# Contents

**Preface** ix

1 **Introduction** 1

2 **The Production Process in Aquaculture** 7
   2.1 Salmon production 9
      2.1.1 Biological system 9
      2.1.2 The grow-out phase 12
      2.1.3 The physical system 15

Bibliography 16

3 **The Supply of Salmon** 17
   3.1 Farmed salmon production 17
      3.1.1 Norway 18
      3.1.2 Chile 23
      3.1.3 United Kingdom 26
      3.1.4 Canada 29
      3.1.5 Other farmed salmon producers 30
   3.2 Wild salmon production 31
   3.3 Regulation of salmon aquaculture 34
      3.3.1 Norway 34
      3.3.2 Scotland 36
      3.3.3 Chile 38
   3.4 The growth of large multinational companies 39

Bibliography 41

4 **Productivity Growth and Technological Change** 43
   4.1 Declining costs 43
   4.2 Scale 45
   4.3 Structure of production costs 48
   4.4 Smolt production 51
   4.5 Improved feed quality 52
   4.6 Diseases and increased survival rates 53
   4.7 Breeding 55
   4.8 Cycles in profitability 56
   4.9 Catching up: regional differences 58
   4.10 Productivity development in Norway relative to other producers 59
   4.11 Cost reductions in the supply chain 62

Bibliography 63
5 Environmental Issues 65
5.1 The fish meal trap 65
  5.1.1 Fisheries management 66
  5.1.2 The markets for oil meals 69
  5.1.3 Concluding remarks on the fish meal trap 72
5.2 Local issues 73
  5.2.1 Organic waste 74
  5.2.2 Antibiotics and chemicals 76
  5.2.3 Salmon escapees and sea lice 78
  5.2.4 Concluding remarks 80
Bibliography 80

6 Markets for Salmon 83
6.1 The European Union markets 84
  6.1.1 France 85
  6.1.2 Germany 88
  6.1.3 United Kingdom 89
  6.1.4 Spain 90
  6.1.5 Italy 91
  6.1.6 Denmark 92
  6.1.7 Poland 93
6.2 The Japanese salmon market 94
  6.2.1 Japanese salmon supply 97
  6.2.2 Outlook for the Japanese salmon market 99
6.3 The United States salmon market 100
  6.3.1 US seafood consumption 100
  6.3.2 Imported fresh and frozen salmon 103
  6.3.3 Market trends 105
6.4 The Russian market 105
6.5 Price development 107
  6.5.1 Real versus nominal price 108
  6.5.2 Exchange rates 109
  6.5.3 Prices in different markets 110
  6.5.4 Prices in different weight classes and for different product forms 113
Bibliography 116

7 Competitiveness and Market Structure 119
7.1 What is a market? 119
  7.1.1 Market size 121
  7.1.2 Market power 122
7.2 The salmon market 123
  7.2.1 Pacific salmon 124
  7.2.2 The early development of the Atlantic salmon market 125