



Attadale Cove, Western Australia, the starting point for the Far Eastern curlew on its long journey north to the Yellow Sea region in China (image by Mu, March 2023).



# Landscapes, cityscapes and seascapes: Safeguarding wetlands, habitat and urbanisation across the East Australasian flyway

YIBIN MU AND SIMON KILBANE

Along with the world's population growth, human activities, urban expansion and land-use change seriously impact natural ecosystems, causing water- and biodiversity-related challenges across lands, cities and seascapes. Proposals to effectively address these challenges include Australia's water-sensitive urban design (WSUD) and China's sponge city design (SCD). However, both strategies neglect how widespread loss and degradation of wetlands, as biodiversity hotspots providing essential ecosystem services, threaten many species interdependent with them. A forward-thinking design hybrid of WSUD and SCD could potentially contain and construct wetlands in urban areas to maintain and/or restore habitat for the Far Eastern curlew, which the International Union for Conservation of Nature lists as a large, endangered wading bird. A focus on this species could enlighten our understanding of planning and design synergies across lands, seas, boundaries, politics, space and time. Considering two end-points in this bird's annual cycle – nesting sites in China and Western Australia – leads to a narrative of collaborative concern and design response. A literature review confirms the necessity of protecting vulnerable birds as a regional concern. Research-by-design demonstrates the feasibility of constructing wetlands and habitat, advancing design discourse of this restoration following the proliferation of WSUD and SCD.

## Introduction

The Ramsar Convention is a treaty, signed by 170 countries, that is aimed at curbing the global loss of wetlands. Yet, although it came into effect in 1975 (Finlayson et al, 2011), wetlands in Australia continue to deteriorate at an alarming rate (Burgin et al, 2016). Large areas of natural wetlands have vanished due to human activities such as agriculture and urbanisation, highlighting wetland loss as a widespread regional concern. For instance, extensive natural wetlands in New South Wales and the southwest of Western Australia have been filled in and readied for human land uses. In China and South Korea, the disappearance of wetlands along the Yellow Sea has deprived a large number of migratory birds of their stopover sites. Such loss of wetlands, as biodiversity hotspots providing essential ecosystem services, threatens the many species that depend on wetlands for survival. The Far Eastern curlew (FEC) (*Numenius madagascariensis*) is a large migratory, wading bird interdependent with wetland habitats. Its population has declined dramatically in recent years: habitat fragmentation and urbanisation have made it a 'vulnerable' species, according to the International Union for Conservation of Nature (BirdLife International, 2010).

Annually, the FEC travels a staggering 12,000 kilometres on each migration (figure 1). Each year, 73 per cent of FECs overwintering in Australia reserve enough energy for the long returning flight north and gain 40 to 70 per cent of their body weight (Finn and Catterall, 2023). From March to May, they reach the Yellow Sea region in China (Amano et al, 2010) and finally arrive at their breeding grounds in relatively uninhabited areas of the Russian Far East from April to June (Antonov, 2010; Szabo et al, 2016). It is there that they breed before starting the cycle once again, moving southward in August to September.

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## KEY WORDS

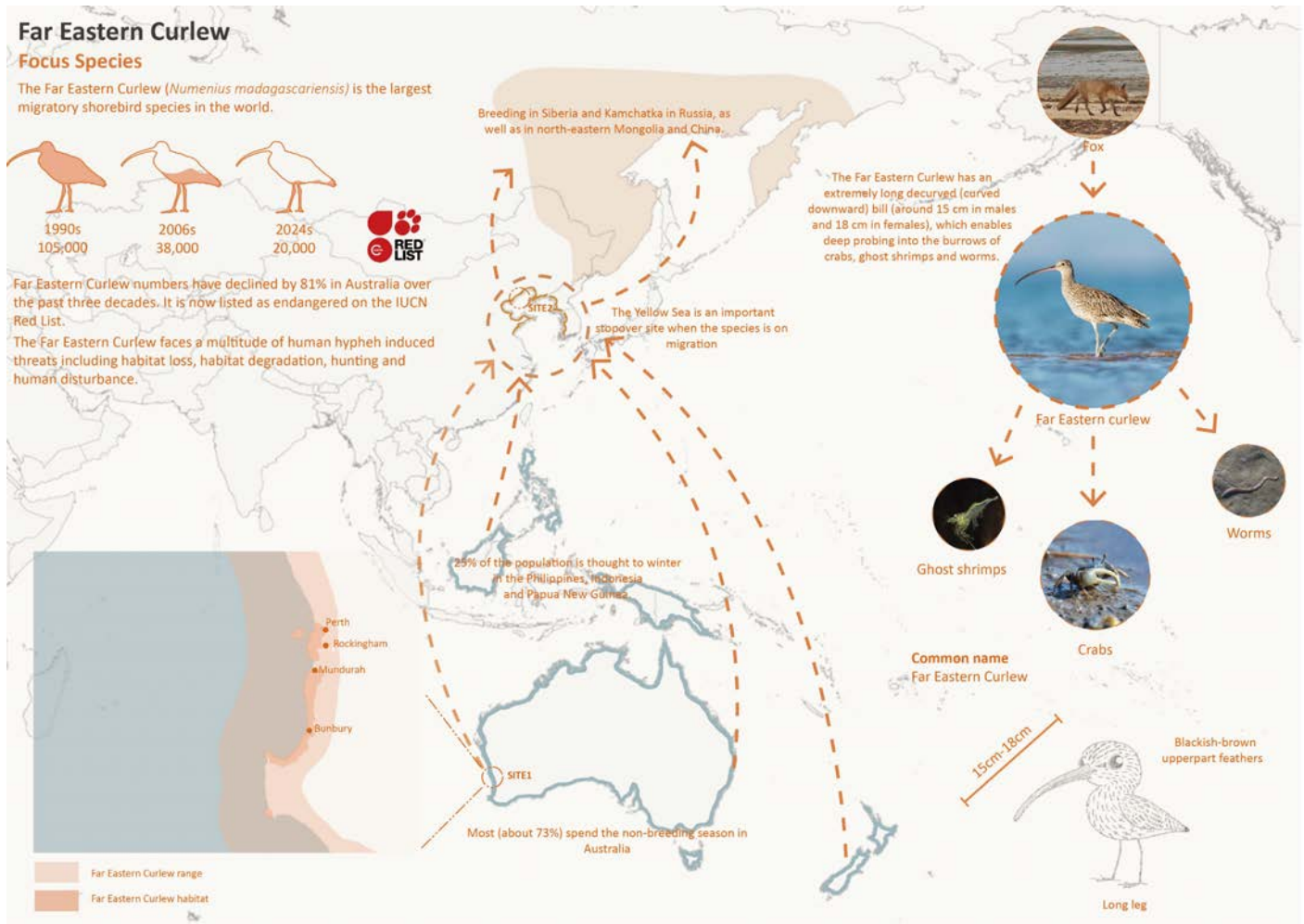
Far Eastern curlew; habitat; wetland; East Australasian flyway; water-sensitive urban design; sponge city design

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**Figure 1.** The East Australasian flyway and migratory patterns of the FEC (image by Mu, 2023).

The life of the FEC integrates intimately with annual migratory seasons, oceanic and water systems, along with the diminishing availability of habitat for these temporal cycles. Habitat of a suitable size and location is critical to both its migration and reproduction. Migratory birds require different wetlands as habitats in different seasons and locations, and the loss or deterioration of even a single habitat severely affect the sustainability of the species (Faaborg et al, 2010; XD Wang et al, 2022). For the FEC, anthropogenic disturbance, substrate type and food density are indicators of their habitat suitability. The density of conspecifics, which strongly influences other bird species, does not significantly affect the FEC. One study from the Yellow Sea, China showed that, in contrast to other curlews, for FECs human disturbance negatively affects their feeding to a significant degree (DL Li et al, 2020). Coming to the same conclusion, Lilleyman et al's (2016) study in the Darwin region of Northern Territory, Australia notes that people and dogs greatly affect FEC populations, whereas Darwin Harbour's East Arm Wharf gathers large numbers of FECs precisely because it is undisturbed by humans.

In contrast to the consensus on the negative impacts of anthropogenic disturbances, voices diverge in relation to research on metrics of substrate type and food density. DL Li et al's (2020) study in the Yellow Sea region suggests that substrate type does not significantly affect FEC feeding rate and that seasonally varying food density was the primary influence on the FEC's choice of habitat. However, Finn and Catterall (2023) suggest that substrate type is an essential criterion for FECs in their habitat selection. The authors classified substrates into two broad categories:

- macro-substrate, further divided into four categories of sand, mud, sandy mud, and coral
- micro-substrate, further divided into seven categories of mud, sandy mud, sand, seagrass, seagrass pools, other pools, and tidal water.

They then used the FEC's feeding rate, success rate and biomass intake rate as indicators on different substrates. The experimental evidence showed that substrate type significantly affected the experimental metrics, with FEC feeding rate and biomass intake rate significantly higher on mudflat than on other substrates. It has also been suggested that habitat location and disturbance, rather than food availability, limit the population of the FEC on these beaches (Lilleyman et al, 2016).

In considering the above views, we concur that Li et al's decision to use the feeding rate as the sole criterion for judgement is limited. However, it cannot be ruled out that the different environments in the Yellow Sea region of China and in Australia may cause variations in population size. Therefore, when choosing suitable ecological environments for the FEC, researchers need to use multiple indicators and to adopt different survey methods according to the location.

### *Approach*

This paper consists of two main parts. First, a literature review summarises and discusses the current research on the FEC and the methods and standards for planning wetland habitats using sponge city design (SCD) and water-sensitive urban design (WSUD) concepts in urban areas. The second part illustrates and reflects on a series of research-by-design explorations and how they relate to the original research aims and objectives.

### *Research significance*

Over the past three decades, the FEC population has declined by 80 per cent in Australia, with only 20,000 to 50,000 individuals surviving by 2023, according to Australian government statistics (Finn and Catterall, 2023). The main reason for the population decline is habitat loss caused by development around the Yellow Sea (DL Li et al, 2020) as the wetlands and shoals of the Yellow Sea are important food supply points for the FEC.

However, since the middle of the twentieth century, 49 per cent of the tidal wetland and 67 per cent of the salt marsh wetland in the Yellow Sea have disappeared, making it the fastest-declining coastal wetland area in the world (Peng et al, 2015). Illustrating this polemical dialogue between human population and the Yellow Sea is the Saemangeum development project in South Korea. In 2006, 401 square kilometres of tidal wetland was reclaimed for commercial development, leading the number of FECs in the area to decline sharply from 87,000 to 2,500 in just two years (Moores et al, 2016).

The survival of the FEC is essential to the ecosystem as the species is a key link in the food chain. Actions to protect the habitat of FECs may also protect the habitat of other migratory birds and maintain the stability of migratory bird populations, making the FEC an umbrella genus. It follows that the protection of this habitat helps maintain the health of all coastal ecosystems and the intertidal habitats that are important for other species as well, thus protecting the integrity and stability of the entire coastal ecosystem (Finn and Catterall, 2023).

The FEC, discovered and named in modern science in 1766, is one of the earliest birds to conquer the ocean and sky. Perhaps in a previous era, FECs flew as the earliest 'messengers' between the continents of Australia and Asia. Our dominant worldview is anthropocentric, but the FEC, as a resident of these two continents since ancient times, also has the inherent right to live in both places.

Furthermore, the ongoing resilience of robust (or even expanded) habitat introduces the potential to consider a reconciliatory ecology that connects people with nature. This is potentially both functional – for instance, through WSUD and SCD – and tacit, through recreational, scenic and aesthetic values, and the spirituality of maintaining robust ecosystems that humans can enjoy and potentially be enthused about protecting.

Despite an increasing number of studies on the FEC in recent years, its population continues to decline, and the fundamental contradiction is that it is impossible to make all countries along the migration route compromise on the protection of wetlands for the bird's survival. At the large scale, several policies guide this effort (for instance, Ramsar), while at the smaller scale, as with the focus of this paper, issues of urbanisation, environmental degradation and habitat protection that directly impact the species are inextricable from larger challenges and the complexity of growing cities. This paper considers these contrasting worlds and ways in which synergies and mutual benefits could emerge to integrate them.

On this basis, this paper uses a literature review to explore the potential of augmented wetland habitat through the lens of SCD and WSUD. In this way, it examines the possibility of coexistence between humans and the FEC by utilising wetland habitat within and adjacent to urban regions. At the same time, wetlands can give back, leading to a 'win-win' reconciliatory ecology (Q Li et al, 2022) that can store, purify and reuse urban water resources while simultaneously improving urban biodiversity.

### Literature review

Keyword retrieval is commonly applied in literature reviews (Schumann et al, 2020). The aim of using it in this instance was to highlight the existing scholarly literature in the fields of FEC, landscape architecture, SCD, WSUD and habitats research that forms the body of knowledge on the impacts of urbanisation on wetland ecosystems, rewilding principles and their application to urban environments, and the theory and practice of SCD, WSUD and urbanisation. This considered literature comes from the Web of Science and the Chinese National Knowledge Infrastructure (CNKI). To keep the focus on timely research, the search period was set between 2018 and 2023.

**Table 1.** Keyword search results

Keywords	Number of articles in Web of Science	Number of articles in the CNKI
LA; Bird habitat	4,623	72
LA; SCD	84	1,194
LA; WSUD	75	0
LA; Bird habitat; SCD	1	0
LA; Bird habitat; WSUD	2	0
LA; Bird habitat; Urbanisation	21	3

As table 1 shows, the landscape industry has a notable lack of research on protecting bird habitats in WSUD and SCD. In the field of landscape, bird habitat and urbanisation are negatively correlated, which proves that urbanisation has led to the loss of bird habitats. Most importantly, no results were yielded through searching for the combined key words of 'Far Eastern curlew' and 'landscape architecture'.

The literature review revealed new approaches to urbanism and wetland habitat design.

### *Alternative development strategies*

Urbanisation is the process of city growth, while urbanism is the study and practice of how cities are organised, experienced and managed. To address the contradiction between urbanisation and water, wetlands and ecological environment, scholars and practitioners worldwide have proposed a diversity of urban development strategies. Examples are WSUD in Australia (Morison and Brown, 2011), SCD proposed by Chinese scholar Kongjian Yu (2016), low impact developments (LID) in the United States (Pyke et al, 2011), sustainable urban drainage systems (SuDs) (Mitchell, 2005; Tang et al, 2018) and blue green cities (BGCs) from the United Kingdom (O'Donnell et al, 2020). All of these initiatives attempt

to coalesce the potential for human settlements and populations to explore and improve the relationship between water, habitat, biodiversity and resilience in a synergistic manner. These strategies profoundly affect the landscape and local ecology (K Yu, 2016; L Yu et al, 2016). In the case of SCD and WSUD, both can expand or protect animal habitats and improve biodiversity.

### *Sponge city design*

Kongjian Yu and Dihua Li (2003) first proposed SCD in *The Road to Urban Landscape: A Discussion with Mayors*, an approach that the Chinese government began to heavily promote in 2014. When Budge (2006) studied the Australian population, he likened the ability of cities to absorb people to a sponge. The core concept of SCD is to consider how a city's spaces function as a giant sponge composed of several tiny sponges by building their facility for low-impact development (W Wang et al, 2015). The metaphor of a sponge has been extended to become a common way of describing the ability of cities to absorb and release water. As more scholars have come to recognise the SCD concept, an increasing number of demonstration projects have won awards worldwide (K Yu, 2016).

While some of these 'sponges' may be natural, others are, or could be, constructed or artificial. Each sponge has the capacity to regulate rainwater, store water resources and purify water bodies. Given the distribution of natural 'sponges' within cities is uneven, different parts of the city vary in their ability to regulate water. So it makes sense to design and construct sponges, which may involve a variety of measures, such as constructing rain gardens, wetlands, green roofs and permeable paving. These structures can absorb, store, infiltrate and purify rainwater, as well as use stored water resources when needed (Yanwei, 2015).

Sponges are the same as the landscape in the 'landscape security pattern' theory. Their pattern in space is composed of specific key locations and spaces. This pattern is essential for solving water problems and protecting biodiversity and populations. The diffusion is of great significance (Xiao et al, 2020). However, with the acceleration of urbanisation, natural sponges are destroyed, artificial sponges become sparse, and the important connections between sponges are increasingly damaged. The SCD creates a vital system by repairing existing sponges, adding new ones and re-planning their layout. This system is different from grey infrastructure. It is more resilient and multi-functional and can solve water problems flexibly and continuously (K Yu, 2016).

### *Water-sensitive urban design*

In WSUD, urban planning and urban water cycle management are integrated and optimised through urban planning and design with water supply, wastewater, stormwater, groundwater and other facilities at different spatial scales from the city to the site. WSUD puts 'water' at the beginning of urban design. It carries water through to every aspect so that water resource use, storage and reuse operate within a 'sustainable' framework (Ghofrani et al, 2017). This can be achieved through high-quality planning and design, including rainwater treatment, wastewater reuse, street greening, soft surfaces, and biodiversity enhancement. WSUD can link the natural water cycle, the built environment and traditional groundwater systems to create a safer and more efficient water cycle, thereby increasing the city's immunity to flooding (Oral et al, 2020; YL Wang and van Roon, 2020).

### *Wetlands in SCD and WSUD*

As natural water treatment systems, wetlands can absorb and filter water, purify water bodies and enhance biodiversity. SCD and WSUD can interact with wetlands to achieve sustainable use of water resources and to improve water quality (Zhang et al, 2020). For example, WSUD can collect and store rainwater and then direct it to wetlands for treatment and purification (Kentula and Paulsen, 2019). Wetlands can well purify rainwater, reduce the pollution level of water bodies and protect water quality in SCD (Min et al, 2021). Wetlands can improve water quality by removing pollutants and nutrients from water through plants and soil (Everett et al, 2016).

Therefore, wetlands are an essential water treatment facility in SCD and WSUD to treat sewage and stormwater discharged by cities. More efficient water management and water quality improvement can be achieved by using wetlands in conjunction with other facilities (for example, permeable paving and bioretention basins) (Sochacka et al, 2021). In addition, wetlands can provide landscaping, improve air quality and increase urban green space. In conclusion, although contamination of wetlands may threaten the survival and reproduction of some species, interactions between SCD, WSUD and wetlands can lead to sustainable use of urban water resources and improved water quality, urban environments and biodiversity (Ghofrani et al, 2017). Therefore, wetlands have an essential role in SCD and WSUD, which can reduce waterlogging problems and improve the utilisation efficiency of rainwater resources.

As noted, however, the research has a significant gap on enhancing biodiversity through wetlands in WSUD and SCD strategies. Even when a paper mentions it, it does so only briefly. This phenomenon might be attributed to the difference in scope between landscape architecture and urban planning. Unlike urban planning, which focuses on the macro and the entire city, landscape design pays more attention to the micro and meso scales, concentrating on specific spaces.

As landscape designers, in response to the current challenge of urbanisation leading to the disappearance of FEC habitats, we can capitalise on our expertise in integrating design with natural ecosystems and habitat preservation. Therefore, taking this research on the FEC as an example, a focus on how to restore the habitats of endangered species within urban wetlands supplements and expands on WSUD and SCD strategies in the field of landscape.

### Research-by-design explorations

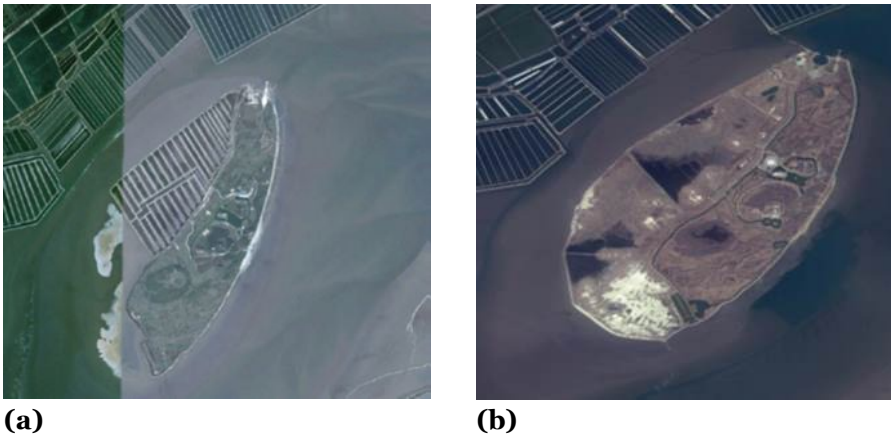
Research-by-design is an academic research approach that employs design as a research method. This approach is mainly applied in landscape architecture and urban design (Dezio et al, 2021). It is particularly suitable for dealing with problems and systems that require continuous adaptation. For instance, in creating a habitat for FECs, research-by-design can further study the habits of FECs through diverse artificial habitat designs and explore its potential to adapt to artificial urban wetlands.

This research method makes design a process not only of design but also of exploration.

- **Scope of geographic range:** The design approach focused on two regions, the Yellow Sea of China and Western Australia, and was mainly concerned with urban environments within these regions.
- **Scope of urban environments:** This study focused on the implementation of wetland rejuvenation in urban environments through WSUD and SCD. Correspondingly, being a location with significant urban population growth and/or pressures was considered as an important factor for selection.
- **Scope of target species:** Although the FEC was the main target species of this design approach, the approach also considered results could apply to other birds and organisms that depend on wetland habitats, as well as visitation and synergistic opportunities for humans visiting and/or residing in the area.

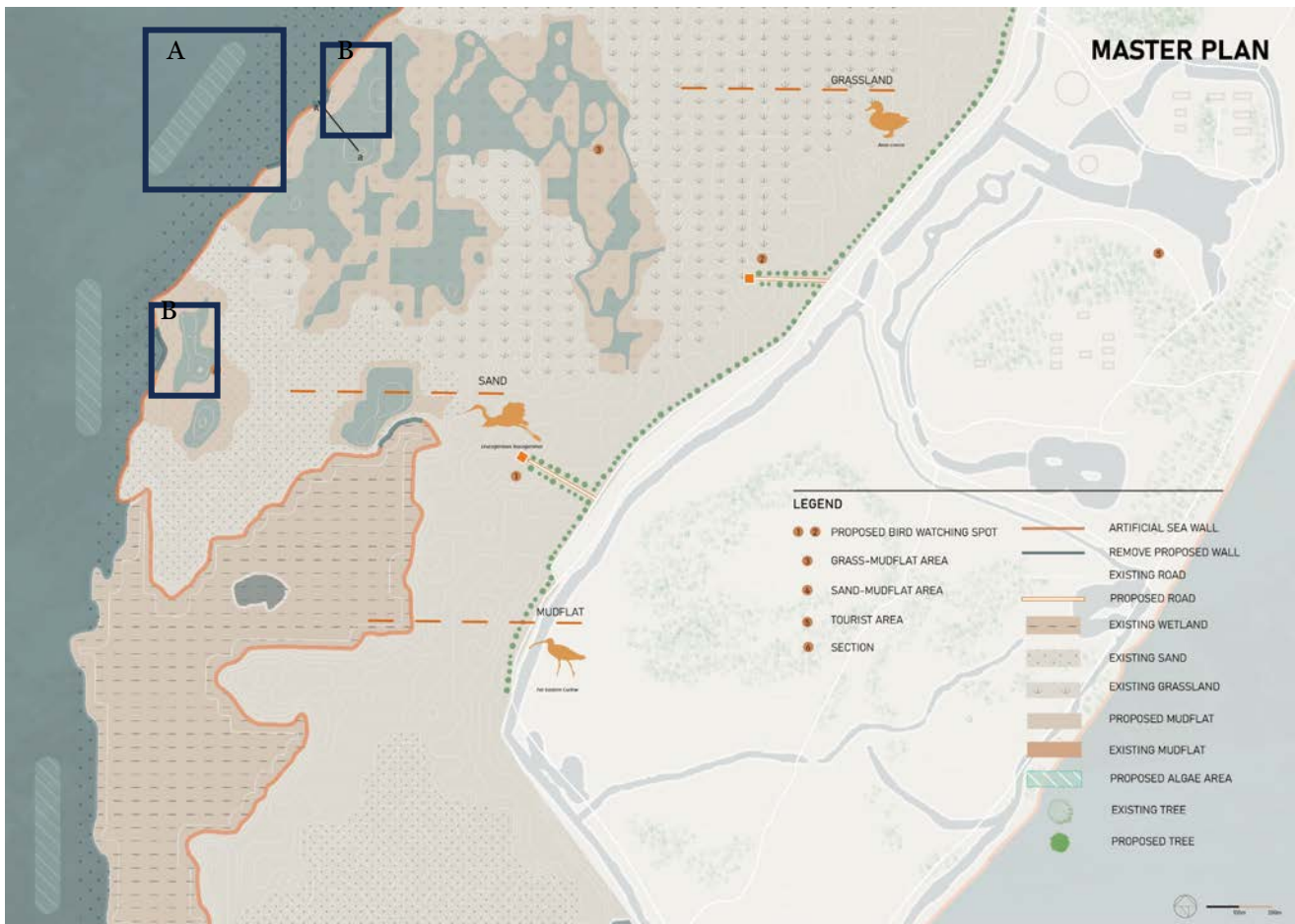
#### *Bodhi Island bird wetland habitat, Hebei, Tangshan, China (440 hectares)*

Bodhi Island, situated near Tangshan, Hebei in the Yellow Sea's severely degraded FEC habitat zone (figure 2) provides critical wetlands and shoals that sustain FEC populations and migratory birds. Formed by Qing River alluvial sedimentation, the island was historically used for sea cucumber farming and salt production until 2008, when Tangshan initiated eco-tourism development, including artificial expansion into former salt fields on its southwest. The northwest's three mudflat types offer diverse FEC habitats, simultaneously serving as a research database for ecological studies.



**Figure 2.** Bodhi Island in (a) 2008 and (b) 2022 (imagery by Google Earth).

Figure 3 outlines the project’s dual-purpose design: the western side depicts constructed wetlands for FECs and migratory birds, while the eastern half displays government-planned resorts. This spatial coexistence model highlights human–bird mutualism: proximity to human zones enhances anti-poaching monitoring, while rare birds and intertidal ecosystems attract global tourists and researchers, boosting local eco-tourism.



**Figure 3.** Bodhi Island Plan (image by Mu, 2023).

The following are some key design moves.

### Algae cultivation area

As figure 3 (block A) shows, the site lies 3.5 kilometres from Jingtang Port, China's largest port. With 90 per cent of the site's coastline occupied by salt pans and fishing grounds and heavy fishing boat activity, oil pollution has surged on its southern coast. To combat this, a seaweed cultivation zone (light-green diagonal band, western sea) has been implemented, mitigating oil contamination, protecting mudflats, enhancing marine biodiversity and sequestering carbon dioxide.

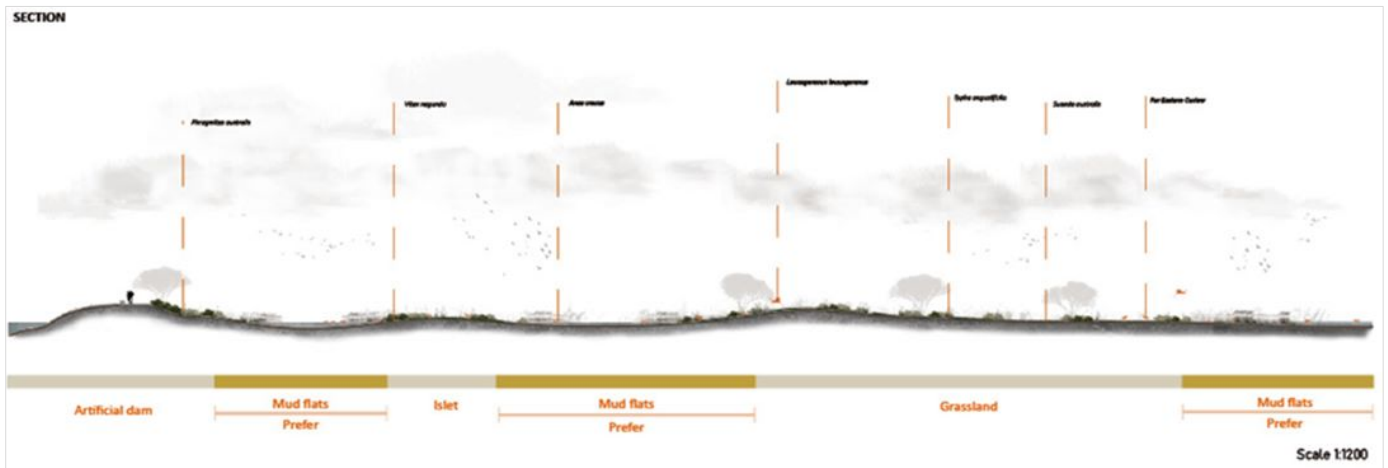
### Forest boundary

Figure 3 also shows a central forest boundary that is proposed despite the site's undisturbed western area. Insufficient supervision allows tourists to illegally access mudflats, threatening nesting bird eggs and food resources. The 50-metre-wide forest strip between the mudflat and road physically obstructs entry, deters egg and seafood harvesting, and visually shields birds from human activity impacts.

### Remove the artificial embankment

The island is a naturally formed feature at the mouth of the Qing river, creating a large and fluctuating area of mudflats. The proposal encourages the removal of existing concrete wall embankments built along the shore, so that natural water flow and tides can once again enter the grasslands and sandy areas of the western part of the island, as illustrated in block B of figure 3.

The landscape zoning of the site creates mudflats divided into three categories: mudflats, grassland mudflats and sandy grasslands. These different habitats can provide more choices of predation sites for migratory birds. Diverse environments are also helpful for observing and studying the habits of FECs. These mudflats are sponge bodies in SCD that absorb and store seawater, replacing grey infrastructure with blue-green infrastructure.



**Figure 4.** Bodhi Island bird wetland habitat section (image by Mu, 2023).

Design strategies focused on expanding FEC habitats through tidal restoration and native revegetation (figure 4). Removing artificial embankments on the island's west side reconnects tidal flows, enabling natural formation of mudflats, islets and grasslands. Native plantings stabilise soils and provide bird shelter, while the dynamic intertidal zone – functioning like a tidal sponge – boosts biodiversity by absorbing and releasing water with tidal cycles. As mentioned in the literature review, anthropogenic disturbance, substrate type and food density are the main influences on the FEC habitat. The large-scale, complex and diverse habitats restored artificially in this area can provide more comprehensive indicators for the FEC habitat research.

Illustrating the proposal by section was also a feature of the design approach, akin to the 'measurable, accurate and visual' approach suggested by Kilbane et al (2019). This

demonstrates the variety of habitats created and their utility for the FEC in supplementing the aerial/masterplan view.

*Attadale Cove wetland habitat, Perth, Western Australia (9.97 hectares)*

Attadale Cove, a critical Western Australian wintering ground for FECs, has seen population declines linked to coastal urban development and sea-level rise, despite its Bush Forever Area status. The site's narrow configuration intensifies conflicts between habitat and human activity.

To address this issue, proposed artificial islets aim to expand FEC habitats while maintaining essential human uses, aligning with DL Li et al's (2020) findings on habitat selection criteria. This nature-based solution implements Lilleyman et al's (2016) successful artificial habitat strategies while mitigating acidic soil exposure and stormwater impacts, supporting WSUD objectives. The dual-purpose design enhances ecological resilience without compromising coastal functionality.



**Figure 5.** Attadale Cove master plan (image by Mu, 2023).

At the master plan level (figure 5), the FEC's preferred mudflat habitats (light-orange zone) face shrinkage from sea-level rise, coastal erosion and adjacent human activities (parks, school, cycling routes). Existing metal fencing and vegetation fail to buffer noise and visual disturbances. A proposed reinforced tree belt, 15 metres wide, along the fence line would mitigate human impacts. Additionally, upgrading the neglected bird-watching platform and adding new observation points will enhance monitoring of habitat dynamics.

The following are some key design moves.



**Figure 6.** Strategy map (image by Mu, 2023).

#### **Eco boardwalk**

As illustrated in block A of figure 6, the boardwalk features separate cycling and running paths while providing shade and minimising avian disturbance. Addressing the site's legacy as a buried waste zone, the design incorporates water-absorbent materials and plants to mitigate acidic soil exposure risks from winter storms. This dual-function solution reduces rainy-season erosion and toxic leaching while enhancing recreational safety.

#### **Artificial islet**

As illustrated in block B of figure 6, the artificial islet gives the FEC enough distance from human activities while protecting it from the threat of feral foxes that roam the site and prey on the FEC (and other species). More importantly, based on the Digital Elevation Model, the artificial islet is located on a higher terrain, which significantly increases the area of the mudflats while avoiding the risk of exposing toxic materials.



**Figure 7.** Attadale Cove bird wetland habitat section (image by Mu, 2023).

In figure 7, section A mainly shows the shielding effect of newly planted native plants on human activities. Bird-watching platforms allow visitors and bird lovers to maintain a suitable distance from the FEC, while also making it easy for researchers to inspect and evaluate the site. In addition, their careful siting maintains critical distance so as not to disturb the birds. Section B illustrates the provision of an expanded menu of salt plains mudflats and shallow open-water areas around the artificial island to cater for the specific needs and tolerances (ie, preferred water depth) of the FEC.

## Discussion

The overarching aim of this research was to explore the ways in which we might better use design approaches to explore possible synergistic outcomes that could augment habitat of the FEC in the face of increasing urbanisation and human activity.

The literature review found many wetlands and habitats along the FEC migration route are disappearing fast (MacKinnon et al, 2012). Taking the loss of habitats around the Yellow Sea as an example, with the disappearance of these food supply points, the FEC cannot obtain enough food to complete its long-distance migration. The best response to this problem, to support the longevity of the species, is to protect and restore these habitats (Finn and Catterall, 2023). However, because the migration space covers a vast area, it is unrealistic to persuade all countries along the migration route to sacrifice economic development and prohibit human activities near these habitats. In such a situation, the only pragmatic solution is to find ways for humans and the FEC to coexist.

Lilleyman et al's (2016) research in the Northern Territory of Australia shows that attracting the FEC to artificial wetlands is feasible. Additionally, Q Li et al's (2022) research on the ecological needs of the FEC for habitats provides standards for the construction of artificial wetlands. Therefore, building artificial wetlands in cities to replace those that have disappeared is one of the main ways to solve the threats to the FEC. More importantly, the construction of these artificial wetlands not only helps the FEC, but also solves the water problems that urbanisation creates. SCD and WSUD provide a good theoretical basis for this, as these wetlands can purify polluted water, reduce flood disasters (K Yu, 2016), and store and reuse water resources, and through these wetlands, humans and birds can achieve mutual benefits.

Based on these combined findings, this paper has adopted the research-by-design approach to explore how wetlands in SCD and WSUD could be used as vectors for increasing bird habitat. The first proposal under these design strategies is to develop wetlands to meet the basic requirements of SCD and WSUD and store, purify and reuse water resources. At the same time, sewage collection on site should not impact birds. Second, these wetlands should have different types of habitats and sites, such as shoals, reeds, mudflats and island lakes, so that they can meet the needs of a variety of bird species. Thirdly, water-purifying abilities are crucial to site design.

Strategies related to human activity propose it is crucial to control the distance between visitors and birds, and to provide protective perimeter vegetation and/or bird-watching platforms in each instance to minimise or prevent human interference. In addition, it is essential to consider future monitoring and maintenance, including regular assessment of the status of plant and predator populations, as well as the influence of humans, to prevent the emergence of invasive plants and animals that may damage the habitat.

Through the integration of theory and practice, this research sets a good precedent for how to restore the habitats of specific wetland species through WSUD and SCD, especially for those species that have been driven away from their habitats by urbanisation. These initiatives can enrich the WSUD and SCD strategies at the micro and meso levels.

## **Conclusion**

This research intersects with Lilleyman et al's (2016) migratory bird habitat restoration through landscape, SCD and WSUD, using the FEC as an example. The FEC is indigenous to the Oceania region and has been part of its tapestry for millennia. With human development across the entire ocean, covering a total length of more than 12,000 kilometres of migration routes, only a diversified design strategy can meet the particular needs of different habitats in the FEC and the conditions of specific to individual countries.

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Mu Yibin graduated from the School of Design, University of Western Australia with a postgraduate degree in landscape architecture in 2024. His research focuses on restoring habitats for animals, especially birds, through landscape design.



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