The Benefits and Costs of Satellite Tracking

By NATHAN J. ROBINSON, PILAR SANTIDRIÁN TOMILLO, and FRANK V. PALADINO

The invention of small, durable, low-cost satellite transmitters in the 1980s enabled scientists to accurately track the movements of sea turtles worldwide. Since then, the use of satellite transmitters has proliferated, and they generate data that have revolutionized our understanding of sea turtle ecology and played a vital role in conservation efforts. We have reaped many benefits from using satellite transmitters; however, their potentially detrimental effects often remain overlooked.

The primary use of satellite transmitters is to determine where animals go. Knowledge of sea turtle movements helps us to prioritize our conservation efforts on the areas where they can have the biggest effects. Such knowledge can help to define the borders of Marine Protected Areas or to facilitate the establishment of multinational agreements and conventions. Data on sea turtle movement patterns can even be used to focus conservation measures in a spatially or temporally dynamic manner. For example, satellite tracking studies conducted on loggerhead turtles north of Hawaii discovered that these turtles primarily inhabit waters colder than 18.5° C. With this knowledge, the TurtleWatch initiative, led by the National Oceanic and Atmospheric Administration, now makes daily recommendations on where to fish in an effort to minimize interactions with sea turtles. Those recommendations are based on remotely sensed sea surface temperature data.

Researcher Jeanne Mortimer watches as a satellite-tagged hawksbill turtle returns to the sea in the Seychelles. © RAINER VON BRANDIS / SAVE OUR SEAS FOUNDATION

Satellite telemetry is also a versatile tool for engaging people in marine conservation. Maps illustrating long-distance sea turtle migrations can captivate community members, stakeholders, students, and donors. Tracking data have even been used as the basis of hypothetical sea turtle "races," including the Great Turtle Races of 2007 and 2009, as well as the annual Tour de Turtles. Those online events have been wildly successful, reaching millions of people. Such telemetry-driven outreach campaigns have raised funding for conservation, increased popular support for conservation-focused legislation, enticed people to volunteer for conservation projects, and created incentives for people to live in a more ecologically friendly manner. Such benefits might be difficult to quantify, but they are nevertheless important.

Whenever an animal-borne device is deployed, however, it has an unavoidable effect on the host animal. Some of those effects, such as handling stress, may last only a few hours. In other cases, the effects may persist for as long as the device remains attached and may include reducing attractiveness to a potential mate, increasing susceptibility to predators, impeding natural movements, or altering the aerodynamics or hydrodynamics of the host in ways that increase energetic costs.

Only rarely have telemetry studies acknowledged the negative effects those devices might have on the organism being studied. Even less frequently have studies attempted to measure those negative effects, and this is especially true for sea turtles. One study did measure the effects that deployed carapace-mounted cameras had on foraging green turtles; it observed that animals displayed abnormal activity levels for the first six hours after being captured. Other studies have shown that leatherback turtles with high-drag transmitters swim slower and may even follow different migratory pathways than do their counterparts tracked with lower-drag satellite transmitters.

> Until we fully understand how satellite telemetry devices affect the behavior, physiology, and fitness of their hosts, we will not be able to maximize their potential for conservation.

Those detrimental effects may appear subtle at first, but they could hint at bigger problems. First, it is important to consider that if a satellite transmitter alters its host's behavior, the data generated will not faithfully reflect the movements of a nontagged individual. Consequently, such behavior alteration limits the usefulness of data intended to infer natural behavior and, in extreme cases, may even negate the purpose of the study. Second, small changes in the behavior and physiology of satellite-tracked turtles could affect their reproductive output or survival rates. For example, a reduction in swim speed could lower a turtle's ability to catch food or could increase the energetic cost of migration. The latter could, in turn, reduce the energy available for reproduction or increase the potential for starvation, a serious concern for postnesting females given their huge energetic investment in egg production. The effects of satellite transmitters on survival rates or reproductive fitness of sea turtles have not been studied, but worrying trends have been noted for other species. Flipper-tagged king penguins were 16 percent less likely to survive and produced 39 percent fewer chicks than their nontagged counterparts. Similar studies using mark-recapture data to assess survival rates of satellite-tracked sea turtles would therefore be very illuminating.

Satellite telemetry has been—and continues to be—a key tool for conservation. The maps on pages 26–27 of this volume of *SWOT Report*, for instance, allow us to see the big picture of African sea turtle movements in ways we could not have dreamed of a few decades ago. Without the important insights provided by satellite transmitters, it is easy to envision a world where global efforts toward the conservation of sea turtles would be far less focused and effective than they are today. In our desire to unlock the secrets of sea turtle movement patterns, however, we have often overlooked the negative effects that these devices might have. Until we fully understand how satellite telemetry devices affect the behavior, physiology, and fitness of their hosts, we will not be able to maximize their potential for conservation. We therefore recommend that sea turtle researchers make every attempt to both minimize and quantify the potentially negative effects of these devices. If we can achieve this goal, we will keep reaping the benefits from satellite telemetry for many years to come. ■