Summary

Statistical theory is presented to form the foundation for the analysis of survival experiments that rely on recapture or resighting data collected after the release of marked individuals. Survival experiments consist of at least one treatment and one control group, animals being marked to reflect group membership, with the purpose of comparing survival across treatment levels. Ideally, proper replication is included in the design of the survival experiment. Numerous alternative models are presented as a basis for robust analysis of the experimental results.

For completeness, an introduction to some basic statistical principles is included in the beginning material. This introduction is followed by development of theory specific to the type of data considered. Theory is provided for experiments where either batch or unique marks are used. The theory is based on a series of nested multinomial models (i.e., models H_0, $H_{1\phi}$, H_{2p}, $H_{2\phi}$, ..., $H_{k-1,\phi}$) for V groups, sampled over k occasions. Five experimental protocols are defined and maximum likelihood estimates of parameters are derived for each model in the sequence under each experimental protocol. Estimators of theoretical sampling variances and covariances are provided as measures of precision and coassociation, respectively, for all parameter estimators. Some empirical estimators of variances are also provided. An intensive battery of statistical tests of hypotheses are given to allow assessment of the validity of assumptions and to aid in model selection.

The importance of some form of replication is emphasized. Several analysis methods for multiple lots are given, including quasi-likelihood approaches. The design of experiments where marked animals are used is covered in some detail.

Material presented in several parts of the monograph is cast in terms of fish survival experiments in relation to hydroelectric dams. Although such experiments provide a convenient example, the theory and methods presented have potential application to many other taxonomic groups and experimental situations. The methodology presented provides a rigorous, comprehensive, and practical reference on the analysis of experiments involving recapture of marked animals. The emphasis is on general inference procedures: point and interval estimates and tests of hypotheses.

The methodology presented is relatively sophisticated and the computational requirements are large. Therefore, we provide comprehensive computer software (RELEASE) to allow a full analysis of experimental data collected under these protocols. RELEASE has a Monte Carlo simulation capability and several other options to allow an investigator to understand better the design and analysis methods for this large class of experiments. An interactive version of RELEASE is easy to use on currently available microcomputers.

The material is written for both biologists and statisticians in an effort to integrate theory and application. A team effort is needed for the effective conduct of large experiments. The design and analysis of large, complex survival experiments involving the replication of several treatments is now possible. Such experiments must involve expertise in several disciplines, and we recommend inclusion of a statistician on the team.

We believe a solid foundation is provided herein for making inference from survival experiments using marked animals. Many extensions and special cases can be developed and explored. Some new directions are given; however, we feel that more experience is needed with real data before major new developments are likely. The interaction between theory and practice under careful scrutiny of good biologists and statisticians (or other critical disciplines) will provide direction for further theory development.