



SESAME:

A Simulation-Estimation Stock Assessment Model Evaluation Project *focused on large pelagic species*



Australian Government
Department of Agriculture,
Fisheries and Forestry



CSIRO
MARINE RESEARCH



Australian Government
Australian Fisheries
Management Authority

JUNE 2004

AFFA-FRRF Project No. 01/2438, and AFMA-MIRF Project No. R00/0833

■ Dale Kolody ■ Paavo Jumpanen ■ Daniel Ricard ■ Jason Hartog ■ Ann Preece ■ Tom Polacheck

SESAME: A Simulation-Estimation Stock Assessment Model Evaluation Project
focused on Large Pelagic Species

Kolody, D.S., Jumppanen P.C., Ricard, D.G., Hartog, J.R., Preece, A.L., and
Polacheck, T.

Published by CSIRO Marine Research

© CSIRO Marine Research 2004

DISCLAIMER

The authors do not warrant that the information in this report is free from errors or omissions. The authors do not accept any form of liability, be it contractual, tortious or otherwise, for the contents of this report or any consequences arising from its use or any reliance placed upon it. The information, opinions and advice contained in this book may not relate to, or be relevant to, a reader's particular circumstances. Opinions expressed by the authors are the individual opinions of those persons and are not necessarily those of the publisher or research provider.

Bibliography.

ISBN 1 876996 64 1.

1. Fish stock assessment - Australia. 2. Fishery resources
- Australia. 3. Tuna fisheries - Australia. 4. Billfish
fisheries - Australia. I. Kolody, Dale, S. II. CSIRO.
Marine Research. III. Title. (Series : Marine research
report (CSIRO. Marine Research) ; no. 241).

639.27780994

Preferred way to cite this publication:

Kolody, D.S., Jumppanen P.C., Ricard, D.G., Hartog, J.R., Preece, A.L., and Polacheck, T. 2004.
SESAME: a simulation-estimation stock assessment model evaluation project focused on large pelagic
species. CSIRO Marine Laboratories Report 241.

This is an electronic publication – limited paper copies printed by Piper Printing.

1 CONTENTS

1	CONTENTS	III
2	EXECUTIVE SUMMARY.....	1
3	INTRODUCTION	8
3.1	RATIONALE.....	8
3.2	OBJECTIVES	10
3.3	BACKGROUND TO SPECIFIC STOCK ASSESSMENT ISSUES FOR SBT AND OTHER REGIONAL TUNA STOCKS	11
3.3.1	<i>Objective I - Stock Recruitment Relationship Estimation.....</i>	<i>11</i>
3.3.2	<i>Objective II - Catch Under-Reporting Biases</i>	<i>13</i>
3.3.3	<i>Objective III - Age Estimation from Cohort-Slicing vs: Catch-at-Length....</i>	<i>13</i>
3.3.4	<i>Objective IV - Unrecognized Changes in SBT Length-at-Age.....</i>	<i>14</i>
3.3.5	<i>Objective V - Fishery Selectivity Assumptions</i>	<i>14</i>
3.3.6	<i>Objective VI - Catchability Assumptions for Relative Abundance Indices..</i>	<i>16</i>
3.3.7	<i>Objective VII - SCTB-MWG Assessment Model Evaluation Project and Assumptions about Fishery Spatial Structure</i>	<i>17</i>
3.3.8	<i>Objective VIII - Uncertainty Quantification.....</i>	<i>20</i>
3.3.8.A	Estimator Performance.....	20
3.3.8.B	Statistical Uncertainty estimation.....	21
3.3.8.C	Model Uncertainty.....	22
3.3.8.D	Assessment Uncertainty and Fisheries Mangement	22
4	METHODS.....	23
4.1	SIMULATION-ESTIMATION METHODOLOGY	23
4.2	OPERATING MODELS.....	25
4.2.1	<i>VSM: a generic fishery simulation model</i>	<i>25</i>
4.2.2	<i>VSM Parameterization of the fishery operating model to resemble the SBT system.....</i>	<i>26</i>
4.2.3	<i>The SPC-OFP YFT simulator and the SCTB-MWG assessment model evaluation project</i>	<i>29</i>
4.3	ASSESSMENT MODELS.....	30
4.3.1	<i>Age-aggregated and age-structured Production Models</i>	<i>33</i>
4.3.2	<i>SCALIA: a generic fisheries stock assessment model.....</i>	<i>33</i>
4.3.3	<i>BIH_2: an independent implementation of a SCALIA-like model.....</i>	<i>39</i>
4.3.4	<i>MULTIFAN-CL.....</i>	<i>39</i>
4.4	CRITERIA FOR EVALUATING ASSESSMENT MODEL PERFORMANCE.....	40
4.5	DATABASE OVERVIEW	47
4.6	QUALITY CONTROL.....	47
5	RESULTS AND DISCUSSION	48
5.1	GENERAL COMMENTS ON ASSESSMENT MODEL IMPLEMENTATION	48
5.1.1	<i>Age-Aggregated Production Models.....</i>	<i>49</i>
5.1.2	<i>Age-Structured Production Models.....</i>	<i>49</i>
5.1.3	<i>SCALIA</i>	<i>50</i>
5.1.4	<i>MULTIFAN-CL.....</i>	<i>51</i>
5.2	BASILINE ASSESSMENT MODEL PERFORMANCE	52

5.3	OBJECTIVE I - STOCK RECRUITMENT RELATIONSHIP ESTIMATION	78
5.4	OBJECTIVE II - ASSESSMENT IMPLICATIONS OF CATCH UNDER-REPORTING BIASES	97
5.5	OBJECTIVE III AGE ESTIMATION FROM COHORT-SLICING VS: CATCH-AT- LENGTH	101
5.6	OBJECTIVE IV - ASSESSMENT IMPLICATIONS OF UNRECOGNIZED CHANGES IN SBT LENGTH-AT-AGE.....	114
5.7	OBJECTIVE V - ASSESSMENT IMPLICATIONS OF FISHERY SELECTIVITY ASSUMPTIONS	126
5.7.1	<i>TEMPORAL VARIABILITY IN SELECTIVITY</i>	126
5.7.2	<i>LENGTH-BASED FISHERY SELECTIVITY</i>	146
5.8	OBJECTIVE VI - ASSESSMENT IMPLICATIONS OF CATCHABILITY TEMPORAL VARIABILITY IN RELATIVE ABUNDANCE INDICES.....	149
5.9	OBJECTIVE VII - THE SCTB METHODS WORKING GROUP AND ASSUMPTIONS ABOUT FISHERY SPATIAL STRUCTURE IN ASSESSMENT MODELS	172
5.10	OBJECTIVE VIII - STOCK ASSESSMENT MODEL UNCERTAINTY QUANTIFICATION	193
5.10.1.A	Estimator Performance	193
5.10.1.B	Statistical Uncertainty Estimation	193
5.10.1.C	Model Uncertainty.....	197
5.10.1.D	Assessment Uncertainty and Fisheries Mangement	198
5.11	GENERAL COMMENTS ON THE RELATIVE PERFORMANCE OF ASSESSMENT MODELS.....	200
5.11.1	<i>Age-Aggregated Production Models</i>	205
5.11.2	<i>Age-Structured Production Models</i>	206
5.11.3	<i>SCALIA</i>	206
5.11.4	<i>BIH_2</i>	207
5.11.5	<i>MULTIFAN-CL</i>	207
5.12	METHODOLOGICAL LIMITATIONS	209
5.13	CONCLUSIONS AND RECOMMENDATIONS	213
6	ACKNOWLEDGEMENTS.....	221
7	REFERENCES	222
8	APPENDICES.....	228
	APPENDIX 1 VSM TECHNICAL DESCRIPTION	229
A1.1	MODEL OVERVIEW	229
A1.1.1	<i>System Dynamics Model</i>	229
A1.1.2	<i>Observation Model</i>	233
A1.2	SYSTEM DYNAMICS MODEL IMPLEMENTATION DETAILS	234
A1.2.1	<i>Recruitment</i>	235
A1.2.2	<i>Generalized Correlated Deviate</i>	236
A1.2.3	<i>Natural Mortality</i>	236
A1.2.4	<i>Fishing Mortality</i>	237
A1.2.4.1	Selectivity Changes	238
A1.2.5	<i>Tagging</i>	243
A1.2.6	<i>Aging</i>	244
A1.2.6.1	Method 1: The absolute growth method	245
A1.2.6.2	Method 2 : The differential growth method.....	245

A1.2.7	<i>Migration</i>	247
A1.2.8	<i>Summary Statistics</i>	248
A1.3	OBSERVATION MODEL IMPLEMENTATION DETAILS	251
A1.3.1	<i>Effort errors</i>	251
A1.3.2	<i>Total catch errors</i>	251
A1.3.3	<i>Age and length distribution errors</i>	251
A1.3.4	<i>Tag reporting rate errors</i>	252
A1.3.5	<i>Age errors through cohort slicing</i>	253
A1.4	LIST OF SYMBOLS	253
A1.5	REFERENCES.....	253
APPENDIX 2 VSM PARAMETERIZATION FOR A FISHERY RESEMBLING SBT		254
APPENDIX 3 AGE-AGGREGATED AND AGE-STRUCTURED PRODUCTION MODELS TECHNICAL DESCRIPTION.....		285
A 3.1	AGE-AGGREGATED PRODUCTION MODELS (AAPMs)	285
A 3.1.1	<i>AAPM Biomass Dynamics</i>	286
A 3.1.2	<i>AAPM Objective Function</i>	286
A 3.2	AGE-STRUCTURED PRODUCTION MODELS (ASPMs)	287
A 3.2.1	<i>ASPM Population dynamics</i>	288
A 3.2.2	<i>Stock recruitment relationship</i>	289
A 3.2.3	<i>Biomass trajectories</i>	290
A 3.2.4	<i>Objective function</i>	290
A 3.3	AAPM AND ASPM DATA PROCESSING AND BIOLOGICAL ASSUMPTIONS	291
A 3.3.1	<i>Computation of total catch biomass time-series</i>	291
A 3.3.2	<i>Computation of nominal LL CPUE</i>	291
A 3.3.3	<i>ASPM Biological parameters</i>	291
A 3.3.4	<i>Selectivity Calculation</i>	292
A 3.3.5	<i>Comments on Parameter estimation</i>	295
A 3.4	REFERENCES	298
APPENDIX 4 SCALIA TECHNICAL DESCRIPTION		299
A 4.1	POPULATION DYNAMICS	299
A 4.2	FISHERY DYNAMICS.....	300
A 4.3	TAG DYNAMICS	304
A 4.4	OBJECTIVE FUNCTION	306
A 4.5	PARAMETER ESTIMATION AND STATISTICAL UNCERTAINTY QUANTIFICATION	307
A 4.6	OUTPUT VISUALIZATION AND GOODNESS-OF-FIT DIAGNOSTICS	308
A 4.7	PROJECTIONS AND REFERENCE POINT CALCULATIONS.....	308
A 4.8	SCALIA EVOLUTION	309
A 4.9	REFERENCES.....	310
APPENDIX 5 MULTIFAN-CL SPECIFICATIONS USED IN THE SBT SIMULATION TESTING.....		323
APPENDIX 6 GRAPHICAL SUMMARY OF SESAME SIMULATED SBT ASSESSMENT MODEL RESULTS		328
A 6.1	F_CALC.....	329
A 6.2	ASPM_D2G.....	337
A 6.3	ASPM_D6G.....	349

A 6.4	SC_BASE	361
A 6.5	SC_MEST	373
A 6.6	SC_NOTAG.....	385
A 6.7	SC_2IDEAL.....	397
A 6.8	MF_YFT.....	409
A 6.9	MF_SCAN	414
A 6.10	MF_QTS	419
A 6.11	BIH_2	424
APPENDIX 7 ACRONYMS USED IN THE SESAME REPORT		429
APPENDIX 8 NON-TECHNICAL DESCRIPTION OF ASSESSMENT ISSUES FOR MANAGERS AND POLICY MAKERS		431
APPENDIX 9 LIST OF WORKING PAPERS ARISING FROM THE SESAME PROJECT.....		436