## Pelagic Fisheries Research Program

# Protected Species Modeling Workshop

Final Report

Honolulu
November 13 – 14, 2001

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Tagore Room, Imin Conference Center, East-West Center
November 13 – 14, 2001

***Tuesday, 12 November***

John Sibert welcomed participants to the workshop. After introductions, Melissa Snover and Shiham Adam agreed to serve as rapporteurs. The report was drafted by John Sibert.

**Sibert** presented background information on the PFRP and the motivation for holding the workshop. The impacts of interactions between fishing operations and protected species have progressed to the point where sustainability of fisheries depends on quantitative assessment of the effects of fishing operations on the dynamics of protected species populations. Such assessments are problematical for most species using the currently available models. Some of the models applied to protected species population dynamics appear not to conform to the format and structure of state-of-the-art fisheries stock assessment models. The purpose of the workshop was to explore these differences in modeling approaches and to assess the feasibility of developing integrated statistical models for species of marine turtles, albatrosses, and marine mammals. The results of these discussions will be incorporated into the next PFRP request for proposals to be issued in December 2001.

Sibert went on to suggest that part of the difference between fisheries stock assessment models and models of protected species population dynamics was linked to differences in life history and how life history influences how and where knowledge of population dynamics is obtained. Sibert attempted to summarize these differences in Table 1, which provoked a lengthy discussion.

**Mark Maunder** presented an introduction to integrated modeling. Integrated models attempt to utilize all available data on a population, such as length-frequency data, catch rates in the fishery, observed birth rates, tag recaptures, and estimates all parameters simultaneously. Maunder contrasted the integrated approach with the sequential approach where an initial analysis is used to summarize the raw data and then the summarized data are included in the population dynamics model fitting procedure. The main advantages of the integrated approach are: 1) all information is included in the analysis, 2) assurance that model assumptions and parameter estimates are consistent throughout all parts of the analysis, and 3) uncertainty is propagated through the analysis and the correlation between parameters is preserved. Extensive data requirements, lengthy computations, and potential parameter confounding are some of the potential disadvantages of the integrated approach.

**John Hampton** presented an overview of MULTIFAN-CL, and integrated model currently used for the large-scale assessment of tuna species in the Pacific. This model incorporates catch, effort, length-frequency, and tagging data into a single analysis. Some of the features of the model include spatial structure, movement, age-dependent natural mortality and trends in catchability. The MFCL approach could be adopted to protected species modeling, but would require changes in model structure to include

different types of data, e.g. as counts of nesting females and number of hatchlings, and additional processes, e.g. reproductive dynamics, sex-specific processes and social behavior. In discussion it was pointed out that information might be lost by using age-based rather than size-based models. However length data may not be a useful basis to model some species such as sea birds and seals.

**Pierre Kleiber** presented an application of MULTIFAN-CL to blue shark stock assessments as an example of an integrate model in a situation where data are limited. Unlike the tuna, shark catches are not accurately reported by most longline fleets. The data had to be "filtered" to discriminate between sets where no sharks were caught and sets in which sharks may have been caught but not reported. The blue shark application also illustrated the use of life history information to constrain the stock-recruitment relationship which is generally ill-determined by the data.

**Paul Breen** presented an application of integrated modeling to the analysis of the population of Hooker's sea lion, which interacts with a New Zealand squid fishery. MCMC simulations were used to produce stochastic simulations based on the posterior distribution of the estimated parameters. Populations were projected for 100 years under different management scenarios. The integrated approach enabled Breen to estimate population trajectories using samples from the joint posterior distribution of estimated parameters as the starting point for simulations. Alternative scenarios were evaluated by computing the risk of extinction following catastrophic events. Policies with the adaptive controls better assured the long-term viability of the sea-lion population. Integrated models are good methods to represent uncertainty into assessment and management, but model complexity can be difficult to explain the results to stakeholders.

Sibert presented a cursory summary of the TURTSIM model developed by **Jerry Wetherall**. Details of the model were insufficient to support an extended discussion. Copies of Wetherall's 1997 NMFS Admin Report were circulated.

**Dan Goodman** emphasized features of protected species biology that puts them on the edges of several different razors. Each species has very peculiar set of the problems that researchers need to solve. Many of these problems are related to small population size. Goodman illustrated these problems by presenting a summary of his analysis of the Hawaiian monk seal population. This population is divided into several sub-populations with peculiar age and sex distributions. The number of breeding females in each sub-population is very small making population projections very uncertain. Goodman applied empirical Bayesian analysis to generate informative prior distributions of population dynamics parameters. By using the empirical covariance matrix of the parameter estimates, Goodman was able to make population projects for each sub-population. The future of some sub-populations was less optimistic than others. In the worst case, most scenarios led to extinction. This result was, in large part, attributable to the current small population size and the distorted age structure.

**Milani Chaloupka** presented an extremely flexible framework for simulating marine turtle population dynamics. This system incorporates population dynamics parameters derived from published studies. The software incorporates user-friendly mechanisms for adjusting various parameters, management policy options, and viewing model output. It is intended as a heuristic tool for policy makers to aid in understanding and explaining observed population trends and can be readily adapted to different species

of turtles. Features numerous options for exploring management scenarios. The model is stochastic and includes options for compensatory and depensatory effects. Chaloupka is currently developing simulations for turtle populations that interact with the Hawaii-based longline fishery.

***Wednesday, November 14, 2001***

Sibert moderated discussion and revision of **Table 1**. This table is an attempt to abstract demographic differences among several protected species. The top half of the table abstracts demographic characteristics in terms of widely used population dynamics parameters. It shows that the demographic features of widely different species can be captured by a relatively small number of parameters and suggests that a generalized model for protected species may be feasible. The second half of the table shows the nature and origin of knowledge of different species depends on which stages of the life cycle are observable, i.e. which stages of the life cycle interact with humans.

**Access to data**. Integrated models are data-intensive, and therefore access to reliable data is an essential prerequisite to the development of integrated models. The availability and accuracy of data appear to vary between different species and geographic areas. **Table 2** summarizes the discussion of data access.

**Marine turtles.** In general data on turtles is decentralized in the extreme; the term "Balkanized" was used in the workshop. Data are individually held by a suite of different governmental and non-governmental (NGO) organizations and individual researchers. These data include nest counts and tagging. Often methods are not standardized or even consistent within one data set. Dan Goodman led an interesting discussion on how to gain access to such data through cooperative data sharing programs. Development of statistical models for marine turtles would be a two phase project – (1) data gleaning and (2) model development. The data gleaning stage will be challenging and should be considered a long term project. It might be possible to do preliminary model development using data from a single well-known subpopulation such as the TURTSIM model developed by Jerry Wetherall.

**Albatross.** Data on the Laysan and black-footed albatross populations relevant to the Hawaii situation are more accessible. There appear to be large amounts of centralized and accessible data on nest counts and banding. US fishery and observer data can be accessed as well. Data on the short tailed albatross are also centralized and held by Japanese researchers. Access to albatross by-catch in the Japanese longline fishery is likely to be difficult. Problematical bookkeeping of information on re-banding of birds was cited as a potential problem in the data. The prospects of development of an integrated statistical model for albatross populations in Hawaii are good.

**Monk Seals.** Data on Hawaiian monk seals are centralized and have been incorporated into an integrated statistical model by Dan Goodman. Monk seals do not interact with pelagic fisheries under current regulations.

**Other issues.** A lively discussion ensued over whether integrated modeling approaches should be applied before application of more traditional approaches. The two approaches are not mutually exclusive and serve as means for model validation and testing. In many cases, problems in the data are revealed in the modeling process. The cycle of model development and data cleansing is repeated until internal inconsistencies

in the data are eliminated and the model is extended so that model assumptions are not violated by the data. The degree to which integrated modeling may outperform the "classic" modeling paradigm needs to be addressed as a research question. It was noted that the Standing Committee on Tuna and Billfish, an informal international research umbrella organization concerned with the central and western Pacific Ocean, is about to embark on and extensive model performance comparison to address this question.

***Conclusions***

**John Sibert** offered the following closing comments and conclusions. The purpose of the workshop was to discuss the options for and the feasibility of developing integrated statistical models for marine turtles, albatrosses and marine mammals. The workshop was very useful to the PFRP and will help in drafting the next request for proposals.

- Development of integrated statistical models for Hawaiian albatross populations is feasible and could be started at any time.
- Development of general integrated statistical models for marine turtles is dependent on large-scale data sets.
- It may be possible to develop integrated models for specific sub-populations.
- Creation of a cooperative data base for marine turtles should be undertaken.
- Development of integrated models for Hawaiian monk seals is not a priority for the PFRP at this time.

Sibert thanked the participants for their input and closed the meeting on Wednesday afternoon with the hope that the participants would be attracted to the forthcoming RFP.

***References***

Hampton, J. and D. A. Fournier. 2001. A spatially disaggregated, length-based, age-structured population model of yellowfin tuna (Thunnus albacares) in the western and central Pacific Ocean. Mar. Freshwater Res. 52, 937–963

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Niel, C. and J. Lebreton (in press) Using demographic invariants to detect overharvest bird populations from incomplete data.

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## Table 1. Demographic Generalizations

| | Tropical Tunas | Marine Turtles | Albatross | Hawaiian Monk Seals | Humans |
|---|---|---|---|---|---|
| Age at maturity | 0-2 | 15-50 | 6-13 | 5-10 | 10-30 |
| Lifetime births per female | $>10^6$ | $10^3$ | $10^2$ | 10 | 1-10 |
| Annual peak fecundity (individuals per female) | $>10^6$ | 100 | 0.5 | 0.75 | 1.0 |
| Lifespan (yrs) | 2-10 | >50 | >50 | 40 | 40-80 |
| Generation Time | 2 yrs | >25 | 25 | 12 | 28 |
| Social structure | ? | ? | monogamous | critical | yes |
| Population Size | ? $10^{10}$ | $10^4 - 10^6$ | 102 - $10^4$ | $10^3$ | $10^9$ |
| Trend | varies | varies | stable or declining | stable or declining | increasing |
| Environmental forcing | strong | ? | moderate | moderate (catastrophic) | weak (?) |
| | | | | | |
| | | | | | |
| Epistemological window | fishery pelagic | breeding littoral neritic | nesting fishery | pupping beaches | records interviews |
| Tagging | moderate pulsed | extensive on-going | extensive continuous | extensive continuous | Orwellian |
| Tracking | yes | yes | yes | yes | not yet |
| Age 0 - 1 | unknown | estimates? | census with parents | census | records census |
| Juveniles | fishery | unknown | ? | census | census |
| Adults | fishery | census | census | census | census |
| Age determination | otoliths | bones tagging | problematic banding | census | records |
| Growth rate | measurements statistical | poorly known | poorly known | measurements | measurements |
| Genetics | some | yes | yes | not yet | yes |
| | | | | | |
| | | | | | |

## Table 2. Data Holdings

| | Nest Counts census & samples | Tagging re-sighting | Tracking | Transect surveys | Fishery |
|---|---|---|---|---|---|
| WP & EP Leatherback | multiple holdings by NGOs and researchers | ditto | yes | EPO | US observers JP data |
| Loggerhead (Japanese?) | multiple holdings by NGOs and researchers | ditto | yes | EPO | US observers JP data |
| EP Green | multiple holdings by NGOs and researchers | ditto | | EPO | US observers JP data |
| Olive Ridley | multiple holdings by NGOs and researchers | ditto | yes | EPO | US observers JP data |
| | | | | | |
| BF Albatross | regular counts of breeding adults; sporadic juvenile re-sighting | chicks and adults; accessible; re-banding problem; | adults; forage on W coast of North America | Pacific Ocean biological survey, 1960s | AK HI observer |
| Laysan Albatross | irregular counts | chicks and adults; re-banding problem; | adults; forage in Aleutian Islands | | AK HI observer |
| ST Albatross | regular counts | all banded as chicks | new FWS/ Japan an study | | AK HI observer |
| | | | | | |
| Monk Seals | Centralized; >30 yrs | 20 yrs; tagged at weaning; other detailed observations | movement rates between rookeries | (other ad hoc experiments) | entanglements |

# Agenda

## Tuesday, November 13

| | |
|---|---|
| 9:00 AM | Opening - John Sibert, PFRP |
| | Goals of the workshop |
| | Appointment of rapporteurs |
| 9:30 AM | Integrated analysis in fisheries stock assessment, Mark Maunder, Inter-American Tropical Tuna Commission, La Jolla, California. |
| 10:00 AM | Break |
| 10:30 AM | Overview of MULTIFAN-CL, John Hampton, Secretariat of the Pacific Community, Noumea. |
| 11:00 AM | Application of MULTIFAN-CL to blue sharks, Pierre Kleiber, NMFS Honolulu. |
| 11:30 AM | Modelling the effect of fishery bycatch on Hooker's sea lions in New Zealand. Paul Breen (NIWA, Wellington), R. Hilborn, M. Maunder and S. Kim. |
| 12:00 PM | Lunch |
| 1:30 PM | Overview of recent models of Hawaiian Monk Seal Populations, Dan Goodman, Montana State University |
| 2:00 PM | Overview of TURTSIM - Jerry Wetherall, NMFS Honolulu – presented by John Sibert |
| 2:30 PM | Interactive simulation models for Pacific sea turtles – Milani Chaloupka, Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management, Indooroopilly, Australia. |
| 3:00 PM | Break |
| 3:30 PM | Information base, types of data currently on hand, accessibility issues - group |

## Wednesday, November 14

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|---|---|
| 9:00 AM | Modeling opportunities and problems - group |
| 10:00 AM | Break |
| 10:30 AM | Draft specifications for integrated statistical models - group |
| 12:00 PM | Lunch |
| 1:30 PM | Summary of discussions - Sibert |

# List of Participants


Shiham Adam
University of Hawaii
JIMAR, Pelagic Fisheries Research Program
1000 Pope Road, MSB 312
Honolulu, HI 96822 USA
Ph. 808-956-6319
FAX 808-956-4104
msadam@soest.hawaii.edu

Karen Bjorndal
Archie Carr Center for Sea Turtle Research
Dept. of Zoology
University of Florida
P.O. Box 118525
Gainesville, FL 32611 USA
Ph. 352-392-5194
FAX 352-392-9166
kab@zoo.ufl.edu

Alan Bolten
Archie Carr Center for Sea Turtle Research
Dept. of Zoology
University of Florida
P.O. Box 118525
Gainesville, FL 32611 USA
Ph. 352-392-5194
FAX 352-392-9166
abb@zoo.ufl.edu

Paul Breen
National Institute of Water & Atmospheric Research
301 Evans Bay Parade
P.O. Box 14901
Wellington, 6003 NEW ZEALAND
Ph. 644-386-0518
FAX 644-386-0574
p.breen@niwa.cri.nz

Milani Chaloupka
CRC (Coastal, Estuary & Waterway Management)
Indooroopilly Sciences Centre, QCCA Bldg.
80 Meiers Road
Indooroopilly, QLD 4068
AUSTRALIA
Ph. 61-7-33629399
FAX 61-7-33629372
m.chaloupka@mailbox.uq.edu.au

Kathy Cousins
Western Pacific Regional Fishery Management Council
1164 Bishop Street, Ste. 1400
Honolulu, HI 96813 USA
Ph. 808-522-8167
FAX 808-522-8226
Kathy.Cousins@noaa.gov

David Fournier
Otter Research Ltd.
P.O. Box 265
Sidney, BC V8L 3S3
CANADA
otter@otter-rsch.com

Dan Goodman
Montana State University
Dept. of Ecology
P.O. Box 173460
Bozeman, MT 59717-3460
USA
Ph. 406-994-3231
goodman@rapid.msu.montana.edu

John Hampton
Secretariat of the Pacific Community (SPC)
Oceanic Fisheries Programme
B.P. D5
Noumea,
NEW CALEDONIA
Ph. 687-260147
FAX 687-263818
JohnH@spc.int

Pierre Kleiber
National Marine Fisheries Service
Honolulu Lab
2570 Dole Street
Honolulu, HI 96822 USA
Ph. 808-983-5399
FAX 808-983-2902
pkleiber@honlab.nmfs.hawaii.edu

Irene Kinan
Western Pacific Regional Fishery
Management Council
1164 Bishop St. #1400
Honolulu, HI, USA 96813
Ph. 808-522-8220
FAX. 808-522-8226
Irene.Kinan@noaa.gov

Jean-Dominique Lebreton
Centre National De La Recherche
Scientifique
Centre D'Ecologie Fonctionnelle et
Evolutive
1919 Route de Mende
34 293 Montpellier Cedex 5
FRANCE
Ph 33-4-67-61-32-05
FAX 33-4-67-41-21-38
lebreton@cefe.cnrs-mop.fr

Mark Maunder
Inter-American Tropical Tuna Commission
(IATTC)
Scripps Institution of Oceanography
8604 La Jolla Shores Drive
La Jolla, CA 92037-1508 USA
Ph. 858-546-7027
FAX 858-546-7133
mmaunder@iattc.org

John Sibert
University of Hawaii
JIMAR
Pelagic Fisheries Research Program
1000 Pope Road, MSB 312
Honolulu, HI 96822
USA
Ph. 202-861-2363
FAX 202-861-4767
jsibert@soest.hawaii.edu

Melissa Snover
Duke University Marine Laboratory
Nicholas School of the Environment
135 Duke Marine Lab Road
Beaufort, NC 28516-9721
Ph. 252-504-7629
FAX 252-504-7648
mls6@duke.edu