maintenance of water depths preferred by various waterbirds, (2) promoting hydrological diversity at the landscape level, and (3) the preservation of UM and IF marshes would be most beneficial for the conservation of wintering waterbird populations.

Xu GJ, He CB, Xu HL, Huang Y, Sun HS. 2012. Application of taxonomic distinctness indices of littoral macroinvertebrate communities for assessing long-term variation in ecological quality status of intertidal ecosystems, *China Environmental Science and Pollution Research* **19(9)**: 3859-3867

(Abstract)

It has been increasingly recognized that taxonomic diversity indices have a number of desirable properties as an indicator for assessing ecological quality status, in particular their less sensitivity to natural habitat type and sampling effort but more to environmental stress and anthropogenic impact, and a statistical framework for the assessment of the significance of departure from expectation. Taxonomic patterns of macroinvertebrate fauna for assessing ecological quality status were studied based on six datasets collected from intertidal zones of the Yellow Sea, near Qingdao, northern China, during the period of 1989-1998. The invertebrate communities were sampled yearly at five stations with different bottom types during summer season (June). A total of 141 macroinvertebrate taxa were identified belonging 119 genera, 81 families, 34 orders, 19 classes, and 10 phyla. Multivariate analyses demonstrated that the taxonomic patterns of invertebrate fauna represented a significant variation in long-term temporal scale during the study period. The average taxonomic distinctness indices (Delta(+)) decreased to a significantly low level, while the variation in taxonomic distinctness measures (I >(+)) increased to a significantly high level compared with the expected values from 1989 to 1998. The pairwise indices of Delta(+) and (I >(+)) showed a decreasing and increasing trend of departure from the expected taxonomic breadth in response to the environmental stress and anthropogenic impact, respectively. These results imply that the ecological quality status has been significantly deteriorated due to the increasing environmental stress and anthropogenic impact in intertidal zones of the Yellow Sea, northern China, and that the taxonomic distinctness indices of macroinvertebrate fauna are a robust indicator for evaluating ecological quality status.

Rochlin I, James-Pirri M-J, Adamowicz SC, Dempsey ME, Iwanejko T, Ninivaggi DV. 2012. The Effects of Integrated Marsh Management (IMM) on Salt Marsh Vegetation, Nekton, and Birds. *Estuaries and Coasts* **35**, 727–742.

(Abstract)

An integrated marsh management (IMM) project in an urbanized watershed on Long Island, New York, USA, aimed to mitigate salt marsh degradation and to reduce mosquito production by an innovative combination of restoration and open marsh water management methods. The grid ditch network at two treatment marshes was replaced with naturalized tidal channels and ponds. Effects of the hydrologic alterations were monitored utilizing a before–after–control–impact approach. The treatment marshes experienced a number of beneficial outcomes including a fourfold reduction in the invasive *Phragmites australis* and increased native vegetation cover in the most degraded portions of the marsh, increased abundance and diversity of marsh killifish and estuarine nekton species, higher shorebird and waterfowl densities, and increased avian species diversity. The successful implementation of IMM concept led to improved marsh health and diminished mosquito production. Therefore, this study may serve as a template for similar large-scale integrated salt marsh restoration projects.

Athearn ND, Takekawa JY, Bluso-Demers JD, Shinn JM, Brand LA, Robinson-Nilsen CW, Strong CM. 2012. Variability in habitat value of commercial salt production ponds: implications for waterbird management and tidal marsh restoration planning. *Hydrobiologia* **697**, 139-155.

(Abstract)

Salt evaporation ponds are used in place of lost natural estuarine habitats for foraging and roosting by waterbirds around the world, but have started to be decommissioned in some areas due to low profitability. In San Francisco Bay, three former salt pond complexes (Alviso, Eden Landing, and Ravenswood) have been decommissioned, i.e., taken out of commission, and are planned for marsh restoration. We compared total and foraging abundance and densities of ducks, shorebirds, and piscivores, as well as eared grebes (*Podiceps nigricollis*) among decommissioned and commercial pond complexes. Complex use was consistent within groups and variable among groups, with most use occurring in decommissioned ponds: 73% of ducks were observed in the Alviso complex and 9% in the commercial ponds; 51% of shorebirds were in the Eden Landing complex and only 17% in commercial ponds; and 56% of piscivores were in the Alviso complex and <18% in commercial ponds. Only eared grebes were more abundant (59%) in commercial ponds. Differences among groups in within-complex and within-pond abundance were likely related to pond salinity and topography, respectively. Our results suggest that the effects of pond conversion on waterbird groups may be disproportionate to pond area depending on the characteristics of the converted ponds.

## Impact assessment and management 2011 and earlier

### 2011

Ferrer M, de Lucas M, Janss GFE, Casado E, Munoz AR, Bechard MJ, Calabuig CP. 2011. Weak relationship between risk assessment studies and recorded mortality in wind farms. *Journal of Applied Ecology* **49**, 38–46.

(Abstract)

1. Wind farms generate little or no pollution. However, one of their main adverse impacts is bird mortality through collisions with turbine rotors.
2. Environmental impact assessment (EIA) studies have been based on observations of birds before the construction of wind farms. We analysed data from 53 EIAs in relation to the actual recorded bird mortalities at 20 fully installed wind farms to determine whether this method is accurate in predicting the risk of new wind farm installations.
3. Bird data from EIAs were compared with bird collisions per turbine and year at functional post-constructed wind farms to identify any relationship between pre- and post-construction studies.
4. Significant differences in birds recorded flying among the 53 proposed wind farms were found by the EIAs. Similar results were obtained when only griffon vultures *Gyps fulvus* and other raptors were considered. There were significant differences in indexes, including the relative index of breeding birds close to proposed locations, among the 53 proposed wind farm sites.
5. The collision rate of birds with turbines was one of the highest ever recorded for raptors, and the griffon vulture was the most frequently killed species. Bird mortality varied among the 20 constructed wind farms.
6. No relationship between variables predicting risk from EIAs and actual recorded mortality was found. A weak relationship was found between griffon vulture and kestrel *Falco* sp. mortality and the numbers of these two species crossing the area.
7. Synthesis and applications. There was no clear relationship between predicted risk and the actual recorded bird mortality at wind farms. Risk assessment studies incorrectly assumed a linear relationship between frequency of observed birds and fatalities. Nevertheless, it is known that bird mortality in wind farms is related to physical characteristics around individual wind turbines. However, EIAs are usually conducted at the scale of the entire wind farm. The correlation between predicted mortality and actual mortality must be improved in future risk assessment studies by changing the scale of these studies to focus on the locations of proposed individual wind turbine sites and working on a species specific level.



Fox AD, Cao L, Zhang Y, Barter MA, Zhao M, Meng F, Wang S. 2011. Declines in the tuber-feeding waterbird guild at Shengjin Lake National Nature Reserve, China – a barometer of submerged macrophyte collapse. *Aquatic Conservation: Marine and Freshwater Ecosystems* **21**, 82–91.

(Abstract)

1. The Yangtze floodplain is globally unique for its extensive ephemeral wetlands, recharged by summer monsoon precipitation. The annual cycle of inundation and water table recession favours submerged macrophytes, including *Vallisneria* that overwinters in desiccated substrates as tubers, which provide high-energy winter food for tuber-feeding waterbirds that were formerly abundant in the region.

2. Large declines among the tuber-feeding waterbirds swan goose *Anser cygnoides* (L.), tundra swan *Cygnus columbianus* (Ord) and hooded crane *Grus monacha* Temminck between 2004/2005 and 2009/2010 at Shengjin Lake, Anhui Province, suggest that major changes in food availability have occurred there.

3. Based on observations of feeding behaviour and energy budgets of these species, it was calculated that at least 5.0 and 8.9 km<sup>2</sup> of *Vallisneria* beds in 2004 and 2005, respectively, would be needed to support observed numbers of these species, compared with less than 1.5 km<sup>2</sup> found in 2009 and 2010.

4. An incomplete macrophyte survey in summer 2000 located at least 7.7 km<sup>2</sup> of *Vallisneria* beds in the Upper Lake, where none was present during resurveys in 2008 and 2009. Declines in tuber-feeding waterbirds at Shengjin Lake coincide with the disappearance of their submerged macrophyte food plants, possibly as a result of eutrophication since the mid-2000s.

5. Widespread declines and concentration of tuber-eating wintering waterbirds at other sites elsewhere in the Yangtze floodplain may also reflect the local collapse of submerged macrophytes and of ecosystem services that these wetlands provide to the human communities.

Yuan L, Zhang L, Xiao D, Huang H. 2011. The application of cutting plus waterlogging to control *Spartina alterniflora* on saltmarshes in the Yangtze Estuary, China. *Estuarine, Coastal and Shelf Science* **92**, 103-110.

(Abstract)

Control and eradication of the exotic and invasive plant *Spartina alterniflora* within the Chongming Dongtan nature reserve, Shanghai, China, is vital for the management and conservation of the saltmarshes. A demonstration project was established using waterlogging and cutting to control this invasive species. Results from 2007 to 2008 showed that, although the managed waterlogging significantly reduced biomass and seed production of *S. alterniflora* at an early stage, the species subsequently showed rapid adaptation to the long-term waterlogging stress. Thus, managed waterlogging alone was insufficient for the effective eradication of *S. alterniflora*. However, managed waterlogging for around 3 months, combined with cutting the above-ground part of *S. alterniflora* at a key stage (flowering period in July), controlled and eradicated the plant successfully. Both the above-ground and below-ground parts of *S. alterniflora* were killed and the plants began to decompose after 3 months. Furthermore, there was no regrowth of the emergent part of *S. alterniflora* in the following years. However, once the impounded water was released restoring the natural hydrodynamic regime of the saltmarshes, the seeds and seedlings of *S. alterniflora* reinvaded the controlled site from the neighboring areas and the *S. alterniflora* community was re-established. Thus, after eradication of *S. alterniflora*, control measures should be maintained to prevent the re-establishment of *S. alterniflora*. The results of this demonstration project indicate a potentially useful and effective approach for the control and management of large-scale invasion by *S. alterniflora* on saltmarshes in the Yangtze Estuary, China.

## 2010

Song, Y.-I., and J. Glasson. 2010. A new paradigm for Environmental Assessment (EA) in Korea. *Environmental Impact Assessment Review* 30:90–99.

(Abstract)

Over the last 30 years, Environmental Impact Assessment (EIA) in Korea has played an important role in decision-making processes particularly for environmentally sensitive projects. However, the EIA system alone has sometimes not been effective enough to ensure the successful resolution of environmental concerns. In order to compensate for the limitations of the EIA system, a new assessment system called Prior Environmental Review System (PERS), which is relevant to Strategic Environmental Assessment (SEA) in some aspects, was introduced in 1993. PERS aims to balance development and preservation by identifying possible environmental impacts of some administrative plans mainly related to development projects in the early stages of planning. However, PERS still appeared to have some weak points such as a limited range of subjects to be assessed, and weakness of tiering (or vertical integration) from PERS to EIA. Therefore, the necessity for reform of the Korean Environmental Assessment (EA) system, including PERS, was raised. In response, the Korean government sought to establish its policy direction for implementing SEA by enhancing the objectivity and expertise of PERS. The policy was approved by the National Assembly in May 2005, and went into effect in June 2006. The introduction of SEA, by enhancing PERS, provides a framework for a system of EA from the strategic level, including PPPs, to the project level. Yet, despite such improvements, some managerial and technical problems associated

with subsequent EA implementation remain. This paper critically reviews the evolution of the EA system in Korea and suggests essential improvements for the current EA system based on experiences of implementation of both EIA and SEA since June 2006, in the context of international good practice.

## 2009

Lourenço, P. M., and T. Piersma. 2009. Waterbird densities in South European rice fields as a function of rice management. *Ibis* **151**:196–199.

(No abstract available)

## 2006

Fox AD, Desholm M, Kahlert J, Christensen TK, Petersen IK (2006) Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. *Ibis* **148**, 129–144.

(Abstract)

European legislation requires Strategic Environmental Assessments (SEAs) of national offshore wind farm (OWF) programs and Environmental Impact Assessments (EIAs) for individual projects likely to affect birds. SEAs require extensive mapping of waterbird densities to define breeding and feeding areas of importance and sensitivity. Use of extensive large scale weather, military, and air traffic control surveillance radar is recommended, to define areas, routes and behaviour of migrating birds, and to determine avian migration corridors in three dimensions. EIAs for individual OWFs should define the key avian species present; as well as assess the hazards presented to birds in terms of avoidance behaviour, habitat change and collision risk. Such measures, however, are less helpful in assessing cumulative impacts. Using aerial survey, physical habitat loss, modification, or gain and effective habitat loss through avoidance behaviour can be measured using bird densities as a proxy measure of habitat availability. The energetic consequences of avoidance responses and habitat change should be modelled to estimate fitness costs and predict impacts at the population level. Our present ability to model collision risk remains poor due to lack of data on species-specific avoidance responses. There is therefore an urgent need to gather data on avoidance responses; energetic consequences of habitat modification and avoidance flights and demographic sensitivity of key species, most affected by OWFs. This analysis stresses the importance of common data collection protocols, sharing of information and experience, and accessibility of results at the international level to better improve our predictive abilities.

## 2001

Atkinson, P. W., S. Crooks, A. Grant, and M. M. Rehfisch. 2001. The success of creation and restoration schemes in producing intertidal habitat suitable for waterbirds. *English Nature Research Reports*, number 425, English Nature, Peterborough.

(Abstract)

1. One of the greatest threats facing coastal waterbirds in the United Kingdom is the loss or degradation of coastal habitats through development or, in the medium to long term, loss of habitat due to climatic change and sea-level rise.
2. Although estimates of the impacts of habitat loss on waterbird populations may be difficult to predict exactly because of the role of density-dependent factors, habitat loss or change has been shown to impact locally by reducing both the abundance of waterbirds using a site and also at the population level by changing mortality and productivity rates. Predictive behaviour-based mathematical models, which are built around understanding of a species relationship with its environment have successfully predicted the population changes observed in the field and also allow the impact of novel situations on changes in population size to be assessed.
3. Under European law, appropriate compensation must be provided when a Natura 2000 site is adversely affected by development. Provision of compensation involves the creation or restoration of habitat of environmental value at least equivalent to that of the displaced habitat.
4. Intertidal habitats pose special problems for restoration because (i) they are topographically and ecologically complex, (ii) they support many species of animals, some of which require specific habitats and linkages to other terrestrial or marine habitats, and (iii) they exist and evolve within dynamic coastal settings, subject to changing tidal levels, salinities and long term forcing factors associated with sea-level rise and climate change.
5. Currently within the UK, the science of coastal habitat creation and restoration is poorly understood. This report collates information from the literature from around the world on projects where new intertidal habitats have been created or restored through the use of managed retreat (setting back of sea walls), sediment recharge and enhanced sedimentation. Specifically, it details the methods used and the stability and long-term geomorphological sustainability of the new habitats and the time scales at which marine invertebrate and waterbird populations colonise and then develop in the new habitats. As very few projects detail specific success criteria or perform adequate monitoring we provide guidelines as to how success may be measured and also how monitoring programs for invertebrates and birds may be carried out.
6. There are few examples of newly restored intertidal habitat in the UK. Consequently, there is limited monitoring data from which to draw conclusions on the success of domestic restoration actions. There are, however, a number of examples of historic natural breaches in flood defense and unmanaged restoration on intertidal habitat from which lessons can be drawn. There are also a number of managed restoration actions in other nations but caution

must be exercised in drawing direct comparisons with these because of ecological and physical differences between coastal settings.

7. When restoring habitats, it is necessary to take an approach based around restoring ecological functions rather than concentrating upon individual attributes. From the available literature it is clear that, given suitable hydrodynamic and geomorphological conditions, it is possible to recreate some types of mudflat and saltmarsh within a relatively short time period (less than five years), though the exact form and function of "mature" restored habitat is near impossible to predict from the outset. The functions supported by estuaries and intertidal habitats often develop at different rates. Vegetation, invertebrate and bird fauna often respond relatively quickly (within a few years) whereas geo-chemical cycling and the restoration of nutrient flow between terrestrial and marine habitats take longer. Experience from the United States indicates that the outcome is often uncertain and unpredictable at the time of restoration and therefore any overall strategy for reaching restoration targets must be thought of in terms of risk at spatial and temporal levels.

8. The reestablishment of intertidal habitat involves the landward relocation of flood defences, the breaching or removal of former outer defences or measures to enhance sedimentation on the foreshore. No one technique is applicable in all coastal situations and each comes with pro and cons. Realignment involving breaching of outer defences enables the reestablishment of intertidal habitat within sheltered conditions but does not address larger estuarine morphological concerns. Bank retreat, the full landward retreat of outer flood defences, enables a more natural estuarine form to develop but may leave the site vulnerable to wave erosion. Enhanced sedimentation within wood fenced containment fields have been tried in a number of open foreshore settings but have been found to have beneficial outcomes only when natural conditions were naturally favourable in the first place.

9. The placement of dredged material either within managed realignment sites or on the open foreshore offers the opportunity to raise the intertidal surface elevation to a level suitable for mudflat or saltmarsh development. There are concerns that this approach does not allow the form of created intertidal habitat to develop features, such as creeks, which would normally develop as a marsh evolves slowly from a mudflat. Early attempts to place dredged material in the intertidal zones often result in the over-consolidation of sediments and poor creek development which, although useful for coastal and flood defence, are not suitable for the restoration of naturally diverse plant and invertebrate communities. New techniques, being developed in the southeast of England involve the placement of high-density slurry to create a marsh (or mudflat) surface of variable topography. Preliminary results indicate that the slurry may adopt the form of the underlying marsh surface and may encourage the development of a proto-creek network. If this were to persist, this would be a major step forward in saltmarsh restoration. Detailed research has yet to be undertaken.

10. Invertebrate communities will colonise suitable intertidal habitats if a source of potential colonisers is available. The rate of colonisation depends on the availability of source colonisers and the life-cycle of individual organisms. Species that are mobile, have a short generation time and a planktonic larval phase are likely to establish relatively quickly. However, bivalve species such as *Mya* spp and *Scrobicularia* spp may take a few years to colonise and grow to a size that are suitable for waterbirds. Evidence from empirical studies shows that although

invertebrates colonise relatively quickly, species composition may be different from surrounding areas, even 10-15 years after colonisation.

11. Birds are mobile and quickly adapt to new habitats. Empirical studies show that colonisation is rapid and at Orplands and Tollesbury Wick, two managed retreat sites in the UK, there was a high degree of bird usage within the first two years although there were differences in the species composition and temporal usage of the sites compared with the surrounding estuary. In other studies, differences between created and natural sites have manifested themselves with a preponderance of generalist, rather than specialist, species on restored sites. All but one of the studies reported here considered that the avifauna supported on restored areas was different to surrounding natural areas. This implies, that in many cases, created intertidal habitat is not supporting the full range of functions found in 'natural' habitats.

12. In the majority of studies reported here, the design of monitoring schemes and the definition of success criteria have been inadequate to determine whether a created or restored wetland has reached its intended target. Monitoring and assessment is an important component in the mitigation/compensation process and, within the UK, there are no agreed protocols for intertidal habitat restoration. In developing such protocols, mechanisms to account for functioning at the wider landscape level (i.e. linkages between the habitat on site and those elsewhere in the coastal area), beyond individual site specific and compliance issues should be sought.

13. There are large gaps in the knowledge about intertidal habitat restoration in the UK. These include the efficacy of the methods used to create areas, how to measure functional equivalence in a manner that is rapid and cost-effective and also the human-use values that are put on intertidal habitats. An experimental approach and an adaptable management framework, with regular assessment of the monitoring data, is essential for any large-scale compensatory project.

14. For compensation projects, it may be wise to demand that habitat to be lost is recreated in advance of that loss. In this way the 'value' of the restored or created habitat may be directly compared with the natural habitat to be lost and measures to ensure equitable replacement can be undertaken.

15. The creation of new habitats as part of compensation for damage to Natura 2000 sites provides the opportunity to recreate historically lost habitats. Many UK flood plains have undergone large-scale development and freshwater-transitional and brackishwater habitats have largely been removed from these areas. Reinstatement of these habitats will improve the linkages between terrestrial and marine habitats and is likely to improve the likelihood of success of compensatory measures.

## **2000**

Wakeham-Dawson, A., and K. W. Smith. 2000. Birds and lowland grassland management practices in the UK: an overview. Pages 77-88. in *Ecology and Conservation of Lowland*

Farmland Birds. Spring Conference of the British Ornithologists' Union, 27-28 March 1999., Southampton, UK.

(Abstract)

Lowland grassland in the UK can be categorized broadly as wet or dry grassland, each of which supports a characteristic assemblage of breeding and wintering bird species. Intensification of grassland management over the last fifty years has included extensive drainage, increased use of pesticides and artificial fertilisers, re-seeding, earlier and more frequent mowing and increased grazing pressure. With a few exceptions, intensification has in general been to the detriment of grassland birds and at least 42 bird species of current UK conservation concern are dependent on grassland at some stage in their life cycle. Species associated with wet grassland have benefited from the acquisition and management of wetland reserves, site management agreements and, to some extent, Environmentally Sensitive Area (ESA) schemes. However, these mechanisms have not been sufficient to prevent overall declines in many breeding bird species. Dry grassland research has provided recommendations for timing and mowing methods that reduce nest and chick mortality in agricultural, ESA and set-aside grassland. The success of grassland management for birds in reserves, ESAs and the agricultural ecosystem more generally, via other agri-environment schemes, depends on conservation becoming a key part of the EU Common Agricultural Policy. It is clear that longterm conservation of grassland bird species relies on EU resources being directed away from agricultural productivity towards policy that allows a sustainable integration of agriculture and conservation.

## 1999

Erfteemeijer, P. L. A., and R. R. Lewis. 1999. Planting mangroves on intertidal mudflats: habitat restoration or habitat conversion. Pages 23-28. in Proceedings of the ECOTONE VIII seminar enhancing coastal ecosystems restoration for the 21st century, Ranong, Thailand.

(Abstract)

After decades of wide-spread mangrove destruction and degradation, an increasing effort is being made by authorities, donor projects, environmental organisations and universities throughout the Asia-Pacific region to rehabilitate and restore mangrove forests. Among these encouraging developments, there are a substantial number of restoration projects in which mangroves are planted on intertidal mudflats. The choice of mudflats for the mangrove planting has the advantage of avoiding conflicting claims over land ownership and development, as would arise in efforts to restore mangroves in abandoned shrimp farm areas or former logging areas. However, the use of the terms "restoration" or "rehabilitation" in such cases is inappropriate, since intertidal mudflats have not been covered in mangrove forests before. Such efforts should therefore rather be termed "afforestation". Although generally poorly acknowledged outside the scientific community, these intertidal mudflats represent a rich and productive ecosystem in themselves, providing an important habitat that supports high densities of intertidal benthic invertebrates and fulfilling a range of key ecological

functions. During low tides, the intertidal mudflats serve as important feeding grounds for large concentrations of migratory shorebirds, while in many areas the mudflats are exploited by humans for bivalves and crabs, contributing substantially to their income and food. This therefore suggests that planting mangroves on mudflats would represent a form of “habitat conversion”, in other words changing one valuable habitat into another. Even if the afforestation is successful, the net gains in such a situation are likely to be less than in the case of restoration efforts in degraded former mangrove areas and abandoned shrimp ponds. The present paper attempts to raise concern over the large-scale planting of mangroves on intertidal mudflats by evaluating the limited success rates of such efforts, and by emphasizing the ecological importance and economic attributes of intertidal mudflats. It is argued that in the site-selection for mangrove restoration, a full environmental assessment should be made of the potential social and environmental impacts. The important ecological and socio-economic attributes of intertidal mudflats indicate that mangrove afforestation in these areas does not constitute a plausible form of wise use of resources.

#### **1994**

Castelle AJ, Johnson AW, Conolly C. 1994. Wetland and stream buffer size requirements – A review. *Journal of Environmental Quality* **23**, 878-882.

(Abstract)

Upland vegetated buffers are widely regarded as being necessary to protect wetlands, streams, and other aquatic resources. Buffer size requirements, however, have typically been established by political acceptability, not scientific merit. This often leads to insufficiently buffered aquatic resources. In order to assist public agencies in formulating appropriate buffer standards, we conducted a literature search of the scientific functions of buffers. The literature search reconfirmed the need for buffers and emphasized the importance of considering specific buffer functions. A range of buffer widths from 3 m to 200 m was found to be effective, depending on site-specific conditions; a buffer of at least 15 m was found to be necessary to protect wetlands and streams under most conditions.