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Seabirds and Synchrony
Combining the fields of mathematics and biology

Spending three months on an island that is closed to the public, without electricity or regular hot water, with only the supplies that can be brought over on a boat, would not seem like ideal conditions in which to pursue groundbreaking research. But for the past eight summers, that is exactly what husband-wife team James Hayward, research professor of biology, and Shandelle Henson, professor of mathematics, have done. They spend each summer at Protection Island National Wildlife Refuge in the Strait of Juan de Fuca, Washington, sharing a tiny two-bedroom cabin with several students, observing every movement of the Glaucous-winged Gulls that nest there in a large colony.

What makes them gladly return to virtual isolation time and time again? Perhaps it’s just plain curiosity or their passion for the subject; or perhaps it’s the knowledge that they are conducting unique, relevant research with promising results.

The Seabird Ecology Team, as it is called, combines the fields of mathematics and biology, using mathematical models to describe, explain, and predict animal behavior. In the past, the team has created accurate mathematical models to predict times and frequencies of harbor seal and seabird behaviors. One practical application of this research addresses the common problem of gulls sitting, or “loafing,” on airport runways and consequently being caught in jet engines. The models that predict gull loafing times can be used to help develop effective systems for keeping birds off runways. The team’s research also has applications in the areas of wildlife conservation and species protection.

Currently, team members are hoping to pinpoint the signal that leads to ovulation synchrony in birds, a phenomenon they discovered over the past three summers. Daily during the field season, the team meticulously checks more than 200 nests throughout the gull colony and records various data. The data are analyzed with laptop computers powered by solar panels mounted outside the cabin. Data collection stops when the sun goes down, around 9 p.m. Data already exist in support of ovulation synchrony in humans and rats, but the Seabird Ecology Team has provided the first observed case of synchrony in a non-mammalian species. The team hopes their discovery will lead to a better understanding of the basic biology of the endocrine system as it relates to reproductive behavior.

Henson and Hayward’s combined disciplines have allowed their research to progress at a steady pace, as they collect reams of data to test their hypotheses. Hayward has been working on Protection Island for 26 years, but he says that since Henson has added her mathematical expertise to his understanding of behavioral ecology, “our productivity and the quality of our work have been tremendously enhanced.” The project, says Henson, is “too much for one person—it really requires interdisciplinary work.”

Their progress has not gone unrecognized. Since 2003 they have received two grants from the National Science Foundation (for $304,000 and $300,000), and their most recent proposal has been recommended for funding ($350,000) by the NSF Division of Mathematical Sciences. Additional assistance has been awarded by the Andrews Office of Research in the form of Andrews University Faculty Grants. Hayward believes the quality and interdisciplinary nature of their work, along with the diversity of their research team and the significant participation of undergraduate students, are some of the reasons the Seabird Team has received funding. Over the past seven years, they have published 15 joint research papers and presented more than 30 invited research talks at conferences and universities. They continue to develop three interdisciplinary classes available to undergraduate students (Calculus I for Biology, Mathematical Modeling in Biology, and a General Ecology lab in mathematical modeling).

Student team members assist with every aspect of the research, and 15 students have coauthored major papers with Henson and Hayward. These students are trained in mathematical biology and processes of research. Team member Brianna Payne began working with the team early in her undergraduate career and is now a graduate student in the biology program. She says participating has helped her develop “a sense of curiosity and a simultaneous ‘can do’ attitude about exploring the questions raised by my curiosity,” which is “invaluable for a satisfying, intellectually stimulating and enjoyable academic experience.”

Undergraduate students have a unique opportunity to participate in this research alongside their professors. In fact, of the 30 students who have helped with the research, only four have been graduate-level students. Biology and music major André Moncrieff joined the Seabird Team as a high school senior to learn more about the birds that have fascinated him since childhood. He says he has gained “a better understanding of math’s role in systems biology and different methods of data collection.”

Clockwise from left: André Moncrieff, Libby Megna and Brianna Payne at work on Protection Island; Shandelle Henson in the converted van which the team calls its "mobile blind;" Jim Hayward outfitted with protection against the colony's persistent "white rain" and kamikaze gulls.