Eradication Tools - Eradication progress

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17/11/2020

## Eradication progress app user guide

This shiny app is primarily to be used for assessing progress towards eradication of a pest population. As an eradication program progresses, and additional data become available, the app will provide updates on the estimate of the residual size of the pest population remaining or the residual proportion of occupied sites. This help file provides some guidance about the use of the app including the types of monitoring data as well as the associated models that can be used to undertake an eradication progress. Before using this app, the practitioner should ideally be familiar with the material in the accompanying document Quantitative decision support for eradication - a primer. In particular, the practitioner should have read Spatial considerations: Extent, Management Zones and Sampling Units and Assessing Progress.

This user guide also makes use of the example data provided in the accompanying ZIP file. Eventually, the app will be able to automatically load these examples directly but for now, please unzip these files into a convenient location.

### Assessing progress

Consideration of the primary removal method is of great importance because the data collected from this method will be used to generate population estimates. For valid estimates to be obtained, the primary removal method must be able to remove individuals at a rate faster than they can be replaced. This can be easily visualised using a cumulative catch curve, which plots the cumulative catch (removals) of individuals against the catch per unit effort (CPUE) (Figure 1). The negative of the slope of this relationship is an estimate of the detection rate (also known as the catchability coefficient). If a clear negative relationship is not evident or there is evidence of a flattening of the relationship (non-linearity), then that suggests that the population might not be reducing at a rate high enough to achieve eradication or that the detection rate of individuals is declining. If this occurs, then alternative removal techniques need to be used. One problem with relying on the cumulative catch versus CPUE plot is that the relationship may suggest that all individuals have been removed, when in fact, eradication has not been achieved. This occurs because the relationship in Figure 1 assumes that detectability is constant for the duration of removal activities when in fact, the residual population is no longer susceptible to the removal method, (e.g. they may be trap-shy and therefore never get caught, resulting in detectability declining to zero). Identifying this situation depends on the use of a monitoring protocol running in parallel with the primary removal method that is able to detect residual survivors (e.g. cameras or scat-detecting dogs).

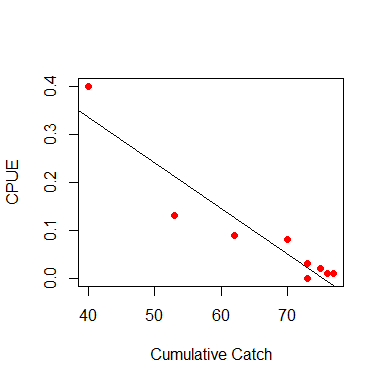


Figure 1. Plot of the relationship between CPUE and cumulative catch

### Models

The models in the eradication progress app are based on closed population removal estimators. This means that the models require data on the total catch of individuals of the pest species removed, at each sampling location, for each of J periods (or “sessions”). Here a period refers to a distinct period of time where removal of the pest is actively occurring. For example, rodent trapping might be undertaken over four consecutive nights, once a month for five months. Hence, there are five periods or sessions with each period consisting of four nights trapping. Data from at least three periods are required for use in the models used here. These models also assume that the population is closed for the duration of the eradication program. In the example above this would mean that the rodent population is not subject to births, immigration, emigration or natural mortality over the five periods so the only change to the population is due to the removals. Alternative models that relax this assumption and allow for recruitment and natural losses to the population in addition to the removals are in the pipeline. The following models are currently available in the app.

* remGP
  + This model implements the catch-effort model of Gould & Pollock (1996). It is an aspatial model which means that removals are aggregated over all removal devices for each period. This means that device locations and habitat information are not used or required for this model. The catch and effort data are assembled from the removal histories by summing removals from each device, separately for each period. Effort data is calculated as the number of devices set in each period.
* remMN
  + This model implements the multinomial removal model of Haines (2018). Unlike remGP, device locations are required for this model and habitat information can be used to model spatial variation in initial abundance. Device locations are assumed to be independent
* remGRM
  + This model estimates the generalised removal model of Dorazio et al. (2005). However, it also has the facility to include additional monitoring data into the analysis in addition to the removal data. The additional monitoring data are assumed to be derived from monitoring devices set in the same general vicinity (or a subset thereof) as the removal devices. Hence, the additional monitoring data should have the same number of rows and columns as the removal data and are uploaded into the app using detection histories button. Removal devices without an associated monitoring device should hav an NA inserted for the appropriate row in detection histories.

### Inputs

All models in the progress app require inputs in particular formats

* Region boundary
  + The shapefiles that define the region of interest. Select all files (.shp, .shp, .dbf, .prj ) as a group. Shapefies should be projected, rather than in geographic format.
* Habitat raster
  + A .tif file(s) containing a map of habitat variable(s) that could be used predict spatially-varying abundance across the region. Multiple .tif files can be selected.
* Trap locations
  + A .csv file containing coordinates of M removal devices in the same projection as region boundary. The first column should be the easting (x) coordinate and the second the northing (y).
* Removal histories
  + A .csv file containing a M x J matrix of removals for each of M removal device in rows and J periods for each device in columns.
* Detection histories
  + A .csv file containing a M x J matrix of detections or counts for monitoring devices set in the same general locations as the removal devices. Removal devices without an associated monitoring device should have an NA inserted in the appropriate row in detection histories.

## Analysis

Once the data for a particular model has been uploaded, pressing the fit model button will run the selected model and print the output in the “fitted model” pane. Outputs include the parameter estimates and a prediction of both the initial population size within the region based on the monitored sites as well as an estimate of the residual population size follwoing the last removal period. Any habitat covariates uploaded previously should also be available and can be selected in the model if desired. The Estimate density surface button displays a map of the predicted initial density across the region.

### References

Dorazio, R. M., Jelks, H. L., & Jordan, F. (2005). Improving Removal-Based Estimates of Abundance by Sampling a Population of Spatially Distinct Subpopulations. Biometrics, 61(4), 1093–1101.

Gould, W. R., & Pollock, K. H. (1997). Catch-effort maximum likelihood estimation of important population parameters. Canadian Journal of Fisheries and Aquatic Sciences, 54, 890–897.

Haines, L. M. (2019). Multinomial N-mixture models for removal sampling. Biometrics, September, 1–9. <https://doi.org/10.1111/biom.13147>