JIMAR, PFRP ANNUAL PROGRESS REPORT
FY 2004

P.I. Name: Mark Maunder, (Main Collaborator: Simon Hoyle)
Inter-American Tropical Tuna Commission

Project Proposal Title: A General Bayesian Integrated Population Dynamics Model for Protected Species

Funding Agency: NOAA.

1. Purpose of the project and indicative results.

Managing wildlife-human interactions is increasingly important as human influence on natural habitats grows. Effective management requires defined objectives and reliable information about the likely consequences of management actions, or lack of such actions. These requirements are general across all taxonomic groups and management issues. Integrated Bayesian population modeling is a method for estimating population dynamics and decision analysis that is generally applicable, extremely flexible, uses data efficiently, and gives answers in a format that can be directly measured against management objectives.

The objective of the project is to generate a general Bayesian integrated model for protected species modeling that can be applied to multiple species and used to provide management advice. The model will be used to estimate the effect of fisheries on the protected species populations. Methods will also be developed to estimate the effect of the management measures on both the protected species and the fisheries. We will apply the model to several protected species populations.

2. Progress during FY 2004. Provide a thorough discussion of accomplishments and problems.

The present report reviews the activity under this contract for the 8 months from August 2003 up to the beginning of April 2004. The project start was delayed several months by the staff appointment process. The work to date has consisted of 5 main lines of activity:

- Development of an integrated model for dolphins
- Albatross modeling
- Development of general model
- Methodological development
- Other applications

These topics are briefly reviewed below

a) Development of an integrated model for dolphins

- An integrated model was developed for the northeastern spotted dolphin population and used to estimate population parameters and conduct forward-project under alternative management scenarios.
- Contacts were made with cetacean researchers and modelers at the Southwest Fisheries Science Centre and a methods working group was established to provide a format for presentation and discussion of research related to this and other projects.
- A visit of SH to Northwest Fisheries Science Centre to meet with cetacean researchers and modelers is planned for June 2004.

b) Albatross modeling

- Albatross modeling was delayed due to difficulties at Patuxent Environmental Research Centre, USGS, in finalizing the mark-recapture database. These issues were resolved and the data became available in March.
- MM and SH met with Jean-Dominique Lebreton, Bill Kendal, and Paul Doherty at EURING 2003 to discuss the albatross mark-recapture data base and analysis of the data
- MM and SH attended week-long course run by Jean-Dominique Lebreton and Roger Pradel on multistate mark-recapture modeling using M-SURGE and goodness of fit testing using UCARE.
- MM and SH spent a week in Montpellier with Jean-Dominique Lebreton's group to work on analyzing mark-recapture data for the Tern Island population of black footed albatross and to developed a detailed work program for analysis of albatross data and development of integrated models. The Tern Island population of black footed albatross mark-recapture data has had irregular marking and resighting effort which causes serious goodness of fit problems. In collaboration with Jean-Dominique Lebreton and Sophie Veran, we developed an approach to solve the goodness of fit problems and generated first estimates of adult survival rate from Tern Island mark-recapture data
- SH developed an individual-based model of albatross population dynamics and capture probability for investigating lack of fit in mark-recapture models and in particular the problems with the Tern Island population of black footed albatross data.
- SH worked with Sophie Veran to investigate the effect of widowing in albatross.
- We made contacts for obtaining fishery effort data for integration into a model of albatross interactions with longline fisheries.

c) Development of a general model for protected species

A number of steps were taken towards developing and extending a general approach for modeling protected species. There has been some debate about how general a modeling

approach can be, when applied across very varied taxonomic groups, and to what extent integration should be carried out.

- We have begun developing an approach based on multistate matrix modeling, designed to be compatible with M-SURGE and its subprogram GEMACO (a concise language for specifying multistate parameter index matrices).
- We have developed a framework to allow the application of MULTIFAN-CL to multiple-recapture mark-recapture data. We have an agreement with David Fournier to implement the necessary changes to MULTIFAN-CL and assist in its application to the Tern Island population of black footed albatross
- We have set up the Condor system (http://www.cs.wisc.edu/condor/) to allow for job scheduling across multiple PCs via distributed computing. This gives us access to additional PCs in the IATTC office, and greatly improves our ability to do simulation testing, management strategy evaluation, and possibly Bayesian integration. We have used this method for simulation testing of different methods to model temporal variation in survival for mark-recapture data.

d) Methodological development

- We have worked with Dave Fournier to test, using simulation analysis, the use of Laplace approximation, as implemented in AD Model Builder, for modeling a) recruitment in population dynamics models and b) survival in mark-recapture models as random effects.
- Evaluated, using simulation analysis, different methods to model time varying survival in mark recapture analyses. (paper in preparation).
- MM and SH attended the EURING technical meeting in Radolfzell, Germany, October 2003 (http://www.phidot.org/euring2003/main_ie.html). This is the premier wildlife modeling meeting and provided instruction on the use of mark-recapture models and other wildlife modeling approaches. At the conference we also attended three short courses: (i) parameter counting & redundancy, (ii) goodness-of-fit testing, and (ii) Bayesian inference.

e) Other applications

- SH is attending a graduate course at UCSD's SIO on Global Issues in Sea Turtle Conservation and Potential Policy Solutions (http://cmbc.ucsd.edu/opportunities/sio.cfm). SH has also made contacts with turtle researchers in preparation for applying the Bayesian integrated modeling approach to a turtle population.

3. Plans for the next fiscal year.

Albatross: We intend to continue our collaboration with Jean-Dominique Lebreton's group on analyzing mark-recapture data for the Tern Island population of black footed albatross and development of integrated models. In a comparative analysis, we will also apply MULTIFAN-CL to the data for the Tern Island population of black footed albatross. Meetings will be held between our group, Jean-Dominique Lebreton's, and

other albatross researchers. We plan to attend the 5-yearly albatross conference in Uruguay, August 2004.

Dolphins: We will develop the spotted dolphin model and analysis further, for publication in a marine mammal-oriented journal.

Turtles: We will develop links with sea turtle researchers and apply general integrated model to a sea turtle population. We will meet with turtle researchers to form collaborative research projects.

General model: The Bayesian integrated model will be further developed and applied to the Tern Island population of black footed albatross and other species. Presentation of results at a modeling conference will be desirable.

Methodological development: MM and SH will attend the 2004 International Biometric Conference and both will give presentations (http://www.ozaccom.com.au/cairns2004/). We will carry out further investigation into appropriate methods to include information in models of protected species and to estimate uncertainty.

Collaborations: We will collaborate with Jaume Forcada, Biological Sciences Division NERC, British Antarctic Survey, to produce a penguin population analysis.

PFRP: We will attend the tuna conference, give presentations on the research, and attend the PI meeting.

4. List of papers published in refereed journals during FY 2004.

Hoyle, Simon D.; and Maunder, Mark N. (in press) 'A Bayesian integrated population dynamics model to analyze data for protected species'. Animal Biology and Conservation. (see Appendix 1 for abstract).

5. Other papers, technical reports, meeting presentations, etc.

Presentation at the EURING technical meeting in Radolfzell, Germany, October 2003: "A Bayesian integrated population dynamics model to analyze data for the eastern Pacific Ocean spotted dolphin" Simon D. Hoyle and Mark N. Maunder.

Poster at EURING technical meeting in Radolfzell, Germany, October 2003: "AD Model Builder: a tool for fitting custom-built highly-parameterized nonlinear models" Mark N. Maunder and Simon D. Hoyle.

Presentation at San Diego Chapter American Statistical Association One-day Conference, February 27, 2004 "Is Bayesian analysis redundant?" Mark. N. Maunder.

Presentation to SWFSC methods working group: "Modeling dolphins" Simon D. Hoyle.

Presentation at University of Arizona: "Statistical and simulation modeling of population dynamics for management - 3 examples" Simon D. Hoyle.

Tuna conference (to be presented): "A general model for protected species: information and uncertainty" Mark N. Maunder and "Integrated Population modeling for the northeastern offshore spotted dolphin (*Stenella attenuata*)" Simon D. Hoyle.

6. Names of students graduating with MS or Ph.D. degrees during FY 2004. Include title of thesis or dissertation.

N/A

7. For multi-year projects, provide budget for the next year on a separate page

Appendix 1: Accepted in a special issue of Animal Biodiversity and Conservation for the proceedings of the 2003 EURING conference.

A Bayesian integrated population dynamics model to analyze data for protected species
Simon D. Hoyle and Mark N. Maunder

Managing wildlife-human interactions demands reliable information about the likely consequences of management actions. This requirement is a general one, whatever the taxonomic group. We describe a method for estimating population dynamics and decision analysis that is generally applicable, extremely flexible, uses data efficiently, and gives answers in a useful format. Our case study involves bycatch of a protected species, the Northeastern Spotted Dolphin (*Stenella attenuata*), in the tuna fishery of the eastern Pacific Ocean. Informed decision-making requires quantitative analyses taking all relevant information into account, assessing how bycatch affects these species and how regulations affect the fisheries, and describing the uncertainty in analyses. Bayesian analysis is an ideal framework for delivering information on uncertainty to the decision-making process. It also allows information from other populations or species or expert judgment to be included in the analysis, if appropriate. Integrated analysis attempts to include all relevant data for a population into one analysis by combining analyses, sharing parameters, and simultaneously estimating all parameters, using a combined objective function. It ensures that model assumptions and parameter estimates are consistent throughout the analysis, that uncertainty is propagated through the analysis, and that the correlations among parameters are preserved. Perhaps the most important aspect of integrated analysis is the way it both enables and forces consideration of the system as a whole, so that inconsistencies can be observed and resolved.