**SSA 200: Strategic Use of Data**

**Activity 3 – Model-based predictions**

**Objectives:**

* Understand the link between data analysis and stochastic projections
* Use projection outputs to make predictions about future conditions for a species
* Implement different future scenarios to describe the range of likely outcomes for a species

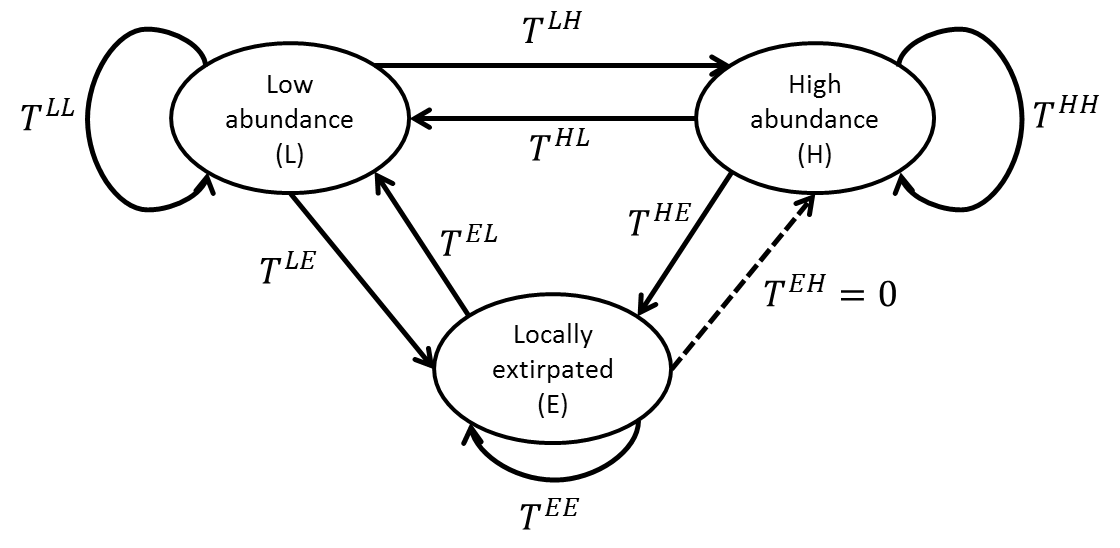
**Background Information:**

The first two activities focused on using available data to better understand the historic and current conditions of a species and to identify the key species needs and stressors that influence their ability to persist. Now we will use the results of those analyses to develop a stochastic population projection that we can use to estimate the probability that the species will persist until some arbitrary time horizon in the future.

We have some information about Island Mouse abundance, but transect surveys were only conducted across part of the range. We also have some anecdotal reports and information from recent satellite images that can tell us something about abundance across the island. We can pull all sources of information together using a **multistate occupancy** model. Under this framework, we will assign each population to one of three categories:

* Low abundance: mice are present but at low numbers, declining or unstable population
* High abundance: mice are consistently present, stable or increasing population
* Locally extirpated: no mice present

Populations can transition between these states with some **transition probability**, which we’ll denote using ***T***. The probability is the probability of transitioning from the low abundance state (L) to the high abundance state (H). The probability is the probability of transitioning from the low abundance state (L) to the locally extirpated state (E). The time step of each transition can be any length of time that is biologically reasonable. Here we will use a one-year time step, so we are talking about the probability of transitioning between states in one year. We can visualize these transitions using a conceptual diagram:



Each arrow represents a transition probability. Note that the arrow from locally extirpated to high abundance is dashed, because here we will assume that this transition probability is equal to 0, in other words it’s not possible for a population to go from locally extirpated to high abundance in one year. The arrows that loop back on each state are the probabilities of remaining in the current state.

We can also visualize the same relationships using a matrix.

In a transition matrix, each cell represents the probability of going *from* the column number/state *to* the row number/state. In this matrix, the columns and rows (in order) represent the extirpated, low abundance, and high abundance states.

Based on all available information, the Island Mouse Recovery Team determined the state of each population over the past 10 years. We used a multistate model to estimate each transition probability, in an analysis similar to a site-occupancy analysis. We fit several models and ranked them using AIC to determine the ecological covariates that were most strongly associated with each transition probability.

Three transition probabilities were found to be strongly associated with ambient noise level. , , and all increased as ambient noise level increased (β = 1.5 ± 0.03, p = 0.001).

1. **What transitions do these probabilities represent? Write your interpretation of this result in a sentence.**

Two transition probabilities were found to be strongly associated with annual temperature range. and both decreased as temperature range increased (β = -1.8 ± 0.41, p = 0.0023).

1. **What transitions do these probabilities represent? Write your interpretation of this result in a sentence.**

We also estimated the baseline probabilities of transitioning among all states. These probabilities with their corresponding standard errors:

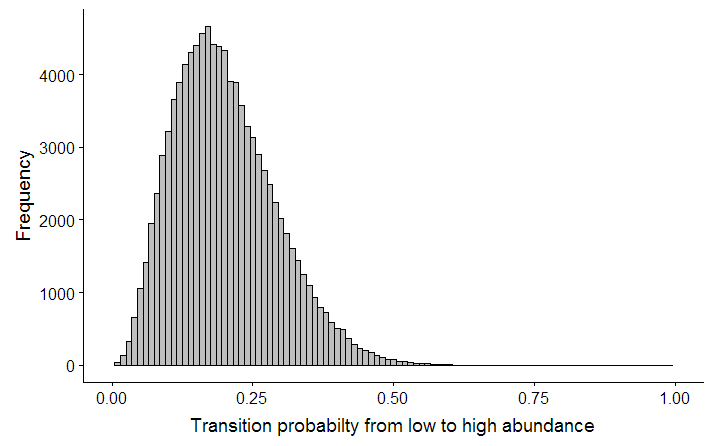
1. **What is the probability of a population that is currently low abundance remaining low abundance in the next year?**
2. **What is the probability of a high abundance population becoming extirpated in one year?**
3. **What is the probability of transitioning from locally extirpated to low abundance?**

**Projecting Future Conditions**

We would like to determine the probability of Island Mice persisting 15 years in the future. We have defined three analysis units based on ecotype (coastal, paradise palms, mountain). The ecotype and current state of each population is listed below:

|  |  |  |
| --- | --- | --- |
| **Population** | **Ecotype** | **Current state** |
| Beach Bums | Coastal | H |
| Cannibal Cove | Coastal | H |
| Castaways | Coastal | L |
| Message in a Bottle | Coastal | H |
| Darlost’s Dome | Mountain | L |
| Misty Mountain | Mountain | L |
| Skull Mountain | Mountain | E |
| Dead Man Dunes | Paradise palms | L |
| Realm of Spirits | Paradise palms | H |
| Snowmelt Thicket | Paradise palms | L |
| Treasure Grove | Paradise palms | L |

Using the estimated transition probabilities above, we will project the population 15 years into the future, replicating that projection 1000 times. Our estimates of the standard error for each parameter represent our uncertainty about the true value of that parameter. To account for this **parametric uncertainty** in the projection, we can use the estimated standard error to define a Beta distribution for each transition probability. For example, the distribution of possible values for the probability of transitioning from low abundance to high abundance ():



For each replicated projection, we will randomly draw a value from this distribution for the transition probability from low to high. Each transition probability will have its own distribution.

If we run that projection,