



Applied Remote Sensing Training (ARSET) Program

Introduction to the Integration of Animal Tracking and Remote Sensing

Homework Questions

Question 1

Telemetry devices are diverse. If you wanted to be able to track a “nuisance” animal in real time to prevent human-wildlife conflict across a mountainous national park, which type of tag should you choose?

Answers: (bold correct)

- a. A solar-powered archival tag that estimates location from Argos satellites
- b. A battery-powered tag that transmits via satellite and estimates location from GPS**
- c. A passive RFID tag whose base stations transmit via GSM
- d. A solar-powered tag that transmits via GSM and estimates location from GPS

Feedback:

Here, location accuracy and latency are the two most important factors: we must know exactly where this animal is, immediately. Because the park is mountainous, it is unlikely to have GSM service everywhere, so GSM is not a good low-latency option. Archival tags require recapture/collection and therefore would not work for this application. The power options were not especially relevant to this question. Satellite transmission is likely to be the most reliable method across a mountainous park, and GPS provides the most precise geolocation. The power options were not especially relevant to this question.

Question 2

Which of the following is not an important consideration when selecting remote sensing data to use with animal tracking data?

Answers: (bold correct)

- a. The spatial resolution of the remotely sensed data
- b. The temporal extent of the remotely sensed data
- c. The coordinate reference system (i.e., projection) of the remote sensing product**
- d. The file size of the downloaded remote sensing data

Feedback

Remote sensing products come in a variety of projections, and reprojection of the remote sensing data and/or animal movement data might be necessary for analysis. However, this reprojection is almost always feasible, so the projection of the product should not be a consideration for whether it is appropriate. The spatial resolution and temporal extent should be considered to ensure they are compatible with the animal tracking data, and the file sizes should be considered to ensure that appropriate storage is available.

Question 3

You have tracking data that follows ten snowshoe hares over one year. Your data have a 1-hour fix rate and approximate accuracy of 20 m. The animals do not migrate and their home range size is between 0.1 and 0.8 sq. km, but they occasionally travel outside their home ranges. You would like to understand how snowshoe hares move relative to a combination of forest type and snow depth. Which of the following is the most appropriate combination of remote sensing layers to answer this question?

Answers: (bold correct)

- a. Daily snow cover at 1-km resolution and annual forest type at 1-km resolution
- b. 5-day snow cover at 2-km resolution and monthly forest type at 100-m resolution
- c. 10-day snow cover at 10-m resolution and static forest type at 20-m resolution**
- d. 5-day snow cover at 200-m resolution and annual forest type at 200-m resolution

Feedback:

Because the snowshoe hares have such small home ranges, it is important to prioritize spatial resolution over temporal resolution. Products at >200-m resolution would be unlikely to measure any

responses to environmental factors because they cannot measure these differences at the scale of movement. Because you only have one year of data, annual and static forest type products are effectively the same.

Question 4

What best describes the primary question that Species Distribution Models aim to answer?

Answers: (bold correct)

- a. Where do animals migrate during the year?
- b. How does the environment differ between where an animal went and where it didn't go?**
- c. What is the home range of an animal?
- d. How do animals interact with human infrastructure like roads?

Feedback:

Species Distribution Models (SDMs) aim to quantify how animals use habitat. Although knowing how animals move (via migration or identifying their home range) is an important part of movement ecology, they can't tell us about habitat use without also incorporating environmental data. SDMs generally don't consider infrastructure like roads or buildings.

Question 5

What is a key benefit of including ambient sensors on animal tracking tags?

Answers: (bold correct)

- a. Animals can collect environmental data in remote locations that are otherwise difficult to access.**
- b. Environmental sensors on animal tracking tags eliminate the need for traditional remote sensing techniques.
- c. Environmental sensors on animal tracking tags can help predict the weather.
- d. Nocturnal animals can record what happens during a lunar eclipse.

Feedback:

Because animals often go to places where humans cannot travel regularly, they can collect ambient environmental observations in many remote places, which is a huge benefit. However, this is a

complementary effort to other remote sensing techniques, not a replacement. Although animals could help make measurements during events like eclipses, and perhaps contribute to weather models, these possibilities do not provide as much overall benefit as collecting data in remote regions.

Question 6

You have tracking data from 20 manatees and want to understand whether manatees could live in a new location. You download sea surface temperature, chlorophyll, and surface currents data, simulate pseudo-absences, and conduct a Species Distribution Model over a grid that includes both the old and new locations. However, the model fit is not great. Which evaluation method could help determine whether you should consider including another environmental covariate like salinity?

Answers: (bold correct)

- a. 10-fold cross-validation
- b. R²
- c. Root mean squared error (RMSE)
- d. **Relative importance of variables**

Feedback:

Relative variable importance is the most direct indicator of how much variables contribute to model. If all variables exhibit similar importance metrics, then it could be helpful for you to try the models with an additional variable to better understand habitat differences. The other methods listed will help you evaluate model explanatory power and predictive skill, but not necessarily help determine whether including additional variables could be helpful.

Question 7

There are many remote sensing environmental variables available for analyses like Species Distribution Models and Step Selection Functions. How do you choose which variables to use in your models?

Answers: (bold correct)

- a. Randomly select a subset of all of the variables to avoid overfitting your model.
- b. Include all available variables to ensure you capture all potential relationships.

- c. **Conduct a literature review to understand which variables have been important in other studies or for similar species, and consider the scale and relevance of each variable to your species and habitat.**
- d. Only use the variables that are available at the highest spatial and temporal resolution.

Feedback:

A literature review will help guide and inform which variables could be important to your models. Avoid restricting your analyses to high-resolution data, or using everything you can possibly download, which could be overwhelming, computationally intensive, and likely not very informative.

Question 8

Why is regularly sampled animal tracking data important for conducting step-selection analysis?

Answers: (bold correct)

- a. Regularly sampled data is important for all habitat selection analyses because it more accurately measures an animal's location
- b. Conditional logistic regression is based on assumptions of independence among data points
- c. It is important that the temporal resolution of the animal tracking data match the temporal resolution of the remotely sensed environmental data
- d. **Step lengths and turning angles depend on sampling interval, so data must be regularly sampled to accurately estimate the distributions of these parameters**

Feedback:

Regularly sampled tracking data is necessary because step lengths and turning angles depend on the sampling interval. For example, step lengths are almost always longer (on average) at longer sampling intervals. Having a variety of sampling intervals in the data would therefore produce unrealistic "alternative" paired steps. Although considering the temporal resolutions of environmental and tracking data is important, it is not imperative that they are the same. Regular sampling has no effect on the independence of data points or on location accuracy.

Question 9

In the deer step-selection example, we saw that the relative strength of selection increased with increasing NDVI but was not related to forest cover. If you were to run this analysis again, which

variables would you want to include in addition to NDVI? All but one are correct - please select the variable that you should not include.

Answers: (bold correct)

- a. Air temperature, because deer are likely to change their movement behavior on very hot or very cold days.
- b. EVI, because it is another vegetation index, so it would probably be another good predictor of deer movement.**
- c. Human population density, because deer are likely to avoid areas with a lot of people.
- d. Forest cover from a different land cover layer, because classification schemes vary and it seems unlikely that deer are not responding to forest cover.

Feedback:

EVI is unlikely to add additional information to the existing model because it is highly correlated with NDVI. The other three variables are likely to be useful for the reasons stated in each answer.