**Avifauna in Arctic Tundra: Acoustic Monitoring of Migratory Birds in Northeastern Siberia**

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**Background and Relevance**  
*Introduce your project, including the need you want to address. Tell us why the issue is important. Cite relevant literature, media coverage, or previous work where applicable (include citations in the Works Cited section below).*

Located at the northeastern Russia, Siberian arctic tundra is favored by numerous migratory bird species (Pearce et al., 1998b). Indigirka River Delta (IRD) is one of the most productive Siberian tundra area that supports 40 – 60 breeding species each summer (Goryachkin, 1994; Pearce et al., 1998a). IRD is the main breeding ground for many rare species, such as Siberian Crane (*Leucogeranus leucogeranus*), which is listed critically endangered in the Red List of IUCN (BirdLife International, 2016). Other characteristic species include Sandhill Crane (*Grus canadensis*), Yellow-billed Loon (*Gavia adamsii*), Ross’ Gull (*Rhodostethia rosea*), and Steller’s Eider (*Polysticta stelleri*). It is not exaggerate to say IRD is the most important breeding grounds of the world for migratory birds.

There is no doubt that IRD deserves continued monitoring and conservation, however, only few research expeditions had been conducted and the quantitative data for bird community are lacking (Pearce et al., 1998a). The arctic tundra in IRD is one of the least explored biomes due to the harsh natural environment. Researchers are not able to get access to the IRD until the Indigirka River channel is open, around late May to June. The lack of transportation and the short summer (i.e., 50 to 60 days) substantially constrain both the spatial and temporal scale of the bird study. A long term monitoring for bird community in IRD Siberian arctic tundra is urgently needed and a new method must be imported to enhance the scale of monitoring.

In this study, we propose to import automatic recording systems to monitor the bird community in the arctic in IRD area. Autonomous recording system has been applied in diverse ecosystems to remotely and non-invasively monitor bird community (Blumstein et al., 2011). Species richness, abundance, composition, and other quantitative data can be derived. With the permanent recordings, automatic recording systems are proved to have the same or even better detection ability than traditional field survey (Celis‐Murillo et al., 2009). Given the progressive vocal activity of the breeding birds in arctic tundra, applying autonomous recordings systems in tundra is promising and will definitely enhance our understanding for the avifauna.

This study will be the first attempt of applying automatic recording systems in Siberian arctic tundra for monitoring migratory birds. By setting up the system, we will examine the bird species richness, abundance and community dynamic in different habitats along the breeding season (i.e., May to July). Large area and long-term detection of birds in tundra is not possible with conventional survey methods but can be achieved by the automatic recording system. We are looking forward to exploring the beauty of avifauna in arctic tundra with bioacoustics.

**Methodology Detail**

*Detail the methods you will use to complete your project and why these are the best methods. Note any special or unusual tools or techniques you plan to employ. List and describe the steps you will take to implement your approach, and provide a timeline for implementation. Indicate which populations, communities, and/or locations you will target with this project. If appropriate, specify the anticipated number of participants/subjects.*

**Study area**

The recording systems will be set in the arctic tundra of IRD area, specifically the Dzhyukarskoe Lake area (70˚56′37.0′′N, 148˚00′22.3′′E). Typical vegetation in the area is composed of dwarf shrubs, grasses, lichens, and mosses. The subsoil is permafrost. In summer time (i.e., breeding season), the temperature ranges from -4 to 22˚C, with an average of 5˚C. Two different habitats will be monitored with two sets of recording systems. There is a research station located by the Dzhyukarskoe Lake that we will use during the fieldwork. Food supply and fuel will be purchased from the nearest village, Chokurdakh ([70°38′N 147°54′E](https://tools.wmflabs.org/geohack/geohack.php?pagename=Chokurdakh&params=70_38_N_147_54_E_region:RU-SA_type:city(2,367))). The IRD area is within the Kytalyk Reserve so that a permit is required from Siberian Branch of the Russian Academy of Sciences.

**Bird species**

The updated species list of IRD area consists 93 species and 57 of them are migratory birds (species list: <https://goo.gl/Ma9q7Y>). We are interested in monitoring all the migratory species especially for the following target species:

* Siberian Crane (*Grus leucogeranus*): One of the rarest species breeding in tundra. The Siberian Crane is listed critically endangered in the Red List of IUCN and only 3,750 individuals were left in the wild.
* Sandhill Crane (*Grus canadensis*): A species has intraspecific competition with Siberian Crane.
* Rough-legged Buzzard (*Buteo lagopus*): A migratory raptor staying in south Asia during winter time. The population of Rough-legged Buzzard is decreasing due to the agriculture management in the south Asia (i.e., individual death by hunting poisoned rats).
* Ross’s Gull (*Rhodostethia rosea*): Not yet well studied in Indigirka river

**Recording equipment**

The type of autonomous recording unit (ARU) we plan to use is the Song Meter SM4 Acoustic Recorder provided by Wildlife Acoustics. Two built-in microphones in SM4 are omnidirectional (i.e., capture sound equally from all directions) with sensitivity at -28dB +/- 3dB at 1kHz. The frequency response of the microphones ranges from 20Hz to 48kHz, which fully covers the frequency of bird sounds, ranging from 1kHz to 8kHz. The SM4 features on its low power consumption, large data storage (i.e., more than one terabyte total capacity), and malleable operation environment (i.e., during rain and low temperature down to -20 ˚C). Furthermore, it provides the flexibility in powering system so that the external solar panels can be connected to provide the electricity. The combination of these features makes SM4 a suitable acoustic recorder in our study.

We will use the scheduled recording function of SM4 to record 10 minutes per hour, 24 hours a day during the breeding season. Given the fact that IRD is with the Arctic Circle, recording bird sounds for 24 hours per day will help us to understand the daily dynamic of vocalization under the midnight sun.

**Audio interpretation**

The audio recordings collected in the field will be analyzed in the laboratory. The analysis can be broken into two stages: signal detection and signal classification. Signal detection involves the extraction of structured sounds of interest while signal classification involves the identification of bird species. We will apply logistic occupancy model to detect the presence of birds in each audio file, then identified the species by comparing the recordings with the bird sound database: Xeno-Canto (https://www.xeno-canto.org/). For each audio file we will calculate the species richness (i.e., the number of species), abundance (i.e., the number of individuals of each species), and composition.

**Project timeline**

Not yet come up with. :P

**Works Cited**

Blumstein, D. T., Mennill, D. J., Clemins, P., Girod, L., Yao, K., Patricelli, G., Deppe, J. L., Krakauer, A. H., Clark, C., & Cortopassi, K. A. **2011**. Acoustic monitoring in terrestrial environments using microphone arrays: Applications, technological considerations and prospectus*.* *Journal of Applied Ecology.* 48(3): p. 758-767.

Celis‐Murillo, A., Deppe, J. L., & Allen, M. F. **2009**. Using soundscape recordings to estimate bird species abundance, richness, and composition*.* *Journal of Field Ornithology.* 80(1): p. 64-78.

Goryachkin, S. V., Zlotin, R.I., & Tertitsky, G.M. **1994**. Russian-swedish expedition "tundra ecology-94": Diversity of natural ecosystems in the russian arctic, a guidebook.

BirdLife International. **2016**. Leucogeranus leucogeranus*.* *The IUCN Red List of Threatened Species 2016.*

Pearce, J. M., Esler, D., & Degtyarev, A. G. **1998a**. Birds of the indigirka river delta, russia: Historical and biogeographic comparisons*.* *Arctic.* p. 361-370.

Pearce, J. M., Esler, D., & Degtyarev, A. G. **1998b**. Nesting ecology of spectacled eiders somateria fischeri on the indigirka river delta, russia*.* *Wildfowl.* 49: p. 110-123.