

Summary of workshop on the importance of animal movement to plant – animal interactions, Panama, April 12 & 13, 2003.

This workshop was aimed at developing ideas and forging collaborations toward the study of plant-animal interactions with the ARTS on BCI. The first day was held on BCI, the second in Gamboa. Both days were well attended by visiting researchers and students interested in the topic who participated in the discussions. This report will briefly summarize the presentations and discussions from the workshop and is organized around the featured speakers and informal discussions that followed.

Martin Wikelski (Princeton University) started with an overview of what we hoped to get out of this workshop: ideas and collaborations. He included a frank discussion of the shortcomings of our FIBR planning grant proposal, especially the lack of concrete hypotheses, lack of diversity of participants... He briefly introduced some of the non-plant related questions ARTS users are interested in addressing including the determinants of animal movement, sources of mortality, physiology, and activity rhythms.

Roland Kays (New York State Museum) continued by describing the present state of the ARTS system, and plans for the future. Presently, the system is using 2 prototype receivers to collect data on animal activity every minute. The physical and network infrastructure are in place for a fully-operational system, but the final automated receiving radios are not yet complete. Iain Couzin (Princeton University) showed an early version of triangulation software he recently completed. The arts team hopes to have the receivers by the end of the summer so that ground truthing and additional software development can be completed before the end of 2003. Before this time, it is difficult to talk concretely about accuracy or range of the final system. However, preliminary range models suggest that the core of the island will have good coverage, especially near the lab and around the 50ha plot. Eventually, additional ‘understory receiving units’ will be available to increase the accuracy of the system over a smaller area. The final ARTS will allow real-time tracking of animal movement 24/7/365. These data will be available to researchers, and posted online. Presently Enzo Aliaga Rossel (graduate student, SUNY ESF) is using hand-tracking and the ARTS to study agoutis, and Roland and Ricardo Moreno (STRI) are using hand-tracking and the ARTS to study ocelots. Preliminary ARTS data have also been collected on a few birds, bats, and one sloth.

Joe Wright (STRI) gave an overview of open questions in plant-animal interactions on BCI. After starting with a broader view, Joe focused in on seed dispersal as the most likely interaction that could be tracked with data on animal movement (perhaps followed closely by mammalian herbivory). Showing data compiled by Egbert Leigh, Joe highlighted the importance of mammals in moving large volumes of seeds, and in birds and bats as having the most potential for longer distance movement. Showing data from his seed traps on the 50ha plot, Joe made the point that seed dispersal is most certainly not random (as assumed by many models of tree diversity), and highlighted how little we actually know about this interaction.

Joe Fragoso (SUNY ESF) discussed how animal movement can be used to address questions about plant biology. Joe brought in examples from his research with peccaries and tapirs to point out that the dynamics of movement routes and habitual foraging areas of animals can have a

strong impact on both seed dispersal and predation. Keeping different scales in mind, Joe discussed ways that these processes could affect forest structure and introduced a few methodologies that might be used to study them. Joe concluded by suggesting that white-lipped peccaries should be reintroduced to BCI. After an initial laugh from the crowd, Joe explained why he thought this would be possible from the peccary point of view, and won a number of participants over to the idea.

THE SECOND DAY

Helene Muller-Landau (on her way to becoming assistant professor at the University of Minnesota) discussed how models of tree diversity are affected by seed dispersal. She pointed out that most models assume random movement of animals, and that quantifying the movement kernel for seed dispersers would be a very significant advance in the field. Helene discussed which animal species are most important seed dispersers and which species should receive immediate attention by ARTS.

Iain Couzin (Princeton) discussed some general modeling approaches for tracking the effect of one individual on another. Using examples from his work with fish and insect movement, he suggested sophisticated modeling approaches that might be useful for studying animal movement data from the ARTS (more at <http://www.princeton.edu/%7Eicouzin/>).

Steve Pacala (Princeton) led a discussion about the importance of animal movement and seed dispersal into a number of larger questions including models of tree diversity, forest regeneration (and carbon cycle), and questions of animal mind. Steve highlighted the fact that seed dispersal is one of the great un-quantified values in models of tree diversity, and that tying this in with questions of how animals decide where to move could lead to some innovative studies (and funding). The importance of having a mapped environment was discussed. The need for an island-wide tree map for both studies of seed dispersal and animal habitat choice/movement decision making was stressed.

General discussion from both days highlighted how important seed dispersal is to questions of tree diversity, and how little is actually known about it – a situation people typically throw their hands up about. There was excitement about the potential for biologists using the ARTS to actually get at this problem. Discussions focused on actual biological systems that could be studied to address these questions, focusing on two general strategies:

1. A short-term study focused on a handful of plants and their dispersers, and
2. A longer-term goal of collecting relevant data on an entire community of dispersers.

For #1, two systems came to light: *Piper-Carolia* and *Myconia* – Manakins+Thrushes. Both of these offer a diverse community of plants dispersed by just a few species of animals. The *Myconia*-bird system drew a bit more attention because of the short synchronized fruiting season, and because of the interesting comparison between the resident manakins and migrating thrushes.

For #2, we discussed the long-term (5-10 years) goal of quantifying the ‘movement kernel’ for 10-20 important seed dispersing animals. Data on animal densities and diet compiled by Egbert

Leigh and Helene were used to get an idea of which species would be included. The idea was that students studying these species might focus on other questions (e.g., habitat choice, behavioral ecology, mortality, etc...) but that each would collect data and quantify the species movement in a similar way so that it could be compared across the community.

Another theme of discussion centered around other ways technology might be used to study this question. Ideas that came up included:

- Remote motion-sensitive video to quantify fruit removal from a particular tree.
- The use of small transmitters mounted on seeds that only transmit a signal when they are moved.
- Basing an amphibious ultra-light aircraft on BCI for regular aerial surveys for tagged animals that move between the mainland and the island.
- The development of a sensor that would detect when an animal defecated, and transmit this data back to ARTS.
- The miniaturization of transmitters (now down to 80mg) and the development of more sophisticated digital transmitters coupled with tiny sensors (Cornell Lab of Ornithology).

In Conclusion there was a general excitement at how the ARTS could be used to address questions of animal movement and seed dispersal that have been a 'black box' for plant biologists for year. AT the same time there was caution from the ARTS crew about exactly what the system would be able to do, and when it would be fully functional. A number of excellent ideas and collaborations were generated by the meeting. Participants were encouraged to scout out potential funding sources, and stay in touch about the progress of the ARTS and the status of preliminary data. No concrete plans were made for specific grants, pending the progress of the ARTS in the next few months. Preliminary data will continue to be collected on agoutis and ocelots over the new few months, with the possible addition of peccaries, bats, antbirds and toucans in the near future.