

CONTENTS

Chapter		Page No.
1		
	1.1 Introduction	1
	1.2 Irish Sea	5
	1.2.1 Geographical area	5
	1.2.2 Hydrography	5
	1.2.3 The plaice fishery	7
	1.3 Plaice biology	10
	1.4 Natural mortality in plaice	12
	1.4.1 Pre-recruit stage	13
	1.4.2 Adult stage	13
	1.4.3 Old age stage	16
2	Data Organisation	
	2.1 Introduction	17
	2.2 Aim	17
	2.3 Grouping of the raw (unraised) returns	18
	2.4 The length and age at maturity	22
	2.4.1 Introduction	22
	2.4.2 Method	22
	2.4.3 Results	24
	2.4.4 Conclusion	25
	2.5 Comparison of return rates from different nations	26
	2.5.1 Introduction	26
	2.5.2 Theory	26
	2.5.3 Method	27
	2.5.4 Results	29

Chapter		Page No.
	2.5.5 Conclusion	30
	2.6 Flow Chart indicating the main steps undertaken in tag-recapture analysis	31
	2.7 Selection of experiments	33
	2.7.1 Introduction	33
	2.7.2 Method	34
	2.7.3 Results	35
	2.7.4 Conclusion	36
3	Review of fisheries models	
	3.1 Introduction	38
	3.2 The basis of the models	39
	3.3 Logistic models	40
	3.4 Structured models	42
	3.5 Virtual population analysis	46
	3.6 Importance of the natural mortality coefficient in fisheries management	48
	3.7 Methods of estimating natural mortality	51
	3.8 The use of tag recapture models to estimate mortality rates from a commercial fishery	56
4	Migration	
	4.1 Introduction	65
	4.2 Method	68
	4.2.1 Experiment 8	70
	4.2.2 Experiment 9	71
	4.2.3 Experiment 11	71
	4.2.4 Experiment 12 + 13 + 14	73
	4.2.5 Irish releases	74

Chapter		Page No.
	4.2.6 Conclusion	74
5	Estimation of auxiliary parameters	
	5.1 Introduction	77
	5.2 Aim	78
	5.3 Tag recapture model	79
	5.3.1 Notations and development of tag recapture model	79
	5.4 Errors in tag recapture analysis	81
	5.4.1 Type A errors	81
	5.4.2 Type B errors	83
	5.4.3 Type C errors	84
	5.5 Multiple regression analysis	85
	5.5.1 Introduction	85
	5.5.2 Theory	87
	5.5.3 Method	88
	5.5.4 Results	90
	5.5.5 Conclusion	92
	5.6 Estimation of total annual instantaneous mortalities using Chapman and Robson's (1960) method	93
	5.6.1 Introduction	93
	5.6.2 Method	94
	5.6.3 Results	95
	5.6.4 Conclusion	96
	5.7 Double tag analysis	98
	5.7.1 Introduction	98
	5.7.2 Theory	99
	5.7.3 Method	100

Chapter		Page No.
	5.7.4 Results	101
	5.7.5 Conclusion	101
	5.8 Tag planting experiment	102
	5.8.1 Introduction	102
	5.8.2 Formulation of the model	103
	5.8.3 Sampling design	105
	5.8.4 Method	105
	5.8.5 Results	106
	5.8.6 Conclusion	108
6	Estimation of the parameters I Simulation Experiments	
	6.1 Introduction	109
	6.2 Aim	111
	6.3 Choosing an appropriate model	111
	6.4 Formulation of the stochastic form of the chosen deterministic model	123
	6.5 Formulation of the objective function for optimization	126
	6.6 Method	133
	6.7 Results	135
	6.8 Conclusion	140
7	Estimation of the parameters II Analysis of 1963-1966 mark recapture data	
	7.1 Introduction	142
	7.2 Aim	143
	7.3 Some possible formulation of objective function from catch equation and virtual population analysis	143
	7.4 Organization of the data for optimization	146

Chapter		Page No.
7.5	Statistical distribution of SB	150
7.5.1	Method	150
7.5.2	Results	152
7.5.3	Conclusion	152
7.6	Analysis of 1963 to 1966 recapture data	152
7.6.1	Introduction	152
7.6.2	Method	153
7.6.3	Results	155
7.6.4	Sensitivity analysis	159
7.6.5	Statistical properties of the parameters (Monte Carlo simulation results)	161
7.6.5.1	Male	163
7.6.5.2	Female	166
7.6.6	Distribution of SB and X	168
7.6.7	Contour of $\hat{\phi}_2(\underline{I})$ in the parameter space	168
7.6.8	Goodness of fit of the model	171
7.6.9	Residual analysis	172
7.7	Seasonal fishing mortalities	174
7.8	Conclusion	177
8	Estimation of the parameters III Analysis of 1979-1980 mark recapture data	
8.1	Introduction	178
8.2	Aim	178
8.3	Design of tagging experiments (Robson-Seber model)	178
8.3.1	Theory	179
8.3.2	Sampling procedure	180

Chapter		Page No.
	8.3.2.1 Precision of the estimate of Z in terms of expenditure	181
	8.3.2.2 Comparison of different types of vessels employed by MAFF laboratory in terms of expenditure	182
	8.4 Migration	184
	8.4.1 Experiment 26	184
	8.4.2 Experiment 27	185
	8.4.3 Experiment 28	186
	8.5 Estimation of total mortality	187
	8.6 Estimation of natural mortality	188
	8.7 Seasonal fishing mortalities	193
	8.8 Conclusion	194
9	Summary and conclusions	
	9.1 Answers to the questions posed in the introduction	196
	9.1.1 Assumptions related to the formulation of the model	197
	9.1.2 Assumptions related to the data	197
	9.2 Summary of results on auxiliary parameters	200
	9.3 Discussion	203
	9.4 Design and analysis of tagging experiments	203
	9.5 General conclusions	206

References

- Appendix A: Data format for the tagging programs
- Appendix B: Program HEFA
- Appendix C: Program HIFD
- Appendix D: Sampling design to collect data for maturity analysis