

**CDI SSF Elements**

Applications, Data, Processing (seems to intersect with several)

**Project Title**

Realizing the unmet biological potential of weather radar

**Fiscal Contact at Lead USGS Cost Center:**

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**Project Description**

The US network of more than 200 weather radars is one of the largest and most comprehensive terrestrial sensor networks in the world, but its use for biological applications is severely hampered by an inability to automate the process of identifying and extracting biological data. We propose to address this challenge in two parts: 1) by completing an exploration of how different radar target types overlap in radar parameter space, and 2) using those results to inform where to focus classification algorithms to mine biological information from weather radar data.

**Deliverables**

1. A publication detailing the degree of separation of different biological target types.
2. A publication outlining progress toward the development of radar biological data mining algorithms.
3. Presentation of these results at a national/international professional meeting<sup>a</sup>.
4. Submissions to ScienceBase: Output from the data pipeline used to build (1) and classified targets resulting from (2).

**Estimated Budget:**

Budget Category	Federal Funding "Requested"	Matching Funds "Proposed"
<b>1. SALARIES (including Benefits):</b>		
Federal Personnel Total:	\$ 9,500	\$ 9,500
Collaborator Personnel Total (1 yr computer science GRA):	\$ 30,000	\$ 5,000
<b>Total Salaries:</b>	\$ 39,500	\$ 14,500
<b>2. TRAVEL EXPENSES:</b>		
Travel (Per Diem, Airfare, Mileage/Shuttle) 1 Trip <sup>a</sup> :		\$ 2,000
<b>Total Travel Expenses:</b>		\$ 2,000
<b>Total Direct Costs:</b>	\$ 39,500	\$ 16,500
<b>Indirect Costs (14%):</b>	\$ 5,530	
<b>Grand Total</b>	\$ 45,030	\$ 16,500

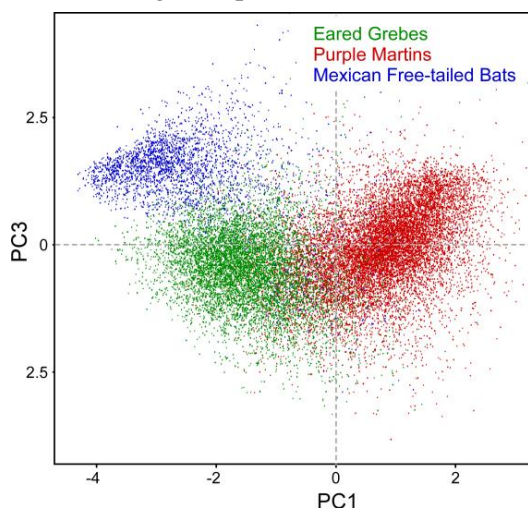
<sup>a</sup>Travel to a specific professional meeting, the 2016 annual American Ornithologist Union meeting in Washington DC, is already planned and supported. If this project is funded, results from it will be presented.

## Project Summary

Although designed for meteorological applications, today's weather radars readily detect the movements of hundreds (thousands really) of species of birds, bats, and insects. Research demonstrates the ability of these radars to capture a variety of animal movements and other behaviors (Diehl and Larkin 2005; <http://bit.ly/1EnwpZ3>). Data from this radar network streams in real-time to a NOAA-supported, publicly accessible archive which currently houses about 2 million gigabytes (2 petabytes) of radar data going back over 20 years. Many speculate that biological data may actually outnumber meteorological data in the NOAA archive. Consequently, this archive, however inadvertently, is one of the largest biological data archives in the world (Chilson et al. 2012).

In a previous CDI-supported project, we developed a data pipeline to retrieve, screen, and pre-process radar data for biological applications. The screening step poses a serious bottleneck in the pipeline since it requires user interaction verifying the radar target type (rain, songbirds, waterfowl, insects) of all data used in a given analysis. This in turn severely limits, or prevents altogether, the ability to use these data to address biological questions and problems that directly impact wildlife and society, especially applications where near real-time processing is necessary. For this reason, the biological potential of this radar network is far from realized. The public and private sector stand to gain considerably by enabling the biological capabilities of the US network of weather radars (and other similar radar networks internationally). Research published to date suggests a range of applications in a variety of fields include but are not limited to the following:

- *Agriculture*: Estimate abundance and track movements of pest insects and their natural predators, bats
- *Earth science*: Explore the influence climate change on biological systems at continental scales
- *Ecology/Conservation*: Monitoring changes in populations of songbirds and cave-dwelling bats
- *Education*: Captivating imagery of birds promotes education; bird watching/feeding are >\$4B industry.
- *Wind/solar energy*: Aid in assessing environmental impacts of alternative energy on birds and bats
- *Flight safety*: Hazard avoidance and risk assessment for bird-aircraft collisions which result in human casualties and tens of millions of dollars in losses annually
- *Health*: Aid in tracking infectious disease carried by flying animals such as avian influenza and white-nose syndrome
- *Meteorology*: Algorithms that detect and remove biological "noise" help prevent disruption of meteorological applications of radar
- *Wildlife management*: Tracking movement, habitat use, and response to restoration by waterfowl and other game species



**Figure.** Separation of three weather radar biological target types in principal component space.

We propose to continue our efforts to develop a software infrastructure that allows enormous quantities of data from the US weather radar network to be automatically mined for biological information. Our long-term goal is for biological products, alongside their meteorological counterparts, to become fully integrated into the standard output of this radar network. This would empower the research community to address questions related to the bulleted subject areas above.

We propose to address this challenge in two parts. 1) Complete a currently unfunded effort to use data flowing through the existing pipeline to explore how different radar biological target types overlap in parameter space using cluster analyses (see Figure). 2) We will develop prototype supervised classification algorithms to identify radar biological target types using results of the cluster analyses to identify which target types these algorithms can most likely be trained to classify.