

References

- Dichmont C. M., Pascoe S., Kompas T., Punt A. E., Deng R. (2010). On implementing maximum economic yield in commercial fisheries. *Proceedings of the National Academy of Sciences* **107**, 16-21.
- DPI&F (2006) 'Fisheries Long-Term Monitoring Program Sampling Protocol - Eastern King Prawn (2007 onwards) Section 1.' Queensland Department of Primary Industries and Fisheries, Brisbane.
- Dredge M., Gardiner P. (1984). Survey discovers new central Qld prawning grounds. *Australian Fisheries* **43**, 16-19.
- Driml S., McBride B. (1982). Economic analysis of recreational boating in Southern Moreton Bay. *Operculum* **5**, 194-198.
- Fina M. (2011). Evolution of catch share management: Lessons from catch share management in the North Pacific. *Fisheries* **36**, 164-177.
- Fousekis P. (2002). Distance vs. ray functions: an application to the inshore fishery of Greece. *Marine Resource Economics* **17**, 251-267.
- Francis R. I. C. C. (1988). Maximum likelihood estimation of growth and growth variability from tagging data. *New Zealand Journal of Marine and Freshwater Research* **22**, 43-51.
- GenStat (2007) GenStat 12th Edition. In. (Lawes Agricultural Trust (Rothamsted Experimental Station))
- Glaister J. P. (1978). The impact of river discharge on distribution and production of the school prawn *Metapenaeus macleayi* (Haswell) (Crustacea: Penaeidae) in the Clarence River region, northern New South Wales. *Australian Journal of Marine and Freshwater Research* **29**, 331-23.
- Glaister J. P. (1991) 'East coast trawl fishery situation paper.' Queensland Fish Management Authority.
- Glaister J. P., Lau T., McDonall V. C. (1987). Growth and migration of tagged eastern Australian king prawns, *Penaeus plebejus* Hess. *Australian Journal of Marine and Freshwater Research* **38**, 225-242.
- Glaister J. P., Montgomery S. S., McDonall V. C. (1990). Yield-per-recruit analysis of eastern king prawns, *Penaeus plebejus* Hess, in eastern Australia. *Australian Journal of Marine and Freshwater Research* **41**, 175-197.
- Glaister J. P., Pond P. C., Storey J. L. (1993) 'Framework for management for the east coast trawl fishery.' Queensland Fish Management Authority.
- Grafton Q. (2000). Governance of the Commons: A Role for the State? *Land Economics* **76**, 504-517

References

- Grafton R. Q. (1996). Individual transferable quotas: theory and practice. *Reviews in Fish Biology and Fisheries* **6**, 5-20.
- Grafton R. Q. (2005). Social capital and fisheries governance. *Ocean & Coastal Management* **48**, 753-766.
- Grafton R. Q., Arnason R., Bjørndal T., Campbell D., Campbell H. F., Clark C. W., Connor R., Dupont D. P., Hannesson R., Hilborn R., Kirkley J. E., Kompas T., Lane D. E., Munro G. R., Pascoe S., Squires D., Steinshamn S. I., Turrís B. R., Weninger Q. (2006). Incentive-based approaches to sustainable fisheries. *Canadian Journal of Fisheries and Aquatic Sciences* **63**, 699-710.
- Graham M. H. (2003). Confronting Multicollinearity in Ecological Multiple Regression. *Ecology* **84**, 2809-2815.
- Greenville J., Hartmann J., MacAulay T. G. (2006). Technical efficiency in input-controlled fisheries: The NSW Ocean Prawn Trawl Fishery. *Marine Resource Economics* **21**, 159-179.
- Grey D. L., Dall W., Baker A. (1983) 'A guide to the Australian Penaeid Prawns.' (Department of Primary Production, Northern Territory Government: Darwin)
- Gribble N., Dredge M. (1994). Mixed-species yield-per-recruit simulations of the effect of seasonal closure on a central Queensland coastal prawn trawling ground. *Canadian Journal of Fisheries and Aquatic Sciences* **51**, 998-1011.
- Harley S. J., Myers R. A., Dunn A. (2001). Is catch-per-unit-effort proportional to abundance? *Canadian Journal of Fisheries and Aquatic Sciences* **58**, 1760-1772.
- Hatcher A. C. (1997). Producers' organizations and devolved fisheries management in the United Kingdom: Collective and individual quota systems. *Marine Policy* **21**, 519-533.
- Haysom N. M. (1975) The Moreton Bay permit system. An exercise in licence limitation. In 'First Australian National Prawn Seminar'. (Ed. PC Young) pp. 240-45. (Australian Government Publishing Service: Canberra: Brisbane)
- Hekel H., Ward W. T., Jones M., Searle D. E. (1979) 'Geological development of northern Moreton Bay.'
- Henry G. W., Lyle J. M. (2003) 'The National Recreational and Indigenous Fishing Survey: A Fisheries Action Program Project.' Natural Heritage Trust, Canberra.
- Herrero I., Pascoe S. (2003). Value versus Volume in the Catch of the Spanish South-Atlantic Trawl Fishery. *Journal of Agricultural Economics* **54**, 325-341.
- Hilborn R., Orensanz J. M., Parma A. M. (2005a). Institutions, incentives and the future of fisheries. *Philosophical Transactions of the Royal Society B-Biological Sciences* **360**, 47-57.

References

Hilborn R., Orensanz J. M., Parma A. M. (2005b). Institutions, incentives and the future of fisheries. *Philosophical Transactions of the Royal Society B: Biological Sciences* **360**, 47-57.

Hilborn R., Walters C. J. (1992) 'Quantitative Fisheries Stock Assessment: Choice Dynamics and Uncertainty.' (Chapman and Hall: New York)

Hill B. J. (1985) Effect of temperature on duration of emergence, speed of movement, and catchability of the prawn *Penaeus esculentus*. In 'Second Australian National Prawn Seminar'. Brisbane, Australia. (Ed. PC Rothlisberg, Hill, B. J., Staples, D. J.) pp. 77-83. (NPS2, Cleveland, Queensland)

Hill B. J., Pashen A. J. (1986) Management of the Queensland east coast otter trawl fishery: An historical review and future options. In 'Fisheries management: Theory and practice in Queensland'. Griffith University. (Ed. TJA Hundloe) pp. 146-66. (Griffith University)

Holland D. S., Ginter J. J. C. (2001). Common property institutions in the Alaskan groundfish fisheries. *Marine Policy* **25**, 33-42.

Huang H., Leung P. (2007). Modeling protected species as an undesirable output: The case of sea turtle interactions in Hawaii's longline fishery. *Journal of Environmental Management* **84**, 523-533.

Hyland S. J. (1987) An investigation of the nekto-benthic organisms in Logan River and Moreton Bay, Queensland with an emphasis on penaeid prawns. University of Queensland.

Hyland S. J., Butler C. T. (1989). The distribution and modification of mangroves and saltmarsh-claypans in southern Queensland, June 1988. *QDPI Information Series Q189004*, 68pp.

Hyland S. J., Courtney A. J., Butler C. T. (1989). Distribution of seagrass in the Moreton Region from Coolangatta to Noosa. *QDPI Information Series Q189010*, 1-42.

Ives M. C., Scandol J. P. (2007). A Bayesian analysis of NSW eastern king prawn stocks (*Melicertus plebejus*) using multiple model structures. *Fisheries Research* **84**, 314-327.

Jentoft S. (1989). Fisheries co-management: Delegating government responsibility to fishermen's organizations. *Marine Policy* **13**, 137-154.

Jentoft S., McCay B. (1995). User participation in fisheries management: lessons drawn from international experiences. *Marine Policy* **19**, 227-246.

Jentoft S., McCay B. J., Wilson D. C. (1998). Social theory and fisheries co-management. *Marine Policy* **22**, 423-436.

References

- Kangas M., Sporer E., O' Donoghue S., Hood S. (2008) Co-management in the Exmouth Gulf Prawn Fishery with comparison to the Shark Bay Prawn Fishery. In 'Case studies in fisheries self-governance. FAO Fisheries Technical Paper 504'. (Eds R Townsend, R Shotton and H Uchida) pp. 231-244. (FAO: Rome)
- Keating J. A., Watson R. A., Sterling D. J. (1990) 'Reproductive biology of *Penaeus esculentus* (Haswell, 1879) and *Metapenaeus endeavouri* (Schmitt, 1926) in Torres Strait.' Qld Dept Primary Industries Information Series, Qld Dept of Primary Industries, QI90018, Brisbane, Australia.
- Kimura D. K. (1978). Logistic model for estimating selection ogives from catches of codends whose ogives overlap. *J. Cons. int. Explor. Mer* **38**, 116-119.
- Kirkegaard I., Walker R. H. (1969) 'Synopsis of biological data on the tiger prawn *Penaeus esculentus* Haswell, 1879.'
- Kirkegaard I., Walker R. H. (1970a) 'Synopsis of biological data on the eastern king prawn *Penaeus plebejus* Hess, 1865.'
- Kirkegaard I., Walker R. H. (1970b) 'Synopsis of biological data on the greentail prawn *Metapenaeus bennettiae* Racel and Dall, 1965.' Commonwealth Scientific and Industrial Research Organisation. Division of Fisheries and Oceanography Fisheries Synopsis No. 6.
- Kirkley J., Squires D., Strand I. E. (1998). Characterizing Managerial Skill and Technical Efficiency in a Fishery. *Journal of Productivity Analysis* **9**, 145-160.
- Kirkley J. E., Squires D., Strand I. E. (1995). Assessing Technical Efficiency in Commercial Fisheries: The Mid-Atlantic Sea Scallop Fishery. *American Journal of Agricultural Economics* **77**, 686-697.
- Kirkman H. (1978). Decline of seagrass in northern areas of Moreton Bay, Queensland. *Aquatic Botany* **5**, 63-76.
- Kirkwood G. P., Somers I. F. (1984). Growth of two species of tiger prawn, *Penaeus esculentus* and *Penaeus semisulcatus*, in the Western Gulf of Carpentaria (Australia). *Australian Journal of Marine and Freshwater Research* **35**, 703-712.
- Kitts A., Thunberg E., Robertson J. (2001). Willingness to participate and bids in a fishing vessel buyout program: A case study of New England groundfish. *Marine Resource Economics* **15**, 221-232.
- Kompas T., Che T. N., Grafton R. Q. (2004). Technical efficiency effects of input controls: evidence from Australia's banana prawn fishery. *Applied Economics* **36**, 1631-1641.
- Kutkuhn J. H. (1966). Dynamics of a penaeid shrimp population and management implication. . *Fisheries Bulletin* **65**, 313-318.

References

Langdon S. J. (2008). The Community Quota Program in the Gulf of Alaska: A Vehicle for Alaska Native Village Sustainability? . *American Fisheries Society Symposium* **68**, 155-194.

Lavery S., Keenan C. (1995) 'Genetic analyses of crustacean stock structure and stock size.' Queensland Department of Primary Industries Conference and Workshop Series.

Lavery S., Keenan C. P. (1994) Genetic analyses of crustacean stock structure and stock size. In 'Proceedings of the Workshop on Spawning Stock - Recruitment Relationships (SRRs) in Australian Crustacean Fisheries'. Joondoburri Conference Centre, Bribie Island, Queensland. (Eds AJ Courtney and MG Cosgrove) pp. 116-26. (Queensland Department of Primary Industries Conference and Workshop Series)

Leal D. (1998). Community-Run Fisheries: Avoiding the “Tragedy of the Commons”. *Population & Environment* **19**, 225-245.

Lee H.-H., Maunder M. N., Piner K. R., Methot R. D. (2011). Estimating natural mortality within a fisheries stock assessment model: An evaluation using simulation analysis based on twelve stock assessments. *Fisheries Research* **109**, 89-94.

Legendre P., Legendre L. (1998) 'Numerical ecology.' (Elsevier)

Libecap G. D. (2007). Assigning property rights in the common pool: Implications of the prevalence of first-possession rules for ITQs in fisheries. *Marine Resource Economics* **22**, 407-423.

Lloyd-Jones L. R., Wang Y. G., Courtney A. J., Prosser A. J., Montgomery S. S. (2012). Latitudinal and seasonal effects on growth of the Australian eastern king prawn (*Melicertus plebejus*). *Canadian Journal of Fisheries & Aquatic Sciences* **69**, 1-14.

Loneragan N. R., Bunn S. E. (1999). River flows and estuarine ecosystems: implications for coastal fisheries from a review and a case study of the Logan River, southeast Queensland. *Australian Journal of Ecology* **24**, 431-440.

Loneragan N. R., Kenyon R. A., Haywood M. D. E., Staples D. J. (1994). Population dynamics of juvenile tiger prawns (*Penaeus esculentus* and *P. semisulcatus*) in seagrass habitats of the western Gulf of Carpentaria, Australia. *Marine Biology* **119**, 133-143.

Lucas C. (1974). Preliminary estimates of stocks of the king prawn, *Penaeus plebejus*, in south-east Queensland. *Australian Journal of Marine and Freshwater Research* **25**, 35-47.

Lucas C. (1975). A method for estimating mortality rates from tag recoveries when fishing is not constant. *Australian Journal of Marine and Freshwater Research* **26**, 75-9.

Mahévas S., Sandon Y., Biseau A. (2004). Quantification of annual variations in fishing power due to vessel characteristics: an application to the bottom-trawlers of

References

South-Brittany targeting anglerfish (*Lophius budegassa* and *Lophius piscatorius*). *ICES Journal of Marine Science* **61**, 71-83.

Masel J. M., Smallwood D. (2000a). Habitat usage by postlarval and juvenile prawns in Moreton Bay, Queensland, Australia. *Proc. R. Soc. Qld* **109**, 107-117.

Masel J. M., Smallwood D. (2000b). Indications of long term changes in the species composition and catch rates of postlarval and juvenile prawns in Moreton Bay. *Proc. R. Soc. Qld* **109**, 119-130.

Matulich S. C., Sever M. (1999). Reconsidering the initial allocation of ITQs: The search for a pareto-safe allocation between fishing and processing sectors. *Land Economics* **75**, 203-219

Maunder M. M., Punt A. E. (2004). Standardizing catch and effort data: a review of recent approaches. *Fisheries Research* **70**, 141-159.

Maxwell W. G. H. (1970). The sedimentary framework of Moreton Bay, Queensland. *Aust. J. Mar. Freshwat. Res.* **21**, 70-88.

Mayer D., Roy D., Robins J., Halliday I., Sellin M. (2005) Modelling zero-inflated fish counts in estuaries – a comparison of alternate statistical distributions. In 'International Congress on Modelling and Simulation 2005'. Brisbane. (Eds A Zerger and RM Argent) pp. 2581-2587. (Modelling and Simulation Society of Australia and New Zealand)

McConnell K. E., Price M. (2006). The lay system in commercial fisheries: Origin and implications. *Journal of Environmental Economics and Management* **51**, 295-307.

McPhee D. P., Mills M., Hundloe T. J. A., Buxton C. D., Knuckey I., Williams K. A. (2008) 'A participatory and coordinated fishing industry solution to the rezoning of the Moreton Bay Marine Park.' Fisheries Research and Development Corporation, Canberra.

Meeusen W., Van den Broeck J. (1977). Efficiency estimation from Cobb-Douglas production functions with composed error. *International Economic Review* **18**, 435-444.

Milford S. N., Church J. A. (1977). Physical oceanography of Moreton Bay, Queensland. *Report of the Department of Physics, University of Queensland February, 1977*, 1-35.

Mincher R. (2008) New Zealand's Challenger Scallop Enhancement Company: from reseeding to self-governance. In 'Case studies in fisheries self-governance'. (Eds R Townsend, R Shotton and H Uchida) pp. 307-321. (FAO: Rome)

Montgomery S. S. (1981). Tagging studies on juvenile eastern king prawns reveal record migration. *Australian Fisheries*, 13-14.

References

- Montgomery S. S. (1990). Movements of juvenile eastern king prawns, *Penaeus plebejus*, and identification of stock along the east coast of Australia. *Fisheries Research (Amsterdam)* **9**, 189-208.
- Montgomery S. S., Courtney A. J., Blount C., Die D. J., Cosgrove M. G., Stewart J. (2007). Patterns in the distribution and abundance of female eastern king prawns, *Melicertus plebejus* (Hess, 1865), capable of spawning and reproductive potential in waters off eastern Australia. *Fisheries Research* **88**, 80-87.
- Morris M. C., Bennett I. (1952). The life history of a penaeid prawn (*metapenaeus*) breeding in a coastal lake (Tuggerah New South Wales). *Proceedings of the Linnaean Society of New South Wales* **76**, 164-82.
- Moxon A. J., Quinn R. H. (1984) 'Economic survey of otter trawlers in south-east Queensland ' Queensland Department of Primary Industries, Brisbane
- Muallil R. N., Geronimo R. C., Cleland D., Cabral R. B., Doctor M. V., Cruz-Trinidad A., Ali P. M. (2011). Willingness to exit the artisanal fishery as a response to scenarios of declining catch or increasing monetary incentives. *Fisheries Research* **111**, 74-81.
- Mulley J. C., Latter B. D. H. (1981a). Geographic differentiation of Eastern Australian penaeid prawn populations. *Australian Journal Marine Freshwater Research* **32**, 889-95.
- Mulley J. C., Latter B. D. H. (1981b). Geographic differentiation of tropical Australian penaeid prawn populations. *Australian Journal Marine Freshwater Research* **32**, 897-906.
- Neville P. (2008) 'Co-management: Managing Australia's fisheries through partnership and delegation.' Fisheries Research and Development Corporation FRDC 2006/068.
- Newell B. S. (1971). The hydrological environment of Moreton Bay, Queensland, 1967-68. *CSIRO Division of Fisheries Technical Report* **30**, 1-33.
- O'Brien C. J. (1994). Population dynamics of juvenile tiger prawns *Penaeus esculentus* in south Queensland, Australia. *Marine Ecology Progress Series* **104**, 247-256.
- O'Connor C. (1979). Reproductive periodicity of a *Penaeus esculentus* population near low islets, Queensland Australia. *Aquaculture [Aquaculture]* **16**, 153-162.
- O'Neill M. F., Courtney A. J., Good N. M., Turnbull C. T., Yeomans K. M., Staunton Smith J., Shootingstar C. (2005) 'Reference point management and the role of catch-per-unit effort in prawn and scallop fisheries.' Department of Primary Industries and Fisheries, Fisheries Research and Development Corporation (FRDC) Final Report 1999/120 Brisbane, Queensland, Australia.

References

- O'Neill M. F., Courtney A. J., Turnbull C. T., Good N. M., Yeomans K. M., Smith J. S., Shootingstar C. (2003). Comparison of relative fishing power between different sectors of the Queensland trawl fishery, Australia. *Fisheries Research* **65**, 309-321.
- O'Neill M. F., Leigh G. M. (2006) 'Fishing power and catch rates in the Queensland east coast trawl fishery.' Department of Primary Industries and Fisheries, QI06051, Brisbane, Queensland, Australia.
- O'Neill M. F., Leigh G. M. (2007). Fishing power increases continue in Queensland's east coast trawl fishery, Australia. *Fisheries Research* **85**, 84-92.
- OECD (2006) Analysis of subsidies to decommissioning vessels and licence retirements in Australia. In 'Financial Support to Fisheries: Implications for Sustainable Development'. (Ed. OECD) pp. 345–377 (OECD Publishing: Paris)
- Okey T. A. (2003). Membership of the eight Regional Fishery Management Councils in the United States: are special interests over-represented? *Marine Policy* **27**, 193-206.
- Pascoe S., Andersen J. L., de Wilde J. W. (2001). The impact of management regulation on the technical efficiency of vessels in the Dutch beam trawl fishery. *European Review of Agricultural Economics* **28**, 187-206.
- Pascoe S., Coglán L. (2002). The contribution of unmeasurable inputs to fisheries production: An analysis of technical efficiency of fishing vessels in the English Channel. *American Journal of Agricultural Economics* **84**, 585-597.
- Pascoe S., Coglán L., Punt A. E., Dichmont C. M. (2010a) Impacts of vessel capacity reduction programs on efficiency in fisheries: the case of Australia's multispecies northern prawn fishery. In '2010 International Institute of Fisheries Economics and Trade (IIFET) conference'. Montpellier, France 13-16 July 2010. (Ed. A Schriver). (IIFET)
- Pascoe S., Koundouri P., Bjørndal T. (2007). Estimating targeting ability in multi-species fisheries: a primal multi-output distance function approach. *Land Economics* **83**, 382-397.
- Pascoe S., Proctor W., Wilcox C., Innes J., Rochester W., Dowling N. (2009). Stakeholder objective preferences in Australian Commonwealth managed fisheries. *Marine Policy* **33**, 750-758.
- Pascoe S., Punt A. E., Dichmont C. M. (2010b). Targeting ability and output controls in Australia's multi-species Northern Prawn Fishery. *European Review of Agricultural Economics* **37**, 313-334.
- Pascoe S., Thébaud O., Vieira S. (2011a) 'Quantitatively defining proxies for biological and economic reference points in data poor and data limited fisheries Milestone Report 4.' CSIRO, Brisbane.

References

- Pascoe S., Vieira S., Dichmont C. M., Punt A. E. (2011b). Optimal vessel size and output in the Australian northern prawn fishery: a restricted profit function approach. *Australian Journal of Agricultural and Resource Economics* **55**, 107-125.
- Pauly M. V. (1967). Clubs, commonality and the core: An integration of game theory and the theory of public goods. *Economica* **34**, 314-324.
- Penn J. W., Caputi N. (1986). Spawning stock-recruitment relationships and environmental influences on the tiger prawn (*Penaeus esculentus*) fishery in Exmouth Gulf, Western Australia. *Australian Journal of Marine and Freshwater Research* **37**, 491-505.
- Penn J. W., Caputi N., Hall N. G. (1995) Recruitment overfishing and management of penaeid fisheries: research, and management strategies developed for the recovery of Western Australian tiger prawn stocks. In 'Proceedings of the Workshop On Spawning Stock Recruitment Relationships (Srrs) in Australian Crustacean Fisheries, Department of Primary Industries, Brisbane, Qld (Australia), 1995'. (Eds AJ Courtney and MG Cosgrove) pp. 127. (Department of Primary Industries, Brisbane: Qld (Australia))
- Petitgas P., Cotter J., Trenkel V., Mesnil B. (2009). Fish stock assessments using surveys and indicators. *Aquatic Living Resources* **22**, 119-1.
- Pomeroy R. S., Berkes F. (1997). Two to tango: The role of government in fisheries co-management. *Marine Policy* **21**, 465-480.
- Pomeroy R. S., Rivera-Guieb R. (2006) 'Fishery Co-management: A Practical Handbook.' (CAB International: Wallingford)
- Pope J. A. (1966). Manual of methods for fish stock assessment. Part III, selectivity of fishing gear. *FAO (Food and Agriculture Organization of the United Nations) Fisheries Technical Paper* **41**, 50.
- Potter M. A. (1975) Movements of the eastern king prawn (*Penaeus plebejus*) in southern Queensland waters. In 'First Australian National Prawn Seminar'. (Ed. PC Young) pp. 10-17. (Australian Government Publishing Service: Canberra)
- Potter M. A., Dredge M. C. L. (1985) Deepwater prawn resources off southern and central Queensland. In 'Second Australian National Prawn Seminar'. (Eds PC Rothlisberg, BJ Hill and DJ Staples) pp. 221-29. (NPS2: Cleveland, Queensland)
- Pradhan N. C., Leung P. (2004). Modeling entry, stay, and exit decisions of the longline fishers in Hawaii. *Marine Policy* **28**, 311-324.
- Preston N. (1985) The effects of temperature and salinity on survival and growth of larval *Penaeus plebejus*, *Metapenaeus macleayi* and *M. bennettiae*. In 'Second Australian National Prawn Seminar'. (Eds PC Rothlisberg, BJ Hill and DJ Staples) pp. 31-40. (NPS2: Cleveland, Queensland)

References

- Properjohn M., Tisdell J. (2010) Results of a pilot travel cost study of the recreational use of Moreton Bay. In 'FishEcon Working Paper Series 1/10'. (University of Tasmania: Hobart)
- Punt A. E., Deng R. A., Dichmont C. M., Kompas T., Venables W. N., Zhou S., Pascoe S., Hutton T., Kenyon R., van der Velde T., Kienzle M. (2010). Integrating size-structured assessment and bioeconomic management advice in Australia's northern prawn fishery. *ICES Journal of Marine Science* **67**, 1785-1801.
- Quinn T. J., Deriso R. B. (1999) 'Quantitative Fish Dynamics.' (Oxford University Press)
- Racek A. A. (1959). Prawn investigations in eastern Australia. *Research Bulletin New South Wales State Fisheries* **6**, 1-57.
- Racek A. A., Dall W. (1965). Littoral Penaeinae (Crustacea:Decapoda) from northern Australia, New Guinea, and adjacent waters. *Verh. K. Ned. Akad. Wet. Afd. Natuurkd. Tweede Reeks* **56**, 1-116.
- Reid C., Campbell H. (1998) 'Bioeconomic analysis of the Queensland Beam Trawl Fishery.' Department of Economics, The University of Queensland, Brisbane.
- Restrepo V. R., Watson R. A. (1991). An approach to modeling crustacean egg-bearing fractions as a function of size and season. *Canadian Journal of Fisheries and Aquatic Sciences* **48**, 1431-1436.
- Robertson J. W. A., Coles R. G., Goeden G. B. (1985) Distribution patterns of commercial prawns and reproduction of *Penaeus esculentus* around the Wellesley Islands in the southeastern Gulf of Carpentaria. In 'Second Australian National Prawn Seminar'. (Eds PC Rothlisberg, BJ Hill and DJ Staples) pp. 71-5. (NPS2, Cleveland, Queensland, Australia: Brisbane)
- Robins C. J., Wang Y.-G., Die D. (1998). The impact of global positioning systems and plotters on fishing power in the northern prawn fishery, Australia. *Canadian Journal of Fisheries & Aquatic Sciences* **55**, 1645-1651.
- Roelfsema C. M., Phinn S. R., Udy N., Maxwell P. (2009). An integrated field and remote sensing approach for mapping seagrass cover, Moreton Bay, Australia. *Spatial Science* **54**, 45-62.
- Rothlisberg P. C., Church J. A., Fandry C. B. (1995). A mechanism for near-shore concentration and estuarine recruitment of post-larval *Penaeus plebejus* Hess (Decapoda, Penaeidae). *Estuarine, Coastal and Shelf Science* **40**, 115-38.
- Rothlisberg P. C., Jackson C. J. (1987). Larval ecology of penaeids of the Gulf of Carpentaria, Australia. II.* Hydrographic environment of *Penaeus merguensis*, *P. esculentus*, *P. semisulcatus* and *P.latisulcatus* zoeae. *Australian Journal of Marine and Freshwater Research* **38**, 19-28.

References

Rothlisberg P. C., Jackson C. J., Pendrey R. C. (1983). Specific identification and assessment of distribution and abundance of early penaeid shrimp larvae in the Gulf of Carpentaria, Australia. *Biological Bulletin (Woods Hole)* **164**, 279-298.

Rothlisberg P. C., Jackson C. J., Pendrey R. C. (1987). Larval ecology of penaeids of the Gulf of Carpentaria, Australia. I. Assessing the reproductive activity of five species of *Penaeus* from the distribution and abundance of the zoeal stages. *Australian Journal of Marine and Freshwater Research* **38**, 1-17.

Ruello N. V. (1975a). Geographical distribution, growth and breeding migration of the eastern Australian king prawn *Penaeus plebejus* Hess. *Australian Journal of Marine and Freshwater Research* **26**, 343-354.

Ruello N. V. (1975b) An historical review and annotated bibliography of prawns and the prawning industry in Australia. In 'First Australian National Prawn Seminar, 22-27 November, 1973'. (Ed. PC Young) pp. 305-341. (Australian Government Publishing Service, Canberra: Maroochydore, Queensland)

Salini J. (1987). Genetic variation and population subdivision in the greentail prawn *Metapenaeus bennettiae* Racek and Dall. *Australian Journal of Marine and Freshwater Research* **38**, 339-49.

Sandler T., Tschirhart J. (1997). Club theory: thirty years later. *Public Choice* **93**, 335-355.

Scotchmer S. (1985). Profit-maximizing clubs. *Journal of Public Economics* **27**, 25-45.

Scott A. (1955). The Fishery: The Objectives of Sole Ownership. *The Journal of Political Economy* **63**, 116-124.

Sen S. (2010). Developing a framework for displaced fishing effort programs in marine protected areas. *Marine Policy* **34**, 1171-1177.

Sen S., Raakjaer Nielsen J. (1996). Fisheries co-management: a comparative analysis. *Marine Policy* **20**, 405-418.

Sharma K. R., Leung P. (1999). Technical efficiency of the longline fishery in Hawaii: an application of a stochastic production frontier. *Marine Resource Economics* **13**, 259-74.

Simmonds E. J., MacLennan D. N. (2005) 'Fisheries acoustics: theory and practice.' (Blackwell Science)

Skilleter G. A., Olds A., Loneragan N. R., Zharikov Y. (2005). The value of patches of intertidal seagrass to prawns depends on their proximity to mangroves. *Marine Biology* **147**, 353-365.

References

Somers I. F. (1975) Growth of eastern king prawns (*Penaeus plebejus*). In 'First Australian National Prawn Seminar'. (Ed. PC Young) pp. 104-111. (Australian Government Publishing Service: Canberra)

Somers I. F. (1987). Sediment type as a factor in the distribution of commercial prawn species in the western Gulf of Carpentaria, Australia. *Australian Journal of Marine and Freshwater Research* **38**, 133-149.

Somers I. F. (1990). Manipulation of Fishing Effort in Australia's Penaeid Prawn Fisheries. *Australian Journal of Marine and Freshwater Research* **41**, 1-12.

Somers I. F., Kirkwood G. P. (1984). Movements of tagged tiger prawns, *Penaeus* spp., in the western Gulf of Carpentaria (Australia). *Australian Journal of Marine and Freshwater Research* **35**, 713-724.

Somers I. F., Poiner I. R., Harris A. N. (1987). A study of the species composition and distribution of commercial penaeid prawns of Torres Strait. *Australian Journal of Marine and Freshwater Research* **38**, 47-61.

Sparre P., Venema S. C. (1998) 'Introduction to tropical fish stock assessment. Part 1. Manual.' FAO Fisheries Technical Paper No, 306.1, Rev.2. Food and Agriculture Organisation, Rome, Italy.

Staples D. J., Vance D. J. (1987). Comparative recruitment of the banana prawn, *Penaeus merguensis*, in five estuaries of the south-eastern Gulf of Carpentaria, Australia. *Marine and Freshwater Research* **38**, 29-45.

Staples D. J., Vance D. J., Heales D. S. (1985) Habitat requirements of juvenile penaeid prawns and their relationship to offshore fisheries. In 'Second Australian National Prawn Seminar'. (Eds PC Rothlisberg, BJ Hill and DJ Staples) pp. 47-54. (NPS2, Cleveland, Queensland, Australia: Brisbane)

Staples D. J., Vance D. J., Loneragan N. R. (1995) Penaeid prawn recruitment variability: effect of the environment. In 'Workshop on spawning stock-recruitment relationships (SRRs) in Australian crustacean fisheries'. Joondoburri Conference Centre, Bribie Island, Queensland. (Eds AJ Courtney and MG Cosgrove) pp. 41-48. (Department of Primary Industries, Brisbane, Queensland (Australia))

Stephenson W., Chant D. C., Cook S. D. (1982). Trawled catches in northern Moreton Bay. II. Changes over two years. *Memoirs of the Queensland Museum* **20**, 387-399.

Sterbenz F. P., Sandler T. (1992). Sharing among Clubs: A Club of Clubs Theory. *Oxford Economic Papers* **44**, 1-19

Sterling D. J. (2005) Modelling the physics of prawn trawling for fisheries management. Ph.D. thesis, Curtin University of Technology, Western Australia.

Stollery K. R. (1988). Cooperatives as an alternative to regulation in commercial fisheries. *Marine Resource Economics* **4**, 289-304.

References

- Tanimoto M., Courtney A. J., O'Neill M. F., Leigh G. M. (2006) 'Stock assessment of the Queensland (Australia) east coast banana prawn (*Penaeus merguensis*) fishery.' Department of Primary Industries and Fisheries, QI06067, Brisbane, Queensland, Australia.
- Taylor-Moore N. (2000) 'Economic Analysis of the Queensland Fishing Fleet.' Queensland Department of Primary Industries, Brisbane.
- Taylor S. M., Webley J. A. C., Mayer D. G. (2011). Improving the precision of recreational fishing harvest estimates using two-part conditional general linear models. *Fisheries Research* **110**, 408414.
- Tingley D., Pascoe S., Coglán L. (2005). Factors affecting technical efficiency in fisheries: stochastic production frontier versus data envelopment analysis approaches. *Fisheries Research* **73**, 363-376.
- Townsend R., Shotton R., Uchida H. (2008) 'Case studies in fisheries self-governance.' FAO, Rome.
- Townsend R. E. (1995). Fisheries self-governance: corporate or cooperative structures? *Marine Policy* **19**, 39-45.
- Townsend R. E. (2010) Corporate governance of jointly owned fishing rights. In 'Handbook of marine fisheries conservation and management'. (Eds Q Grafton, R Hilborn, D Squires, M Tait and MJ Williams) pp. 520-531. (Oxford University Press: New York)
- Townsend R. E., McColl J., Young M. D. (2006). Design principles for individual transferable quotas. *Marine Policy* **30**, 131-141.
- Townsend R. E., Pooley S. G. (1995). Corporate management of the Northwestern Hawaiian Islands lobster fishery. *Ocean & Coastal Management* **28**, 63-83.
- Uchida H., Uchida E., Lee J.-S., Ryu J.-G., Kim D.-Y. (2010). Does self management in fisheries enhance profitability? Examination of Korea's coastal fisheries. *Marine Resource Economics* **25**, 37-59.
- Uchida H., Wilen J. E. (2004) Japanese coastal fisheries management and institutional designs: a descriptive analysis. In 'IIFET 2004 Japan'. Tokyo. (Ed. A Schriver) p. (CD Rom). (IIFET)
- Uchida H., Wilen J. E. (2007) How can fishery comanagement groups enhance economic performance? Hints from Japanese coastal fisheries management. In 'American Agricultural Economics Association Annual Meeting'. (Portland, OR, July 29-August 1, 2007)
- Vance D. J., Bishop J., Dichmont C. M., Hall N., McInnes K., Taylor B. R. (2003) 'Management of common banana prawn stocks of the Gulf of Carpentaria: separating the effects of fishing from those of the environment.' CSIRO, AFMA Project No. 98/0716.

References

- Vance D. J., Staples D. J. (1992). Catchability and sampling of three species of juvenile prawns in the Embley River, Gulf of Carpentaria, Australia. *Marine Ecology Progress Series* **87**, 201-213.
- Vance D. J., Staples D. J., Kerr J. D. (1985). Factors affecting year-to-year variation in the catch of banana prawns (*Penaeus merguensis*) in the Gulf of Carpentaria, Australia. *Journal du Conseil International pour l'Exploration de la Mer* **42**, 83-97.
- Venables W. N., Dichmont C. M. (2004). GLMs, GAMs and GLMMs: an overview of theory for applications in fisheries research. *Fisheries Research* **70**, 319-337.
- Venables W. N., Ripley B. D. (1999) 'Modern applied statistics with S-PLUS.' (Springer)
- Wang Y.-G. (1999). A maximum-likelihood method for estimating natural mortality and catchability coefficient from catch-and-effort data. *Marine and Freshwater Research* **50**, 307-311.
- Watson R. A., Restrepo V. R., Aiken D. E., Waddy S. L., Conan G. Y. (1995) Evaluating closed season options with simulation for a tropical shrimp fishery. In 'Shellfish Life Histories and Shellfishery Models. Selected Papers from a Symposium Held in Moncton, New Brunswick, 25-29 June 1990' pp. 391-398. (ICES: Copenhagen (Denmark))
- Watson R. A., Turnbull C. T. (1993). Migration and growth of two tropical penaeid shrimps within Torres Strait, Northern Australia. *Fisheries Research* **17**, 353-368.
- White T. (1975a) Factors affecting the catchability of a penaeid shrimp *Penaeus esculentus*. In 'First Australian National Prawn Seminar'. (Ed. PC Young) pp. 115-137. (Australian Government Publishing Service: Canberra)
- White T. F. (1975b) Population dynamics of the tiger prawn *Penaeus esculentus* Haswell 1879, (Crustacea: Penaeidae) in the Exmouth Gulf fishery, and implications for the management of the fishery. Ph.D. Thesis, University of Western Australia.
- Wingard J. D. (2000). Community transferable quotas: Internalizing externalities and minimizing social impacts of fisheries management. *Human Organization* **59**, 48-57.
- Young P. C. (1975) Preliminary observations on the environment and biology of juvenile king prawns *Penaeus plebejus* in Moreton Bay, Queensland. In pp. 18-36)
- Young P. C. (1978). Moreton Bay, Queensland: A Nursery Area for Juvenile Penaeid Prawns. *Australian Journal of Marine and Freshwater Research* **29**, 55-75.
- Young P. C., Carpenter S. M. (1977). Recruitment of Postlarval Penaeid Prawns to Nursery Areas in Moreton Bay, Queensland. *Australian Journal of Marine and Freshwater Research* **28**, 745-773.

References

Young P. C., Kirkman H. (1975). The seagrass communities of Moreton Bay, Queensland. *Aquatic Botany* **1**, 191-202.

Zhou S. J., Punt A. E., Deng R., Bishop J. (2011). Estimating multifleet catchability coefficients and natural mortality from fishery catch and effort data: comparison of Bayesian state-space and observation error models. *Canadian Journal of Fisheries and Aquatic Sciences* **68**, 1171-1181.

20 Appendix 1. Intellectual property

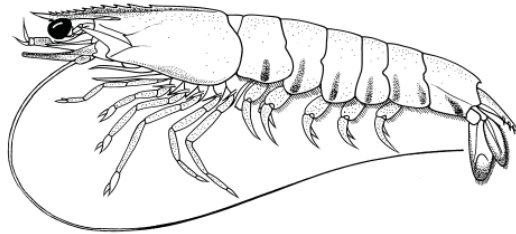
No intellectual property has arisen from the research.

21 Appendix 2. Staff

(in alphabetical order)

- Dr Peter Baxter, Centre for Applications in Natural Resource Mathematics (CARM, UQ)
- Dr Tony Courtney, Principal Fisheries Biologist (DAFF)
- Dr James Innes, Fisheries Economist (CSIRO)
- Mr Marco Kienzle, Fishery Resource Assessment Scientist (DAFF)
- Ms Michelle Landers, Fisheries technician (DAFF)
- Ms Jennifer Larkin, Fisheries technician (DAFF)
- Dr George Leigh, Fishery Resource Assessment Scientist (DAFF)
- Mr Michael O'Neill, Fishery Resource Assessment Scientist (DAFF)
- Dr Sean Pascoe, Fisheries Economist (CSIRO)
- Mr Andrew Prosser, Fisheries Biologist (DAFF)
- Dr David Sterling, MBSIA
- Professor You-Gan Wang, Centre for Applications in Natural Resource Mathematics (CARM, UQ)

22 Appendix 3. Survey of fishing power changes, economics and harvest strategies



**Fishing Power, Economics and Harvest
Strategy Survey
Moreton Bay Otter Trawl Vessels
2010**

This questionnaire relates to the following vessel ONLY

Vessel Name -

.....

Vessel Symbol -

.....

Interviewee and Date -

.....

Record number (6000+)-

.....

Answering the Survey –

The survey will provide information to establish the catching ability of your vessel. The questions are designed to record the historical change in your vessel and fishing gear characteristics.

Please provide dates on all vessel/gear changes where possible. This information is very important for us to understand the changes that occurred in your fishery over time. If a question does not accommodate your vessel/gear set up, please specify in your own words. If exact figures are not available please provide careful estimates. If you don't know some details please write "DON'T KNOW" for the question.

Individual vessel owners'/operators' information will be treated as strictly confidential. No individual or business will be able to be identified from the results in any reports. Your individual information will be entered onto an electronic database that has restricted access.

Vessel And Licence Specifications

Please provide information on changes to the vessel listed on the cover for the period from **purchase date to present**. If certain vessel specifications have changed more than twice, please record this information on **the back of page**. If exact figures or dates are not available please provide careful estimates. If you just don't know some details please write down **“DON'T KNOW”**.

<u>Purchase Details</u>	
When did you purchase this vessel?	..... /.....(M/Y)
Purchase price of vessel?	\$.....
Year vessel was built?	.....
How many hull units for this vessel (M1 should be able to say, but M2 may not have hull units)?	.....
Estimated value of licence and symbol (either T1/M1 or M2 Excludes other symbols)?	Licence value \$..... Symbol value \$.....
Insured value of boat	\$.....
Estimated value of replacement value of vessel?	\$.....

<u>Owner/Skipper Relationship</u>				
How have you been related to the skipper(s)? Please tick the relevant box. If there was more than one type of skipper, please record the years operated by each skipper.				
	Owner-Skipper	Related Family Member	Non-Family Skipper	Other
Moreton Bay	<input type="checkbox"/> (year to year)	<input type="checkbox"/> (year to year)	<input type="checkbox"/> (year to year)	<input type="checkbox"/> (year to year)
Repeat details if required	<input type="checkbox"/> (year to year)	<input type="checkbox"/> (year to year)	<input type="checkbox"/> (year to year)	<input type="checkbox"/> (year to year)

For T1/M1 only, approximately how much of your trawl fishing effort (i.e. each year) is expended in Moreton Bay?

10% or less	20%	30%	40%	50%	60%	70%	80%	90%	100%

For T1/Mi only, if you do trawl elsewhere, what percentage of your effort is spent in the other sectors of the Queensland trawl fishery?

Eastern king prawn (outside the Bay)	Scallop fishery	North Queensland tiger/endeavour prawns	Red spot king prawns	Banana prawns	Beam trawl	Other
%	%	%	%	%	%	%

<u>Vessel Specifications</u>	When you first fished with this vessel.	Provide details of any changes that have been made during your ownership/operation, with the first change in gear recorded first.
1. Engine manufacturer	.....(type) Age of engine .....(Years)	.....(type)/..... (M/Y) Age of engine .....(Years)
2. Engine Rated Power–(hp or kW)	.....(hp).....(kW)	.....(hp).....(kW) ...../.....(M/Y)
3. Engine Rated RPM	.....(RPM)	.....(RPM)...../.....(M/Y)
4. Maximum trawling RPM	.....(RPM)	.....(RPM)...../.....(M/Y)
5. Normal trawling RPM		
Targeting Bay prawns	.....(RPM)	.....(RPM)...../.....(M/Y)
Targeting Greasy prawns	.....(RPM)	.....(RPM)...../.....(M/Y)
Targeting king prawns	.....(RPM)	.....(RPM)...../.....(M/Y)
Targeting tiger prawns	.....(RPM)	.....(RPM)...../.....(M/Y)
Targeting other species (please specify e.g., squid)	.....(RPM) .....(species)	.....(RPM)...../.....(M/Y) .....(species)
6. Normal trawling speed for		
Targeting Bay prawns	.....(knots)	.....(knots)/..... (M/Y)
Targeting Greasy prawns	.....(knots)	.....(knots)/..... (M/Y)
Targeting king prawns	.....(knots)	.....(knots)/..... (M/Y)
Targeting tiger prawns	.....(knots)	.....(knots)/..... (M/Y)
Targeting other species (please specify e.g., squid)	.....(knots) .....(species)	.....(knots)...../.....(M/Y) .....(species)
7. Steaming speed (knots)	.....(knots)	.....(knots)/..... (M/Y)
8. Reduction	..... :1	..... :1/..... (M/Y)
9. Max. Fuel Capacity (litres)	.....(l)	.....(l)/..... (M/Y)
10. Fuel Consumption (litres per night)	.....(litres per night)	..... (litres per night)/..... (M/Y)
11. Propeller Diameter (inches or cm)	.....(").....(cm)	.....(").....(cm)/..... (M/Y)
12. Propeller Pitch (inches)	.....(")	.....(") ...../..... (M/Y)
13. Kortz Nozzle (tick box)	Yes <input type="checkbox"/> No <input type="checkbox"/>	Yes <input type="checkbox"/>/..... M/Y installed

Vessel Specifications: continued. (complete only if you have changed vessel specifications more than once)

<u>Vessel Specifications</u>	<u>Additional Changes</u>	<u>Additional Changes</u>
1. Engine manufacturer	.....(type)/..... (M/Y) Age of engine .....(Years)	.....(type)/..... (M/Y) Age of engine .....(Years)
2. Engine Rated Power–(hp or kW)	.....(hp).....(kW) ...../.....(M/Y)	.....(hp).....(kW) ...../.....(M/Y)
3. Engine Rated <i>RPM</i>	.....(RPM)...../..... (M/Y)	.....(RPM)...../..... (M/Y)
4. Maximum trawling <i>RPM</i>	.....(RPM)...../..... (M/Y)	.....(RPM)...../..... (M/Y)
5. Normal trawling <i>RPM</i>		
Targeting Bay prawns	.....(RPM)...../..... (M/Y)	.....(RPM)...../..... (M/Y)
Targeting Greasy prawns	.....(RPM)...../..... (M/Y)	.....(RPM)...../..... (M/Y)
Targeting king prawns	.....(RPM)...../..... (M/Y)	.....(RPM)...../..... (M/Y)
Targeting tiger prawns	.....(RPM)...../..... (M/Y)	.....(RPM)...../..... (M/Y)
Targeting other species (please specify e.g., squid)	.....(RPM)...../.....(M/Y) .....(species)	.....(RPM)...../.....(M/Y) .....(species)
6. Normal trawling speed for		
Targeting Bay prawns	.....(knots)/..... (M/Y)	.....(knots)/..... (M/Y)
Targeting Greasy prawns	.....(knots)/..... (M/Y)	.....(knots)/..... (M/Y)
Targeting king prawns	.....(knots)/..... (M/Y)	.....(knots)/..... (M/Y)
Targeting tiger prawns	.....(knots)/..... (M/Y)	.....(knots)/..... (M/Y)
Targeting other species (please specify e.g., squid)	.....(knots)...../.....(M/Y) .....(species)	.....(knots)...../.....(M/Y) .....(species)
7. Steaming speed (knots)	.....(knots)/..... (M/Y)	.....(knots)/..... (M/Y)
8. Reduction	..... :1/..... (M/Y)	..... :1/..... (M/Y)
9. Max. Fuel Capacity (litres)	.....(l)/..... (M/Y)	.....(l)/..... (M/Y)
10. Fuel Consumption (litres per night)	.....(litres per night)/..... (M/Y)	.....(litres per night)/..... (M/Y)
11. Propeller Diameter (inches or cm)	.....(").....(cm)/..... (M/Y)	.....(").....(cm)/..... (M/Y)
12. Propeller Pitch (inches)	..... (") ...../..... (M/Y)	..... (") ...../..... (M/Y)
13. Kortz Nozzle (tick box)	Yes <input type="checkbox"/>/..... M/Y installed	Yes <input type="checkbox"/>/..... M/Y installed

Navigation Capabilities

One of the most important aspects to fishing is the ability to find and trawl the most productive areas. Specialised navigation equipment plays an important role in identifying and returning to productive fishing grounds. Please provide the following details for the vessel listed on the cover. If exact dates are not available please provide careful estimates. If you don't know some details write "DON'T KNOW" for the question.

<u>Navigational Equipment</u>	Has the equipment ever been used on the vessel? <small>(Tick one box for each question. Please provide month/year if equipment was installed after the vessel was purchased)</small>	Has the equipment been updated or retired since first use? <small>(please provide month/year of change)</small>
1. Colour Echo sounder	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....
2. Sonar	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....
3. Radar	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....
4. Satellite Navigation (SatNav)	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....
5. Global Positioning System (GPS)	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....
6. Differential GPS (DGPS)	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....
7. Plotter (interfaced with GPS)	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....
8. Autopilot	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....
9. GPS interfaced with the autopilot	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....
10. Radar interfaced with the GPS/Plotter	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....
11. GPS interfaced with computer mapping software eg. CPLOT.	<input type="checkbox"/> No <input type="checkbox"/> Yes, already installed when vessel purchased <input type="checkbox"/> Yes, installed after vessel purchased (...../.....)	<input type="checkbox"/> 1 st update/..... <input type="checkbox"/> 2 nd update/..... <input type="checkbox"/> retired/.....

Searching Capabilities

Please provide the following details for the vessel listed on the cover. If exact figures are not available provide careful estimates. If you don't know some details write "DON'T KNOW" for the question.

<u>Try-Gear Net</u>	
1. Does your fishing vessel use try-gear? If yes, on a normal night what percentage do you use try gear? If "No", then go to next section (Communication Devices)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Less than 25 % of the night worked <input type="checkbox"/> 25 % to 50% of the night worked <input type="checkbox"/> 50 % to 75% of the night worked <input type="checkbox"/> More than 75 % of the night worked
2. When did this fishing vessel first start using try-gear?	...../..... Month/Year
3. What type of try-gear do you use in the Moreton Bay Prawn fishery?	<input type="checkbox"/> Beam <input type="checkbox"/> Otter
4. What is the total head rope length of the try-gear (fathoms or metres)?	.....(fm) or .....(m)
5. In which position do you tow the try-gear?	<input type="checkbox"/> Stern <input type="checkbox"/> Port <input type="checkbox"/> Starboard
If you changed details of your try gear usage, repeat the details below.	
6. When did you change your try gear?	...../..... Month/Year
7. What type of try-gear do you use in the Moreton Bay Prawn fishery?	<input type="checkbox"/> Beam <input type="checkbox"/> Otter
8. What is the total head rope length of the try-gear (fathoms or metres)?	.....(fm) or .....(m)
On a normal night what percentage do you use try gear? If "No", then go to next section (Communication Devices)	<input type="checkbox"/> Less than 25 % of the night worked <input type="checkbox"/> 25 % to 50% of the night worked <input type="checkbox"/> 50 % to 75% of the night worked <input type="checkbox"/> More than 75 % of the night worked
9. In which position do you tow the try-gear?	<input type="checkbox"/> Stern <input type="checkbox"/> Port <input type="checkbox"/> Starboard

Note: 1 fathom = 6 feet or 1.8 metres

Communication Devices

The ability to communicate with other vessels could influence where you fish. This is just another aspect how technology could influence your catch rates and play an important role to identify productive fishing grounds. Please provide the details of communication equipment installed or carried on the vessel listed on the cover. If exact dates/figures are not available please provide careful estimates. If you just don't know some details please write "DON'T KNOW" for the question.

<u>Communication Devices</u>	Has the equipment ever been used on the vessel? (Tick one box for each question. Please provide month/year if equipment was used after the vessel was purchased)	What is the relative amount you use each device to communicate at present?	
		From vessel to vessel? (per 100 communications)	From vessel to shore? (per 100 communications)
1. HF Radio	<input type="checkbox"/> No <input type="checkbox"/> Yes, already used when vessel purchased <input type="checkbox"/> Yes, but first used after the vessel was purchased./..... M/Y End Use Date ...../.....M/Y	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%
2. VHF Radio	<input type="checkbox"/> No <input type="checkbox"/> Yes, already used when vessel purchased <input type="checkbox"/> Yes, but first used after the vessel was purchased./..... M/Y End Use Date ...../.....M/Y	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%
3. UHF Radio	<input type="checkbox"/> No <input type="checkbox"/> Yes, already used when vessel purchased <input type="checkbox"/> Yes, but first used after the vessel was purchased./..... M/Y End Use Date ...../.....M/Y	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%
4. 27 meg Marine Radio	<input type="checkbox"/> No <input type="checkbox"/> Yes, already used when vessel purchased <input type="checkbox"/> Yes, but first used after the vessel was purchased./..... M/Y End Use Date ...../.....M/Y	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%
5. Mobile phone	<input type="checkbox"/> No <input type="checkbox"/> Yes, already used when vessel purchased <input type="checkbox"/> Yes, but first used after the vessel was purchased./..... M/Y End Use Date ...../.....M/Y	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%
6. Satellite phone	<input type="checkbox"/> No <input type="checkbox"/> Yes, already used when vessel purchased <input type="checkbox"/> Yes, but first used after the vessel was purchased./..... M/Y End Use Date ...../.....M/Y	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%
7. Email	<input type="checkbox"/> No <input type="checkbox"/> Yes, already used when vessel purchased <input type="checkbox"/> Yes, but first used after the vessel was purchased./..... M/Y End Use Date ...../.....M/Y	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%
8. Others (please specify, eg. Cb radio, fax, etc.)	<input type="checkbox"/> No <input type="checkbox"/> Yes, already used when vessel purchased <input type="checkbox"/> Yes, but first used after the vessel was purchased./..... M/Y End Use Date ...../.....M/Y	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%	<input type="checkbox"/> No <input type="checkbox"/> less than 25 % <input type="checkbox"/> 25 to 50 % <input type="checkbox"/> 50 to 75 % <input type="checkbox"/> more than 75%

Turtle Exclusion Devices (TED) and Bycatch Reduction Devices (BRD)

The use of TEDs and BRDs can change your catching ability. Please provide the following information. If exact dates/figures are not available please provide careful estimates. If you just don't know some details please write "DON'T KNOW" for the question.

Turtle Exclusion Devices (TEDs)	
<p>When did you start using a TED?</p> <p>Please tick each of the following devices this fishing vessel has used during your ownership/operation?</p> <p>TEDs:</p> <p>Super Shooter.....</p> <p>AusTED.....</p> <p>Nordmore.....</p> <p>Seymour.....</p> <p>Kevin Wicks.....</p> <p>Standard.....</p> <p>Weedless.....</p> <p>Flounder.....</p> <p>Own Design.....</p> <p>Don't Know.....</p> <p>Others (please specify).....</p>	<p style="text-align: center;">...../..... M/Y (compulsory introduction of TEDs 05/99)</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p>

Bycatch Reduction Devices (BRD)	
<p>When did you start using a BRD?</p> <p>Please tick each of the following devices this fishing vessel has used during your ownership/operation?</p> <p>BRDs:</p> <p>Square mesh panel</p> <p>Square mesh codend.....</p> <p>Half round square mesh codend.....</p> <p>Fisheye.....</p> <p>Bigeye.....</p> <p>Radial escape section.....</p> <p>V-Cut and Bell Cod End.....</p> <p>Popeye Fish excluder.....</p> <p>Don't know.....</p> <p>Others (please specify).....</p>	<p style="text-align: center;">...../..... M/Y (compulsory introduction of BRDs 12/02)</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p> <p>.....<input type="checkbox"/> Start date/..... End date/.....</p>

Trawl Gear Types

The trawl gear essentially determines how effectively a vessel fishes, especially by changing swept area. The setup of trawl gear varies with vessels and many different net types are used. The following table is designed for you to record information on trawl-gear starting from when you first fished with the vessel until 30 June 2010.

All questions relate to the main trawl nets, not the cod-end.

- The first column is for you to record the **original** trawl gear when you first started fishing with the vessel listed on the cover.
- The next 3 columns are for you to record any changes from the original gear. **Please record the new details and the month/year when the change occurred.** If there were more than 3 changes, please record details on the back of the page.

Moreton Bay Otter Trawl Fishery

Trawl-Gear Please answer questions row by row.	When you first fished with this vessel	Provide details of any gear changes that have been made during your ownership/operation.		
1. Net Type (Please tick one box) Single..... Double..... Triple..... Quad..... Five..... Please specify Month/Year of changes <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
2. Total Net Head Rope Length Please specify Month/Year of changes	.....(fm) Please specify Month/Year of changes	.....(fm)/..... M/Y	.....(fm)/..... M/Y	.....(fm)/..... M/Y
3. Net mesh size (inches ") Please specify Month/Year of changes	..... (" ) Please specify Month/Year of changes	..... (" ) ...../..... M/Y	..... (" ) ...../..... M/Y	..... (" ) ...../..... M/Y
4. Did/Do you use knotless mesh?	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes/..... M/Y	<input type="checkbox"/> No <input type="checkbox"/> Yes/..... M/Y	<input type="checkbox"/> No <input type="checkbox"/> Yes/..... M/Y
5. Ground Gear Type (tick box) Drop chain..... Drop mud rope..... Drop chain with sliding rings..... Danglers or Christmas-treedrops..... Looped ground chain..... Drop rope with chain..... Other (please specify)..... Please Specify Month/Year of changes <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
6. Ground line specification Maximum gauge of chain (mm) Style of chain link (please circle one style)	.....(mm) short/regular/long	.....(mm) short/regular/long	.....(mm) short/regular/long	.....(mm) short/regular/long
Do you use Stainless steel chain? Please Specify Month/Year of changes	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No/..... M/Y	<input type="checkbox"/> Yes <input type="checkbox"/> No/..... M/Y	<input type="checkbox"/> Yes <input type="checkbox"/> No/..... M/Y

7. Otter-boards types (tick box)				
Bison..... <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Louvre..... <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Flat Timber..... <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Flat Timber-steel <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Kilfoil..... <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Collins..... <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Other (please specify)...	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Please specify Month/Year of changes		...../..... M/Y	...../..... M/Y	...../..... M/Y
8. Otter-board dimensions				
Length (feet).....	.....(ft)	.....(ft)	.....(ft)	.....(ft)
Height (feet).....	.....(ft)	.....(ft)	.....(ft)	.....(ft)
Please Specify Month/Year of changes		...../..... M/Y	...../..... M/Y	...../..... M/Y
9. Do you have a hopper on board your vessel?	<input type="checkbox"/> Yes <input type="checkbox"/> No			
10. Do you have any comments on factors that you believe effects your vessel fishing performance? (i.e., fishing gear/designs, vessel performance, vessel design)	..... ..... ..... ..... ..... .....		

Economic Survey Questions

Total Value of Sales

	2008-09 tax year	2009-10 tax year
Total revenue from sale of all catch	\$.....	\$.....
% Breakdown for Moreton Bay trawl fishery -		
‘Bay’ prawns%%
Greasy prawns%%
King prawns%%
Tiger Prawn%%
Other Species%%
% Of income by fishery sector -		
Trawl Inside Bay%%
Trawl Outside Bay%%
Non Trawl Fishing (e.g., pot, line, gill net)%%
Is this gross or net of agent commission?	Gross / Nett	Gross / Nett

Who do you mainly sell your product to?

.....

Personal/Family Details

Age of Skipper	..... Years	Family Fishing History (number of generations of fishermen)	.....
Total years fishing	..... Years	Years as a skipper	..... Years
Highest level of formal education	..... .....	

Appendices

Training courses and other qualifications achieved
--	----------------

Fishing (Trip) Costs

Item	Cost/day at sea (estimate)		Total cost over year (from accounts)	
	2008-09	2009-10	2008-09	2009-10
Fuel and oil costs	\$.....	\$.....	\$.....	\$.....
Fuel use (litres)	.....l/day	.....l/day	.....l	.....l
Ice costs	\$.....	\$.....	\$.....	\$.....
Gear maintenance costs (fix, repair, clean, etc.)	\$.....	\$.....	\$.....	\$.....
Trip related costs List some of these 1)..... 2)..... 3).....	\$.....	\$.....	\$.....	\$.....
Other running costs (e.g. packaging, freight)	.....\$/kg	.....\$/kg	\$.....	\$.....

Annual Crew Costs

Are you the skipper	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Average number of crew (excluding owner/skipper)	.....	% of time employ a skipper%
Total crew payments from accounts	2008-09	\$.....	Include/exclude skipper?
	2009-10	\$.....	Include/ exclude skipper?
Skipper Share (if not owner)	.....% Gross / Nett revenue		
Crew Share	.....% Gross / Nett revenue	Fixed Payments	.....\$/week

(Net revenue in this case is net of trip costs)

Other costs

Item	2008-09	2009-10
Boat repairs and maintenance (annual costs not already covered above)	\$.....	\$.....
Engine repairs and maintenance	\$.....	\$.....
Gear replacement (capital item costs borne solely by owner)	\$.....	\$.....
Other repairs and maintenance	\$.....	\$.....
Safety compliance costs (equipment)	\$.....	\$.....
Lease/wharf fees (beach plot rent where applicable)	\$.....	\$.....
Insurance costs	\$.....	\$.....
Other rental or hire costs (e.g. workshop)	\$.....	\$.....
Administration costs (e.g. accountancy, telephone, bank charges, etc.)	\$.....	\$.....
Interest payments		
Fishing business loan repayment – Amount paid off <u>Capital</u>	\$.....	\$.....
Fishing business loan repayment – Amount paid off <u>Interest</u>	\$.....	\$.....
Other costs (e.g. vehicle costs,.)	\$.....	\$.....

Harvest Strategy Evaluation Questions

Please rate how you feel about the following statements in regard to the Moreton Bay trawl fishery. For each statement tick one box.

1) Current management of the Moreton Bay prawn trawl fishery is very good.

Strongly disagree **Disagree** **Neither disagree or agree** **Agree** **Strongly agree**

--	--	--	--	--

2) There are too many trawlers in Moreton Bay prawn trawl fishery.

Strongly disagree **Disagree** **Neither disagree or agree** **Agree** **Strongly agree**

--	--	--	--	--

3) There is too much trawl fishing effort in Moreton Bay.

Strongly disagree **Disagree** **Neither disagree or agree** **Agree** **Strongly agree**

--	--	--	--	--

4) The M2 vessels should have effort units.

Strongly disagree **Disagree** **Neither disagree or agree** **Agree** **Strongly agree**

--	--	--	--	--

5) The size of the prawns that are being harvested is too small and well below the size needed to maximise value from the fishery.

Strongly disagree **Disagree** **Neither disagree or agree** **Agree** **Strongly agree**

--	--	--	--	--

6) The value of the prawn catch could be improved by using larger mesh.

Strongly disagree **Disagree** **Neither disagree or agree** **Agree** **Strongly agree**

--	--	--	--	--

7) Additional seasonal or spatial closures could increase the value of the prawn catch.

Strongly disagree **Disagree** **Neither disagree or agree** **Agree** **Strongly agree**

Appendices

--	--	--	--	--

8) The Moreton Bay prawn trawl fishery cannot compete against imported vannamei prawns.

Strongly disagree **Disagree** **Neither disagree or agree** **Agree** **Strongly agree**

--	--	--	--	--

9) The main market for the Moreton Bay prawn trawl fishery should be the supply of bait-prawns.

Strongly disagree **Disagree** **Neither disagree or agree** **Agree** **Strongly agree**

--	--	--	--	--

10) Are there other technical changes that could be implemented to improve management of the fishery?

.....
.....
.....

23 Appendix 4: R code for analysis in section 12

Code to plot fishing effort by year

```
x = read.csv("Moreton Bay Otter trawl data 1988-2010.csv",
header=TRUE)
y1 = c(table(x$FishingStartDateYear)) / 1000
x1 = as.numeric(names(y1))
plot(x1, y1, type = "b", xlab = "Year", ylab =
"Unstandardised effort (thousands of nights)", yaxs = "i",
ylim = c(0, 1.04 * max(y1)))
```

Code for Figure 12-1

```
lf0 = glm(Tiger ~ -1 + Auth + fYear + Cell * fMonth, family =
quasipoisson(link = "log"))
BoatCoef = coef(lf0)[paste("Auth", levels(Auth), sep="")]
hist(exp(BoatCoef) / 10, 20, main = "",
xlab = "Boat efficiency", ylab = "Frequency")
```

Code for Figures 12-2 and 12-3

```
plot((tapply(MonthSeq1, MonthSeq1, mean) - 1) / 12 + 1988,
tapply(Effort1, MonthSeq1, sum) / (10 * tapply(Days1,
MonthSeq1, sum)), type = "l", xlab = "Year", ylab = "Fishing
efficiency (relative units)")
plot(tapply(Month1, Month1, mean), tapply(Effort1, Month1,
sum) / 1e5, type = "b", xlab = "Month", ylab = "Total
effective effort (relative units)")
```

Code for aggregation of data

```
MC = paste(MonthSeq, Cell) # Month-cell combination
Month1 = tapply(Month, MC, mean)
Year1 = tapply(Year, MC, mean)
Tiger1 = tapply(Tiger, MC, sum)
MonthSeq1 = tapply(MonthSeq, MC, mean)
Site1 = tapply(Site, MC, mean)
Cell1 = factor(levels(Cell)[tapply(as.numeric(Cell), MC,
mean)])
Effort1 = tapply(exp(BoatCoef)[Auth], MC, sum)
Days1 = tapply(Auth, MC, length)
```

Code for Figures 12-4 and 12-7

```
plot(tapply(Year1, Year1, mean), tapply(Effort1, Year1, sum))
plot((tapply(MonthSeq1, MonthSeq1, mean) - 1) / 12 + 1988,
tapply(Tiger1, MonthSeq1, sum) / tapply(Effort1, MonthSeq1,
sum), type = "l", xlab = "Year", ylab = "Catch
rate (relative units)")
y = tapply(Tiger1, Year1, sum) / tapply(Effort1, Year1, sum)
plot(tapply(Year1, Year1, mean), y, type = "b", xlab = "Year",
ylab = "Catch rate (relative units)", yaxs = "i", ylim = c(0,
1.04 * max(y)))
y = tapply(Tiger1, Month1, sum) / tapply(Effort1, Month1, sum)
plot(tapply(Month1, Month1, mean), y, type = "b", xlab =
"Month", ylab = "Catch rate (relative units)", yaxs = "i",
ylim = c(0, 1.04 * max(y)))
```

Appendices

Code for Figure 12-8

```
x = tapply(Year1 + (Month1 - 3) / 4, MonthSeq1, mean)
y = log(tapply(Tiger1, MonthSeq1, sum)) - log(tapply(Effort1,
MonthSeq1, sum))
z = tapply(Month1, MonthSeq1, mean)
l = z >= 3 & z <= 6
x[!l] = NA
y[!l] = NA
plot(x, y, type="l", xlab = "Year",
ylab = "Log catch rate, March to June (relative units)")
l1 = x == floor(x) # March
points(x[l1], y[l1])
```

Code for Figures 12-9 and 12-10

```
# Monthly pattern of effort
par(mfcol = c(3, 4))
fMonth1 = factor(Month1)
for (i in 1:nlevels(Cell1)) {
  l = as.numeric(Cell1) == i
  SiteCurrent = mean(Site1[l])
  y = tapply(Effort1[l], fMonth1[l], sum) / 1000
  y[is.na(y)] = 0
  plot(as.numeric(levels(fMonth1)), y, xlab = "Month", ylab =
"Relative effort", main = paste("Site ", SiteCurrent, ": ",
levels(Cell1)[i], sep = ""), type = "b", ylim = c(0, 1.02 *
max(y)), yaxs = "i")
}
```

```
# Monthly pattern of CPUE
fYear1 = factor(Year1)
fMonth1 = factor(Month1)
fSite1 = factor(Site1)
lf = glm(Tiger1 ~ -1 + fYear1 + fMonth1 : Cell1 +
offset(log(Effort1)), family = quasipoisson(link = "log"))
Recruit1 = exp(coef(lf)[paste("fYear1", levels(fYear1),
sep="")][as.numeric(fYear1)])
Fit1 = fitted(lf)
```

```
par(mfcol = c(3, 4))
for (i in 1:nlevels(Cell1)) {
  l = as.numeric(Cell1) == i
  SiteCurrent = mean(Site1[l])
  y = tapply(Fit1[l], Month1[l], sum) /
tapply(Effort1[l] * Recruit1[l], Month1[l], sum)
  plot(tapply(Month1[l], Month1[l], mean),
y, xlab = "Month", ylab = "Relative catch rate",
main = paste("Site ", SiteCurrent, ": ", levels(Cell1)[i],
sep = ""),
type = "b", ylim = c(0, 1.02 * max(y)), yaxs = "i")
}
```

Code for Figure 12-12

```
# Use a GLM to do the catch curve analysis.
l = !is.na(match(Site1, c(6, 7, 8, 12, 13, 14, 17))) & Month1
>= 3 & Month1 <= 6
```


Appendices

```
x = Month1 - 6 # Define intercept to apply to month 6, to
measure how many prawns are alive in June in each year.
lf2 = glm(Tiger1 ~ -1 + fYear1 / x + fSite1 +
offset(log(Effort1)), family = quasipoisson(link = "log"),
subset = 1)
```

```
# Plot Z.
YearsCurrent = as.numeric(levels(fYear1))
l = YearsCurrent >= 1992 # Remove inconsistent years.
plot(YearsCurrent[l], -coef(lf2)[paste("fYear1",
levels(fYear1), ":x", sep="")] [1], xlab = "Year", ylab =
expression("Total mortality rate " ~ italic(Z) ~ "(March to
June) (month"^Abstract~)"), type = "b", mar = c(5, 5, 4, 2))
```

Code for Figure 12-13

```
LogCpueJun = coef(lf2)[paste("fYear1", levels(fYear1), sep =
"")]
YearsCurrent = as.numeric(levels(fYear1))
l = YearsCurrent >= 1992
plot(YearsCurrent[l], exp(LogCpueJun)[l], xlab = "Year", ylab =
"Relative abundance in June", type = "b", yaxs = "i", ylim =
c(0, 1.02 * max(exp(LogCpueJun[!is.na(LogCpueJun)])))
```

Code for Figure 12-14

```
SitesCurrent = c(7, 8, 12, 13, 14)
MonthsCurrent = 7:12
fMonth2 = factor(paste(Year1, Month1))
l = !is.na(match(Site1, SitesCurrent)) & !is.na(match(Month1,
MonthsCurrent))
lf3 = glm(Tiger1 ~ -1 + fMonth2 + fSite1 +
offset(log(Effort1)), family = quasipoisson(link = "log"),
subset = 1)

for (i in MonthsCurrent) {
  x1 = coef(lf3)[paste("fMonth2", levels(fYear1), " ", i, sep =
"")]
  names(x1) = levels(fYear1)
  assign(paste("LogCpue", i, sep = ""), x1)
}

YearsCurrent = as.numeric(levels(fYear1))
l = YearsCurrent >= 1992
for (i in MonthsCurrent) {
  y = get(paste("LogCpue", i, sep = "")) - LogCpueJun
  l1 = l & !is.na(y) & YearsCurrent != 2008 # Anomalous year
  plot(YearsCurrent[l], -y[l] / (i - 6),
  xlab = "Year", ylab = expression("Offset mortality rate June
to October" ~ "(month"^- 1} ~)"),
  main = month.name[i], type = "b")
  lf4 = lm(y[l1] ~ YearsCurrent[l1])
  lines(YearsCurrent[l1], -fitted(lf4) / (i - 6), lty = 2)
  readline("Press enter to continue")
}
```