## Background:

We are facing a biodiversity crisis that is unprecedented in human history, caused by myriad human impacts including habitat loss and fragmentation, invasive species, pollution, unsustainable harvesting, and climate change (Barnosky et al. 2011). For example, the 2018 World Wildlife Fund Living Planet Index (WWF 2018) suggests that we have lost approximately 70% of global diversity since 1970 – a period of marked human population growth and dramatic increases in industrialization and economic growth in many countries. The UN Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) estimates that there are one million species at risk of extinction in the next decades (IPBES 2019). Conservation action (e.g. national and international treaties, species legal protections, reserve design and designation) requires detailed quantitative data on temporal trends in population sizes (e.g. Bonebrake et al. 2010), shifts in species ecology (e.g. breeding phenology; Adams 2010), and changes to species distributions (e.g. Sekercioglu et al. 2008; Marini et al. 2009). The need for continuous monitoring and demographic data is particularly important for migratory species, especially in the Northern Hemisphere, that require breeding grounds, stop-over sites during seasonal migrations, and wintering grounds that may encompass many countries (e.g. Amano et al. 2010; Wang et al. 2017). Birds also serve as important bioindicators of ecosystem health surveys of waterbird diversity in particular can provide insights into ecosystem health (Zhang and Ma 2011).

One of the most important migratory stop-over sites in eastern Asia is the Chongming Dongtan Nature Reserve, located on the eastern edge of Chongming Island, the largest estuarine alluvial island in the world and part of the Yangtze River Delta (MacKinnon et al. 2012). Reflecting its global ecological importance, the Dongtan Reserve is designated as National Nature Reserve in China and a Ramsar Wetland of International Importance (MacKinnon et al. 2012). Dongtan wetlands are critical for over 100 migratory waterbirds, including the critically endangered spoon-billed sandpiper (*Eurynorhynchus pygmeus*), the endangered black-faced spoonbill (*Platalea minor*) and the vulnerable hooded crane (*Grus monacha*) (MacKinnon et al. 2012).

There are many means to monitor population numbers for individual species or groups of species that includes visual monitoring by human observers, automated audio recorders with song recognition, and environmental DNA surveys. This study will be part of a larger collaborative project to compare different methods for surveying avian diversity and the environments upon which they depend including invertebrate diversity and water chemistry.

## Objectives

Environmental DNA (eDNA) is revolutionizing the way that we monitor organisms in nature (Bohmann et al. 2014; Thomsen and Willerslev 2015; Valentini et al. 2015). eDNA results from excretion or defecation, secretions, gametes, and carcasess. Regardless both quantitative PCR and Next Generation Sequencing (NGS) methods can be used to test for the presence of species even when they

have not been acoustically or visually confirmed as present (Valentini et al. 2015). NGS approaches may allow us to survey the entirety of particular taxonomic groups using conserved DNA primers and massively parallel sequencing (Hudson 2008). The overarching goal is to sample water for eDNA at multiple locations throughout the Dongtan Reserve over a period of significant bird migration. The hypotheses relates to comparisons to two other means of surveying (visual point counts and acoustics): 1. That NGS data will capture temporal trends in bird species and invertebrate richness and abundance over the migration period. 2. That eDNA will detect species that were not found using either acoustic or visual surveys for birds, or physical surveys for aquatic benthic invertebrates.

**Significance of the project**

Humans have never had greater impacts on global environments than now. This is a consequence of burgeoning human populations and increasing industrialization in emerging economies like those in many Asian countries resulting in unprecedented rates of habitat loss and conversion, pollution, and ultimately global climate change. This is having profound and potentially irrevocable consequences for the natural world. This study contributes to understanding shifts in avian migratory patterns at one of the most important stop-over sites in Asia for shorebirds and waterfowl, and helps test the effectiveness of eDNA Next Generation Sequencing approaches to surveying biodiversity. More broadly, and in conjunction with other members of the MITACS research team, this study will help us to better monitor aquatic ecosystem health using a suite of tools moving us to more comprehensive methods for monitoring the Yangtze River and other major riverine and lake systems.

## Timeline

TBD

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