Mark-Recapture Estimates Exercise

1. Warren *et al.* (2004) examined the population of rainbow trout in the Upper Niagara Springs pond in 2000. Fish were captured at two times by using an electrofishing unit attached to a driftboat. The capture history of all fish examined in the two samples is in the **`RBTroutUNSP`** data frame in the **FSAdata** package. Use these capture histories to construct an appropriate population estimate, with a 95% confidence interval, for Upper Niagara Springs pond in 2000.

2. The **`mr.closed1.sim()`** function can be used to simulate the population estimates from many samples from populations with a known number of individuals and various other characteristics (such as different mortalities or catchabilities between marked and unmarked fish). The specific arguments of this function and the meanings of the parameters in the slider bars are described by typing **`?mr.closed1.sim()`** in R.

   Compute and summarize 500 resamples (the default) for each situation described below. Use the defaults for all arguments that are not explicitly stated in each question. Make sure to press the "Re-Randomize" button several times for each simulation to reduce the chance of making conclusions based on spurious results.

   a) Compute Petersen estimates for a known population of 1000 fish (this is the default), an expected 200 marked fish, and an expected 200 captured fish in the second sample. How does the mean of the 500 population estimates compare to the known initial population size? What does this result indicate about Petersen estimates?
   b) Repeat the above question but use Chapman rather than Petersen estimates (you will need to close your previous version of **`mr.closed1.sim()`** and open a new version with **`mr.closed1.sim(type="Chapman")`**. How does the mean of the 500 population estimates compare to the known initial population size? What does this result indicate about the Chapman estimates (especially relative to the Petersen estimates)?
   c) For each situation below, use **`mr.closed1.sim(type="Chapman")`** to determine whether the Chapman estimate is an unbiased, biased low, or biased high estimator of the initial population size. You should provide a graphic to support your conclusions for each situation. Note that each situation should use the default values for each parameter except for the parameter identified in the question and after each question return the simulator to the default values by pressing the "Reset" and "Re-Randomize" buttons.
      i. Simulate the loss of tags by setting the "PR(Tag Loss)" to a value greater than 0.
      ii. Simulate mortality for both marked and unmarked fish by setting both "PR(Surv Tagged)" and "PR(Surv UNTagged)" to the same value less than 1.
      iii. Simulate increased mortality on marked fish by setting "PR(Surv Tagged)" to a value less than 1.
      iv. Simulate increased mortality on unmarked fish by setting "PR(Surv UNTagged)" to a value less than 1.
      v. Simulate recruitment to the population by setting "Proportion Recruit" to a value greater than 0.
      vi. Simulate increased catchability of tagged fish (i.e., "trap-happiness") by setting "Ratio PR(Capture)" to a value greater than 1.
      vii. Simulate decreased catchability of tagged fish (i.e., "trap-shyness") by setting "Ratio PR(Capture)" to a value less than 1.

3. Baker and Borgeson (1999) reported on a study of the abundance and harvest of lake sturgeon in Black Lake, Michigan. Sturgeon were captured with gill nets beginning on 5 May 1997 and continuing through 23 July 1997. On each day, the total number of captured fish, the number of fish that had previously been marked, and the number of fish that had not been previously marked that were marked and returned to the population were recorded. The results from their sampling efforts are found in the **`SturgeonBL`** data frame in the **`FSAdata`** package. Use these data to construct both Schnabel and Schumacher-Eschmeyer estimates of the number of sturgeon in the population at the beginning of the study and comment on the validity of the assumptions. [Hint: closely examine the provided file.]