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Staying ahead of the game: A framework for effective aquaculture decision-making

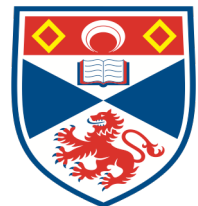
Andrew S. King

RD, B.Sc., M.Sc., MBA., Dip.Mar., C.Eng., FRINA

This thesis is submitted in fulfilment for the requirements for a conjoint degree of PhD at the University of Tasmania and the University of St Andrews, February 2016



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STATEMENTS AND DECLARATIONS

University of Tasmania

Declaration of Originality:

I, Andrew S. King, hereby certify that this thesis, which is approximately 53,000 words in length contains no material which has been accepted for a degree or diploma by the University or any institution, except by way of background information and duly acknowledged in the thesis, and to the best of my knowledge and belief no material previously published or written by another person except where due acknowledgement is made in the text of the thesis, nor does the thesis contain any material that infringes copyright.

I was admitted as a research student in September 2011, and as a candidate for the degree of PhD in October 2011. The higher study for which this thesis is a record was carried out at both the University of Tasmania (the principal supervisory institution, source of funding and place of residence during the course of the PhD) and the University of St Andrews, under a cotutelle agreement between these institutions from 2011 to 2016, and with additional supervisory support from CSIRO Australia.

Statement of Ethical Conduct

The research associated with this thesis abides by international and Australian codes on human and animal experimentation, the guidelines by the Australian Government's Office of Gene Technology Regulator and the rulings of the Safety, Ethics and Institutional Biosafety Committees of the University. Ethics approval was granted under the University of Tasmania's human ethics (minimal risk) research procedure: Ethics approval Reference No. H14069.

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Andrew Stephen King
Hobart, Australia & St Andrews, Great Britain
August 2015

ABSTRACT

Globally, Atlantic salmon aquaculture is faced with a critical challenge: How best to deliver long-term sustainable growth, whilst optimising the opportunity for the expansion of the industry presented by an increasing global seafood demand?

This thesis presents a novel framework of complementary decision support approaches to enable decision-makers to better understand the factors influencing aquaculture development, and examine alternative production (growout) technologies that more effectively address the challenges associated with intensification and expansion. The framework was developed through a combination of fieldwork (international data-gathering), key stakeholder discussions, and the application of targeted qualitative and quantitative analytical approaches; using the Tasmanian industry as a Case Study. The initial research focused on shorter-term (tactical) decision support. A situational analysis defined the business environment, and appraised viable expansion options (offshore, closed-containment and extractive bio-remediation). An economic analysis of selected options then provided a comparison of financial performance and risk. The outputs of this initial component next informed strategic decision-making approaches; employing scenario analysis to explore plausible strategies for the adoption of land-based recirculating aquaculture systems; and qualitative modelling to understand the causal dynamics driving and regulating the industry, and their impact on technology selection.

Whilst it was clear that business economic viability is paramount, the results suggested that societal acceptance (the Social License to operate) is playing an increasingly important role in influencing business decisions. There is no single 'right' technological solution; social acceptance, in particular considerations regarding human wellbeing, trust, and animal welfare concerns, will shape the business environment and therefore technology selection. The research emphasised the importance of employing a balance of tactical and strategic decision-making techniques, and of engaging with a broad range of industry stakeholders. It also highlighted the complexity and dynamic nature of the industry and that key variances (economic, regional, strategic, technological, and temporal) must be included in decision-making.

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TABLE OF CONTENTS

STATEMENTS AND DECLARATIONS	i
ACKNOWLEDGEMENTS	v
ABSTRACT	vii
TABLE OF CONTENTS	ix
LIST OF FIGURES AND TABLES	xiii
LIST OF ABBREVIATIONS	xxii
CHAPTER 1: THESIS INTRODUCTION	1
1.1 Background to the Research	3
1.2 Research Purpose	7
1.3 Thesis Structure	8
1.4 Research Boundaries	9
CHAPTER 2: SITUATIONAL ANALYSIS PART A – BUSINESS ENVIRONMENT	11
2.1 Introduction	13
2.2 Aim(s) and Objectives	15
2.3 Method	16
2.3.1 Data Collection	16
2.3.2 Analysis	18
2.4 Results	19
2.4.1 Macro Business Environment	19
2.4.2 PESTEL Analysis	20
2.4.3 SWOT Analysis	24
2.5 Discussion	25
2.6 Conclusion	31

CHAPTER 3: SITUATIONAL ANALYSIS PART B – TECHNOLOGY SELECTION	33
3.1 Introduction	35
3.2 Aim and Objectives	38
3.3 Method	39
3.4 Results	44
3.4.1 Technology Characterisation	44
3.4.2 Technology Screening (Tasmanian Industry Case Study) Error! Bookmark not defined.	
3.5 Discussion	53
3.6 Conclusion	58
 CHAPTER 4: ECONOMIC ANALYSIS	 59
4.1 Introduction	61
4.2 Aim and Objectives	63
4.3 Method	64
4.3.1 Overview	64
4.3.2 Production Scenarios	67
4.3.3 Modelling Assumptions (Fiscal, Biological, Capital and Operating)	71
4.3.4 Financial Performance Indicators	78
4.4 Results	80
4.4.1 Deterministic and Stochastic Analyses	80
4.4.2 Sub-Scenario Analysis	90
4.5 Discussion	95
4.6 Conclusion	103

CHAPTER 5: SCENARIO ANALYSIS	105
5.1 Introduction	107
5.2 Aim and Objectives	110
5.3 Method	111
5.4 Results	117
5.4.1 Stakeholder Discussions	117
5.4.2 Scenario Narratives	122
5.4.3 Narrative Feedback and Analysis	123
5.5 Discussion	133
5.6 Conclusion	141
 CHAPTER 6: QUALITATIVE MODELLING	 143
6.1 Introduction	145
6.2 Aim and Objectives	146
6.3 Qualitative Modelling	147
6.3.1 Signed Digraphs	147
6.3.2 Model Development	151
6.3.3 Salmon Aquaculture's System Dynamics	158
6.3.4 Evolution of Salmon Aquaculture's System Dynamics	164
6.3.5 Technology Adoption Perturbations (Tasmanian Industry Case Study)	167
6.4 Discussion	173
6.5 Conclusion	180
 CHAPTER 7: WHAT DOES IT ALL MEAN?	 181
7.1 Research Context	183
7.2 Research Application	185
7.2.1 Application of the Decision Support Framework	185
7.2.2 Growout Technology Selection Statements	187
7.3 Reflecting on the Impact of the Research	189
7.4 Future Research Directions	191
7.5 Concluding Remarks	192

CHAPTER 8: APPENDICES	193
Appendix 1A – Case Study: The Atlantic Salmon Industry in Tasmania	195
Appendix 2A – Request for Participation (Example)	201
Appendix 2B – Visit Confirmation (Example)	202
Appendix 2C – Example Situational Analysis Interview Proforma	203
Appendix 2D – Example Situational Analysis Interview Record Sheet	204
Appendix 2E – Country Case Studies Fieldwork Companies and Organisations Referenced in the Country and Technology Case-studies	206
Appendix 2F – Country Case Studies	207
Appendix 3A – Atlantic Salmon Growout Production Expansion Options	218
Appendix 3B – Technology Case-Study AgriMarine FCC	224
Appendix 3C – Technology Case-Study Atlantic Sapphire RAS	226
Appendix 3D – Technology Case-Study AquaDome FCC	229
Appendix 3E – Technology Case-Study Cooke Aquaculture’s IMTA	231
Appendix 3F – Technology Case-Study Galway Bay Deep Sea Development	233
Appendix 3G – Technology Case-Study Isle of Barra High-Energy Site	235
Appendix 3H – Technology Case-Study Namgis RAS Project	237
Appendix 3I – Technology Case-Study SEAfood System IMTA	239
Appendix 3J – Example Technical Interview Proforma	241
Appendix 3K – Example Technical Interview Record Sheet	242
Appendix 3L - Technology Selection Challenges and Risks Identified in the Data Gathering Fieldwork.	243
Appendix 4A – Deterministic Analysis Results	247
Appendix 4B – Stochastic Analysis Results	251
Appendix 4C – Growth Models	255
Appendix 5A – Participant’s Briefing Sheet	259
Appendix 5C – Scenario Narrative Feedback Form	262
Appendix 6A – Generic Aquaculture Production Signed Digraph Model	265
CHAPTER 9: REFERENCES	267

LIST OF FIGURES AND TABLES

Figures

Figure 1.1	Uncertain and predetermined elements of decision-time horizon (adapted from Van der Heijden 2011).	6
Figure 2.1:	Principal drivers and trends acting on the business environment of the global Atlantic salmon aquaculture industry.	19
Figure 2.2:	Relative ranking of the top drivers that participants (<i>n</i> =27) considered would influence the future development of the Atlantic salmon aquaculture industry, categorised by country (and region), and grouped by PESTEL factor.	23
Figure 2.3:	Principal internal characteristics of the industry (strengths and weaknesses) and external (opportunities and threats) business environment factors with the potential to influence expansion of Atlantic salmon aquaculture in Australia (Tasmania), as identified in discussions with the Tasmanian aquaculture industry and regulators.	24
Figure 2.4:	Probable direction of growout technology adoption for expansion, derived from the country studies. The length of arrows reflecting the relative strength and bearing of the top two or three PESTEL (Political, Economic, Social, Technical, Environmental and Legal) drivers, from Figure 2.2.	26
Figure 3.1:	Schematic representation of the inter-related components involved in the selection of the appropriate production technology.	36
Figure 3.2:	Technology selection framework adopted in this research, illustrating the hierarchy of the decision process, and the data collection and analyses. PESTEL analysis – political, economic, societal, technical, environmental and legal. SWOT analysis – strengths, weaknesses, opportunities and threats. RAG screening – Red, Amber and Green status.	42
Figure 3.3:	Growout technology screening - RAG (Red, Amber, Green) assessment of eight alternative production scenarios against seven selection criteria in a Tasmanian Case Study operating environment.	52
Figure 4.1:	RAS production salmon ongrowing cycle modelled.	69
Figure 4.2:	Production profiles (Years 1 – 3) used within the economic modelling.	70
Figure 4.3:	Comparison of the principal financial performance indicators for the four technologies from the deterministic modelling. Net income including debt and working capital interest. NPV calculated a 15 year period, 7% discount factor.	83

Figure 4.4: Comparison of initial capital investment for the production scenarios with probability distributions for each of the alternatives.	84
Figure 4.5: Overlapping Year 3 cost of production distributions for the production scenarios.	87
Figure 4.6: Probability spread of third year net income for the production scenarios showing extreme P(5) and P(95) values for PS1 and PS2.	88
Figure 4.7: Comparison of net present value (7% discount factor, 15 Yr. period) distributions for the alternative production scenarios illustrating a AU\$100 million range between PS1 (P5) and PS2 (P95) projections.	89
Figure 4.8: The impact of Amoebic Gill Disease on sea-pen cost of production (COP) projections.	90
Figure 4.9: Sensitivity of steady state (Year 3) net income to the impact of one-off events.	92
Figure 4.10: Influence of the assessed risk premium (through discount rate selection) on calculated long-term NPV investment returns.	94
Figure 4.11: Atlantic salmon RAS capital costs (AU\$) per kg production capacity, for previous economic studies, presentations and industry data, and for the current study.	96
Figure 4.12: Comparison of cost of Atlantic salmon production (AU\$/kg) - taken from economic studies, presentations, industry data and pers. comm. sources. Dotted lines indicate comparative groupings by growout technology type, excluding Tasmanian AGD data points.	97
Figure 5.1: Outline of data collection and feedback to the participants during the three iterative rounds of the Delphi Context scenario research.	112
Figure 5.2: Ranking of the likelihood for each of the RAS narrative scenarios over each of three timeframes (2015-2020, 2020-2025 and 2025-2030) as identified by Round 3 participants ($n=30$).	126
Figure 5.3: Round 3 interview participant's ($n=30$) assessment of the likelihood (likely and very likely ratings combined) of RAS technology being adopted by 2030 for the growout of Atlantic salmon for each of the four scenarios.	127
Figure 5.4: Correlation of Australian (X) and Rest of World (■) participant's ($n=30$) assessment of the change factors' influence on adoption of land-based RAS for the growout of Atlantic salmon. Data points joined to assist visual interpretation.	131
Figure 5.5: Correlation between Manager's (○) and Executive or Director's (◆) assessment of the change factors influence on adoption of land-based RAS	

for the growout of Atlantic salmon. Data points joined to assist visual interpretation.	132
Figure 6.1: A stylised example of Signed digraph and 'Community' matrix representations for aquaculture environmental regulation. Positive direct effects are shown by arrows (or +1 in matrix), and negative direct effects by lines ending in a circle (or -1). Self-effects are depicted by lines returning to the source variable, which may be either positive or negative. Perturbations (increases) occur down the matrix columns, whilst responses (predictions) to perturbations are read across rows.	148
Figure 6.2: Community and Adjoint matrix representations of four variables within a 14 variable system (depicted in Appendix 6A). The Community matrix identifies the direct interactions between the variables. The Adjoint matrix shows the direction of change (increase or decrease) and the net number of effects (direct and indirect) that contribute to a variable's response.	149
Figure 6.3: The various levels of system stability a) illustrating a stable system, dominated by negative feedback cycles; b) an unstable Class 1 conditional system dominated by positive feedback cycles and c) an unstable Class 2 system dominated by higher level feedback oscillatory behaviour.	150
Figure 6.4: Mind-map representation of the macro and micro business environment factors, trends and drivers (grouped by PESTEL) operating on the Atlantic salmon Industry. The representation formed the basis for construction of the signed digraph models.	152
Figure 6.5: Core signed digraph Model A: a generic salmon aquaculture business environment, with regulation, economic and supply sub-sectors identified. Each of the 14 variables is represented by a grey circle, links ending in an arrow denote a positive direct effect from one variable to another, links ending in a filled circle denote a negative direct effect, and a link connecting a variable to itself denotes a self-effect. All changes are from a positive input to the variables, and are described in Table 6.3.	155
Figure 6.6: Sign digraph Model B of Atlantic salmon aquaculture production [Tasmanian Case Study]. Reflecting removal (greyed out) of the commercial fisheries contribution (Fi) and the availability of imports (Imp) in the domestic market place. All changes are from a positive input to the variables.	157
Figure 6.7: Principal aquaculture production regulation mechanisms. Spatial regulation operates through increased production reducing the availability of sites for expansion. Heightened environmental (biological) loadings impart a regulatory response; and societal concerns induce a tightening of production regulations through political interaction.	159

- Figure 6.8: Expanded model of the Cost of Production (COP) illustrating the absence of feedback loops and the linearity of the sub-system. The model includes operational (OPEX) and capital (CAPEX) categories of Financial Costs (FC) and the food conversion, mortality and growth performance constituents of Production Efficiency (PE). Links ending in an arrow denote a positive direct effect from one variable to another, links ending in a filled circle denote a negative direct effect, and a link connecting a variable to itself denotes a self-effect. A square annotated with a +/- denotes an effect that can be either positive or negative depending on certain conditions (or a tipping point). All changes are from a positive input to the variables. 161
- Figure 6.9: Signed digraph models depicting increasing system complexity of Atlantic salmon aquaculture production within a region or country as an industry matures. Evolutionary direct effects are highlighted in black, a dotted line indicating optional developments. 166
- Figure 6.10: Signed digraph representation of a simultaneous perturbation to Tasmanian aquaculture production through adopting an Offshore (OFF) expansion strategy. The direct effect on environmental loadings (EnvLo), depicted by the dashed-line, was evaluated in perturbation scenario I, and excluded in scenarios II and III (Table 6.6), and the negative spatial constraint (Sp Con) link omitted in scenario III. 168
- Figure 6.11: Signed digraph representation of a simultaneous perturbation to Tasmanian aquaculture production through adopting an IMTA expansion strategy. The dashed-lined refers to direct effects on production efficiency (PE). A financial cost (FC) perturbation was included in scenario IV and excluded in V, Table 6.6. 169
- Figure 6.12: Signed digraph model of a simultaneous perturbation to Tasmanian aquaculture production through adopting land-based RAS. The direct effect on environmental loadings (EnvLo) was evaluated in scenario VI and the uncertainty associated with obtaining a social licence to operate in scenarios VII, VIII and IX (Table 6.6). 170
- Figure 6.13: Compiled perturbation responses from the scenario Adjoint matrices of the comparative strength of the transmitted direct and indirect feedback cycles from running the Atlantic salmon Model B [Tasmanian Industry Case Study] with alternative technology adoption options and under specified perturbations (Figures 6.10 to 6.12, and Table 6.6). 172
- Figure 6.14: Signed digraph sub-models illustrating potential interactions between demand (Dem) and social license challenge (SLC) through population (Pop) and per-capita (Per Cap) driven increases in demand. Sub-model A, represents where no societal concerns materialise as population and per capita consumption grow. Sub-model B scenario is where rising per capita

consumption, driven by an increasing affluent consumer base, is accompanied with heightened concerns over the impact of aquaculture; however there is (as yet) no impact on demand. In sub-model C demand growth driven by an aging population is accompanied by a rise in social license challenges, which in turn acts to reduce demand.	174
Figure 7.1: Representation of the targeted analytical approaches explored in this thesis, illustrating the potential fit against tactical and strategic decision time horizons.	184
Figure 7.2: The dimensions of sustainability in salmon growout technology selection.	190
Figure 8.1: Tasmanian farmed salmonid production 2003 – 2013.	195
Figure 8.2: Salmon farming marine growout sites in Tasmania (February 2013) showing the number of leases, leased acreage (hectares) and percentage of the total leased area.	196
Figure 8.3: Comparison of international Atlantic salmon producer's seawater growout phase water temperatures illustrating Tasmania's higher temperatures.	197
Figure 8.4: Comparison between Australian wild caught and aquaculture tonnages 2003 – 2013 showing increasing aquaculture share and declining wild catch.	198
Figure 8.5: Comparison of the Atlantic salmon market in Australia. Domestic market and import volumes (tonnes), 2008 -2013.	199
Figure 8.6: Australian domestic and export market (tonnes) for Tasmanian Atlantic salmon sales 2008 – 2013.	200
Figure 8.7: The principle of extractive aquaculture associated with salmon aquaculture sea-pens.	223
Figure 8.8: AgriMarine System Overview.	225
Figure 8.9: Langstan Laks Atlantic Salmon Growout System and Production Flow.	227
Figure 8.10: Aquadome Prototype Floating Closed Containment System.	229
Figure 8.11: Layout of Cooke Aquaculture's Friar's Head IMTA Site.	231
Figure 8.12: Friar's Head Mussel and Macroalgae Culture.	232
Figure 8.13: Deep Sea sites proposed within the Irish Fisheries Board Galway Bay development.	233
Figure 8.14: Marine Harvest Scotland's Hellisay site.	235
Figure 8.15: Namgis RAS Facility Module Design.	238
Figure 8.16: SEAfood System Illustrative Configuration and Species Spatial Relationship.	239

Tables

Table 1.1:	Major research aims and how the thesis chapters relate to them.	7
Table 2.1:	Numbers of the individual participants who took part in the situational analysis data collection interviews - business environment (Chapter 2) and technology selection (Chapter 3) - showing a breakdown of the principal focus of the discussion, organisational category, country, and position or level.	17
Table 2.2:	Comparison of the principal PESTEL factors affecting Atlantic salmon production development in five internationally distinct farming regions as identified in the country studies (Appendix 2F).	21
Table 2.3:	Participants ($n=27$, Business Environment focused interviewees) ranking of the top three PESTEL drivers that they considered would influence the future development of the Atlantic salmon aquaculture industry.	22
Table 3.1:	Production technology case-studies selected to visit and interview for this research (FCC - Floating Closed Containment, RAS - Recirculating Aquaculture Systems, IMTA – Integrated Multi-Trophic Aquaculture).	40
Table 3.2:	Near-term business development criteria for the Tasmanian industry derived through the business environment situational analysis and the technology characterisation.	43
Table 3.3:	Near-term operational assumptions developed through discussion with the Tasmanian industry.	43
Table 3.4:	Primary technology selection criteria (as identified through stakeholder surveys) categorised as economic, societal, technical and environmental factors. Showing comparison of the principal advantages and disadvantages of alternative production systems relative to inshore sea-pen production. A tick ✓ denotes where a characteristic of a particular technology is considered advantageous to adoption, a cross ✕ unfavourable, and when enclosed within parentheses the advantage or disadvantage is circumstance specific; n/a – considered not applicable.	46
Table 3.5:	Key categorical drivers underpinning the decision to invest in a particular growout technology as identified in the technology case-studies.	47
Table 3.6:	Technology adoption challenges and risks identified by the interview participants, with number of times raised during the 90 interviews. Brackets indicate where predominantly associated with a specific technology.	50
Table 4.1:	Principal input variables and assigned stochastic distributions.	66
Table 4.2:	Sea-pen equipment specifications modelled PS1 and PS2.	67

Table 4.3:	Straight-line depreciation profiles for illustrative capital items assumed in the modelling.	71
Table 4.4:	Thermal Growth Coefficient (TGC) and water temperature (°C) profile at 5m depth.	73
Table 4.5:	Capital costs modelled for inshore sea pens scenario (PS1).	74
Table 4.6:	Capital costs modelled for production scenario 2 – High-Energy / Remote Site sea pens.	75
Table 4.7:	Capital costs modelled for production scenario 3 – Freshwater RAS.	75
Table 4.8:	Capital costs modelled for production scenario 4 – Freshwater RAS system and High-Energy / Remote Site sea-pens.	76
Table 4.9:	Deterministic model operating budget showing Year 3 steady state net income.	77
Table 4.10:	Steady state labour requirements post month six ramp-up.	78
Table 4.11:	Comparison of the biological outputs from the deterministic biological modelling for the three alternative technologies compared to the baseline inshore pens scenario for a 6,000 t HOG production.	80
Table 4.12:	Comparison of the Year 3 Cost of Production split (%) illustrating dominance of feed, smolt and overhead costs (deterministic modelling).	81
Table 4.13:	Comparison of the fiscal outputs from the deterministic modelling for the three alternative technologies compared to baseline inshore pens scenario for a 6,000 t HOG production (shown graphically in figures 4.3(a) to (d)).	82
Table 4.14:	Forecast parameters and statistics generated from Monte Carlo simulations (25,000 iterations).	85
Table 4.15:	The impact of AGD on the inshore sea-pen production. Illustrating the reductions in COP and capital expenditure, and increased fifteen-year NPV returns against the baseline scenario (PS1), should there be no impact.	91
Table 4.16:	The impact of AGD on the High-Energy / Remote Site sea-pen production scenario PS2. Illustrating the increases in COP and capital expenditure, and reduced NPV, for bathing barge and wellboat treatment regimes.	91
Table 4.17:	Increases to freshwater RAS profitability through potential cost and revenue initiatives, showing incremental 3rd year net income against PS3 baseline.	93
Table 5.1:	Makeup of the participants in each round of the stakeholder engagement.	114

Table 5.2:	Common drivers for the adoption of land-based Atlantic salmon growout RAS, identified as unsolicited responses raised by participants ($n=31$) during Delphi Round 1.	117
Table 5.3:	Societal trends and perceptions identified in the initial Delphi round, that participants ($n=31$) considered could influence adoption of RAS technology for Atlantic salmon growout. Trends have been grouped by themes and then by clusters, and a judgement made of the contribution (positive, negative or neutral) that the trends could make to future adoption.	119
Table 5.4:	Change factors and associated descriptions derived through the initial round of stakeholder discussions that could influence the adoption of RAS technology for Atlantic salmon growout.	121
Table 5.5:	Assessment of the likelihood of RAS technology being adopted for Atlantic salmon growout by 2030 in each of the four scenarios. Categorised by the organisational sector of the interview participants in Round 3 ($n=30$).	127
Table 5.6:	Participants ranking of the comparative influence of the change factors on the adoption of land-based RAS technology for the growout of Atlantic salmon. Change factors ranked by median, and then variance, influence scores. PESTEL (Political, Economic, Societal, Technical, Environmental and Legal or Regulatory) categories enable comparison of the results with the results of Chapter 3.	129
Table 5.7:	Mean influence levels of the change factors as identified by the participant's ($n=30$) organisational sector. The top two (ranked by mean and then variance) for each sector are identified with a circle, and the lowest with a square. Where mean and variance are the same for an individual change factor both occasions have been identified.	130
Table 6.1:	Definitions of fourteen key variables identified from the mind-mapping exercise (names and numbers are used consistently within all models, and in parentheses in the text).	153
Table 6.2:	Qualitative signed digraph models developed to reflect a range of salmon aquaculture production business environments and the stages of industry development.	154
Table 6.3:	Sign of the direct effects between the supply, regulation and economic variables influencing salmon aquaculture production (Figure 6.5). The numbers corresponding to the variables defined in Table 6.1.	156
Table 6.4:	Categorised feedback cycles for the signed digraph models, identifying the process, feedback sign, constituent variables and links. Illustrating increasing complexity with alternative sources of supply and industry maturity. The cycles have been allotted arbitrary starting points of	

	aquaculture production (1), sales price (6) and societal concerns (5) and the presence of an individual loop within a model distinguished by a tick / check. Variables defined and numbered as in Table 6.1.	162
Table 6.5:	Comparative system stability of the signed digraph models detailing Class of Stability, Weighted Feedback (wFn), and Weighted Determinant (wDn) Ratio to Class 2 stability threshold.	163
Table 6.6:	Technology adoption perturbations scenarios applied to a signed digraph of Atlantic salmon aquaculture in Tasmania (represented by Model B) showing perturbation scenario reference number (I to IX), expansion type (Offshore, IMTA or Land-based RAS), and perturbed variables. A positive perturbation of a variable is indicated by + sign, negative perturbation by - sign, and where a variable is not perturbed by a blank.	167
Table 6.7:	Predicted sign responses for twelve key variables from running the Atlantic salmon Model B [Tasmanian Industry Case Study] with alternative technology adoption options and under specified perturbations (Figures 6.10 to 6.12, and Table 6.6). Ambiguous predictions with a relatively high probability of sign determinacy (>0.85) are enclosed in parentheses; a "?" denotes those with a low probability where knowledge about the relative interaction would be required to determine the response direction; and a sign encased within square brackets depicts where a supporting condition, referenced by the superscript, has been used to interpret the lower probability ambiguity. A zero indicates no response predicted.	171
Table 8.1:	Tasmanian Salmonid Growers Association's Strategic Plan Metrics.	200
Table 8.2:	Sea state (Hs) limits to routine fish husbandry in marine sea-pens derived through discussions with manufacturers and operators.	219

LIST OF ABBREVIATIONS

AGD	Amoebic Gill Disease
ASC	Aquaculture Stewardship Council
CAGR	Compound Average Growth Rate
CAPEX	Capital Expenditure
CPM	Competitive Profile Matrix
CRC	Australian Seafood Cooperative Research Centre
COP	Cost Of Production
DCF	Discounted Cash Flow
DFO	Department of Fisheries & Oceans, Canada
DPIPWE	Department of Primary Industries, Parks, Water and Environment, Tasmania
EBIT	Earnings Before Interest and Tax
EIS	Environmental Impact Statement
ENGO	Environmental Non Governmental Organisation
FAO	Food and Agricultural Organisation
FCC	Floating Closed Containment
FCR _b	Biological Feed Conversion Ratio
FCR _e	Economic Feed Conversion Ratio
FRDC	Fisheries Research and Development Corporation, Australia
FRP	Fibre Reinforced Plastic
FTE	Full Time Equivalent
HOG	Head On Gutted
H _s	Significant Wave Height (mean wave height, trough to crest of the highest 1/3 of the waves)
ISFA	International Salmon Farmers Association
IMTA	Integrated Multi Trophic Aquaculture

IRR	Internal Rate of Return
NPV	Net Present Value
OPEX	Operational Expenditure
PESTEL	Political, Economic, Social, Technological, Environmental and Legal
RAS	Recirculating Aquaculture System(s)
ROE	Return On Equity
ROI	Return On Investment
ROW	Rest Of the World
SBP	Selective Breeding Programme
SEPA	Scottish Environmental Protection Agency
SME	Subject Matter Expert
SOPs	Standard Operating Procedures
SSPO	Scottish Salmon Producers Organisation
SWOT	Strengths, Weaknesses, Opportunities and Threats
TGC	Thermal Growth Coefficient
TSGA	Tasmanian Salmonid Growers Association