Water as a Habitat: Episode 5
What's Lurking in the Waters?

Are Lionfish Derbies Effective?

Lionfish derbies are single day events where competitors aim to collect and remove as many lionfish from a specified area as possible. These tournaments have been an important tool in suppressing local populations of lionfish.

But, how do you determine the effectiveness of these derbies?

By applying a simple mathematical model, the impact of the derby can be measured in terms of a reduction in lionfish as a percentage of the original population estimate.

$$Impact\ of\ Derby\ = \frac{Catch\ at\ Derby}{Estimated\ Population\ Size}$$

In order to calculate the estimated population size of the lionfish in a specified area, three pieces of data must be collected. Each data set is collected at a different time. These are:
- Abundance of lionfish in area before the derby, A_1
- Total catch of lionfish during the derby, C
- Abundance of lionfish in area after the derby, A_2

Using these three quantities, the catchability quotient, Q, can be calculated.

$$Q = \frac{A_1 - A_2}{C}$$

The estimated population size, $\widehat{N}$, of the lionfish in a specified area is then found by:

$$\widehat{N} = \frac{A_1}{Q}$$

Investigation

In October of 2010, the Punta Langosta pier in Cozumel, Mexico was the site of a lionfish derby. One day prior to the derby, scientists observed 121 lionfish in the target area. A total of 81 lionfish were caught during the derby. After the derby, 54 lionfish were counted in the same target area.

1. Calculate the catchability quotient, Q, for the lionfish.

$$Q = \frac{A_1 - A_2}{C} = \frac{121 - 54}{81} = 0.8272$$

2. Calculate the estimated population size, $\widehat{N}$, of lionfish in this area before the derby.

$$\widehat{N} = \frac{A_1}{Q} = \frac{121}{0.8272} = 146 \; lionfish$$

3. Calculate the estimated population size of the lionfish in this area after the derby.

$$After \; Derby \; Population = \widehat{N} - C = 146 - 81 = 65$$

4. Calculate the impact of the derby on the lionfish population.

$$Impact \; of \; Derby \; = \frac{Catch \; at \; Derby}{Estimated \; Population \; Size} = \frac{81}{146} = 0.555 = 55.5\% \; reduction$$

5. Do you think all derbies have the same impact? What variables impact the success or failure of a derby like the one on the Punta Langosta pier?
No. The impact of the derby is dependent upon three observed variables, the number of lionfish before, during, and after the derby. These counts will vary depending on location and time of year.

6. What factors do you think cause the catchability quotient to fluctuate? Explain your reasoning.
Since the catchability quotient is based on the observed populations both before and after the derby, variations may occur if counts aren't performed in the same place in the same manner. Q is also dependent upon the number of lionfish caught, so education, effort, and availability and quality of supplies will also have an impact on the ability to catch lionfish.

7. Write and completely simplify a formula for the estimated population size, $\widehat{N}$, in terms of only the observed data.

$$\widehat{N} = \frac{A_1}{Q} = \frac{A_1}{\dfrac{A_1 - A_2}{C}} = \frac{C \bullet A_1}{A_1 - A_2}$$

8. How could you use the estimated population size to determine the population density of lionfish around the pier?

   Population density is the number of fish per unit of area. You would calculate the population density by dividing $\widehat{N}$ by the area of the observed region.

9. The area checked around the pier was 5,720 square meters, where 10,000 m² = 1 hectare (ha). Calculate the pre- and post-derby population densities of the lionfish in terms of fish per hectare in and around Cozumel.

$$D_1 = \frac{146\ fish}{0.5720\ ha} = 255.2\ fish\ per\ hectare$$

$$D_2 = \frac{65\ fish}{0.5720\ ha} = 113.6\ fish\ per\ hectare$$