The failure of 'command and control' approaches to fisheries management: lessons from Australia

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Abstract: The traditional 'command and control' approaches to fisheries management – ones that focus on input restrictions and total catch limits – fail to provide the incentives for those who fish to do so efficiently and in a manner that gives industry a long-term stake in the future of the fishery. This paper provides a discussion of the failure of these 'command and control' approaches to fisheries management in two specific cases: the Australian northern prawn and southeast trawl fishery, drawing valuable policy and management insights that may prove useful to the management of other fisheries around the world.

Keywords: fisheries management; input and output controls; sustainability.

Reference to this paper should be made as follows: Kompas, T. and Gooday, P. (2007) 'The failure of 'command and control' approaches to fisheries management: lessons from Australia', *Int. J. Global Environmental Issues*, Vol. 7, Nos. 2/3, pp.174–190.

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1 Introduction

Given the problems with open access resources, as well as the effectiveness of modern fishing technology, there are few capture fisheries, if any, which will not be both overexploited and unprofitable unless they are managed effectively. For a fishery to be economically efficient, it requires that management targets be set correctly, enforced effectively and delivered in a least cost and incentive-compatible manner. An efficient outcome is important not only because it protects fish stocks and promotes sustainability, but also because it ensures that inputs will be allocated to the fishery correctly and in a way that maximises the returns from fishing. By contrast, inefficient fisheries are plagued by low profits and excessive boat capital or fishing capacity, with the all too familiar outcome of 'too many boats chasing too few fish'.

The traditional 'command and control' approaches to fisheries management – ones that focus on input restrictions and total catch limits – fail to provide the incentives for those who fish to do so efficiently and in a manner that gives the industry a long-term stake in the future of the fishery (Grafton et al., 2006a). These approaches often result in considerable effort creep (increases in fishing power) and excessive and wasteful competition, with both inappropriate levels and combinations of inputs used to catch fish (Kompas et al., 2004). The negative consequences of input and output controls are nicely illustrated by the recent experience in Australia's Commonwealth fisheries. In the past 10 years, the Australian federal government has committed $90 million per year to fisheries research and ecologically sustainable development, undertaken substantial buybacks of fishing effort, implemented detailed scientific fishery management plans that incorporate strong stakeholder involvement and expanded its National Representative System of Marine Protected Areas. Despite such strategies, substantial effort creep in input-controlled fisheries and the inability to decrease Total Allowable Catches (TACs) when necessary in output controlled fisheries has contributed to a three-fold increase in the number of Commonwealth fisheries classified as overfished in the past 10 years (Caton and McLoughlin, 2004). The economics of these fisheries has also suffered. The Australian Bureau of Agricultural and Resource Economics (ABARE) surveys have consistently shown close to zero net returns in most Commonwealth fisheries over the past several years (Kompas and Gooday, 2005).

This paper provides an evaluation of the failure of traditional 'command and control' approaches to fisheries management in two specific cases: the Australian northern prawn (NPF) and southeast trawl (SETF) fishery. While management actions are currently being implemented to improve the biological and economic status of all Commonwealth managed fisheries (AFMA, 2005), including the adoption of harvest strategy rules, there are still valuable policy and management insights to be drawn from these two cases; insights that may prove useful to the management of other fisheries around the world. Section 2 of this paper briefly outlines previous studies of the effectiveness of input and output controls in various fisheries. Section 3 details the NPF and the failure of input controls due to excessive effort creep and overcapitalisation, even though a 'Maximum Economic Yield' (MEY) target has now been established in the fishery. Section 4 discusses the SETF and the failure of output controls and Individual Transferable Quotas (ITQs), largely due to inappropriately set and non-binding TACs. Section 5 draws some additional and overall policy lessons learnt from the NPF and SETF. Section 6 concludes.

2 Previous studies

Correcting for the market failures that occur within fisheries is notoriously difficult in practice. The management of a fishery affects economic efficiency in two fundamental ways. The first is through determining and enforcing a harvest level for the fishery. The second is by influencing the way in which that harvest is caught. The choice of management regime will have a substantial bearing on both of these factors as it largely defines the incentive structure that fishers operate within. Fishery management regimes need to be carefully designed to ensure that the potential benefits from management are not dissipated.

The problems associated with input controls are well documented (e.g. Townsend, 1990). As noted by Wilen (1979), restrictions on the use of one set of inputs provide an incentive for fishers to use other, unrestricted inputs more intensely to circumvent the controls. The absence of constraints on most inputs makes increased effective effort, competitive fishing and rent dissipation inevitable. Due to their impact on the mix of fishing inputs used, input controls also have a negative impact on technical efficiency and thus cost and profitability in a fishery (Greenville et al., 2006; Kompas et al., 2004; Pascoe and Robinson, 1998).

Nevertheless, rapid dissipation of rents and technical inefficiency may not be inevitable in all input control cases. Input control regimes work by raising the costs of some input combinations. Anderson (1985) points out that where this raises the unit costs of effort without raising total costs by an equivalent amount, there may be net benefits from the regulation. This is most likely when the unrestricted inputs are poor substitutes for the restricted inputs (Campbell and Lindner, 1990; Townsend, 1990). Townsend cites lobster and abalone fisheries as cases where input regimes might work effectively.

Worldwide, ITQs are used in many fisheries and have been advocated by economists as offering the best solution to fishery management problems (see, e.g. Grafton, 1996). There is a breadth of evidence about their performance, but with few exceptions (Grafton et al., 2000), not a consistent and full evaluation of their efficiency. Extensive reviews are contained in Committee to Review Individual Fishing Quotas (1999) and Squires et al. (1995). The efficiency of ITQs may depend on aspects of both the design of quota rights and the characteristics of the fishery in which they are applied.

Fisheries dominated by single high-valued species are amongst those that appear to have yielded large efficiency gains from the adoption of ITQs. For example, early analysis of Australia's Southern Bluefin Tuna industry by Geen and Nayar (1989) found substantial efficiency gains from the use of ITQ management. Gauvin et al. (1994) examined conditions in the US wreckfish fishery prior to and immediately after the introduction of ITQs. They suggest that higher average and more stable prices along with an apparent reduction in capital and effort, following the move to ITQs, are consistent with an increase in efficiency. Similarly, Weninger (1998) finds significant efficiency gains from the adoption of ITQs in US clam fisheries.

ITQs have not always reached their full potential, even in primarily single species fisheries. For example, Grafton et al. (2000) find that adopting ITQs delivered uneven improvements in productive efficiency (the cost effectiveness of landing a given catch) in the British Columbian halibut fishery, although consequent increases in revenue and product form did imply that overall economic efficiency increased considerably. In particular, Grafton et al. (2000) show that short-run efficiency gains from privatisation may take several years to materialise and can be compromised by restrictions on transferability, duration and divisibility of the property right; while long-run gains in efficiency can be jeopardised by preexisting regulations and the bundling of the property right to the capital stock. Despite their uneven successes on the cost side, results for a number of fisheries indicate that ITQs have allowed fishers to spread effort over the season and concentrate on selling high quality fresh in place of frozen product (Wilen and Homans, 1997).

Evidence for the performance of ITQs in multispecies fisheries is mixed (Squires et al., 1998). Arnason (1993) finds strong evidence for gains in economic efficiency in the move to ITQs in Iceland's fisheries, some of which are multispecies trawl fisheries. Campbell and Lindner (1990) estimate significant efficiency gains across a variety of New Zealand fisheries and Kompas and Che (2001) find some early indirect evidence that ITQs have improved returns in the Australian southeast fishery. Of more significance are the results contained in Kompas and Che (2005) where it is estimated that the efficiency gains and cost reductions associated with the introduction of ITQs and enhanced quota trades in the southeast fishery are considerable. Dupont et al. (2005) find that transferability provisions of the ITQ program in Canada's multispecies Scotia-Fundy groundfishery have encouraged exit and more efficient operations to prevail. On the other hand, Squires and Kirkley (1996) find that the potential economic gains from applying ITQs in a US mixed trawl fishery are small.

3 The Australian Northern prawn fishery

The NPF extends over a defined fishing area of close to one million square kilometres between Cape Londonderry in Western Australia and Cape York in Queensland. Fishing is confined to the inshore parts of that area, with around 27% of the area fished and substantial areas closed for habitat protection. The fishery is managed by the Australian Fisheries Management Authority (AFMA).

3.1 Extent and nature of the fishery

Northern prawn is a multispecies fishery, with nine commercial species of prawn. Over the period 1992–1993 to 2001–2002, tiger and banana prawns made up an average of 84% of catch (Galeano et al., 2004). The principal species are grooved tiger, brown tiger, white banana and red-legged banana prawns. Key aspects of the biology and habitat requirements of these species differ in ways that have an important bearing on fisheries management. For example, year-to-year availability of banana prawns is highly variable. Stocks are strongly influenced by weather patterns, generally peaking in years in which there has been high rainfall. The variability of stocks makes it difficult to set catch or effort in a way that protects spawning stocks but also allows operators to profit from a year in which prawns are abundant. That task is made more difficult by the absence of a known stock-recruitment relationship. White banana prawns, which account for around 80% of the banana prawn catch, form dense aggregations or 'boils' that are easily identified from spotter planes. Most are thus caught in daytime trawls of relatively short duration and in a fishing season that lasts only a few weeks.

Tiger prawn stocks are both more stable and more predictable than banana prawn stocks. To a considerable extent, recent management changes for the fishery as a whole have been influenced by estimated stock-recruitment relationships for grooved and brown tiger prawns and the consequent assessment of current and future stocks. Since 1987 there has been a ban on daylight fishing for tiger prawns, although fishing was always predominantly at night.

In 2003, there were 97 boats active in the fishery, down from 172 in 1992, before a major compulsory reduction in A-units (a measure of engine power and hull size) in 1993. Over the period 1992–1993 to 2001–2002, real revenue for operators in the northern prawn fishery fluctuated between $85.6 million and $137.4 million, with an average of $108.6 million in 2002–2003 US dollars (Galeano et al., 2004). The fluctuations were driven by variation in catches, particularly of banana prawns, price changes resulting from changes in demand in Asian markets and exchange rate movements. Currently, in 2006, there are 85 boats in the fishery.

3.2 Managing the fishery

The NPF was established in the late 1960s. Active management of the fishery began with seasonal closures for banana prawns in 1971. Over more than three decades since that beginning, management change has been continuous. Both the aims and instruments of management have evolved over that time. Of the issues that are important to achieving sustainability and economic efficiency in the fishery, there are two overlapping sets of management measures that have been and continue to be important. One is the changing, but increasingly stringent controls on some inputs, designed to control effort. The other is the use of seasonal and area closures to conserve stocks through protection of habitat for juveniles and the protection of spawning stocks. Key management developments in terms of capacity and effort controls are listed in Table 1.

Table 1 Management changes in the NPF

1971	Seasonal closures for banana prawns introduced
1977	Controls on boat replacement
1980	Additional controls on boat replacement
1984	Unitisation of fishery introduced: Class A Units (fishing right) and Class B Units (boat hull volume and engine power allowance)
mid 1980s	Buyback scheme implemented to reduce effort according to a target of 70,000 Class A units in the fishery
1989	20,810 Class A units sold under the above scheme, but falls short of target
1990	Further restructuring through a voluntary buy-back scheme and a 30% reduction in units across the board with a target for the fishery of 53,844 units. Target achieved and vessel numbers reduced from 216 to 132 by 1993
1990	April opening date to target market sized prawns and a mid-season closure to reduce catch of spawners introduced
1995	New management plan and SFRs introduced to replace Class A and B units
1999	First season shortened by 14 days and second season by 18 days
2000	New management system based on control of gear units according to head-rope length of fishing nets. First season shortened by 5 days and second season by 5 days
2002	Effort cut by 40%. This was achieved through a 25% reduction in total allowable headrope length and a shortening of the first season by 14 days and the second season by 7 days
2004	MEY defined as the target level of catch
2005	25% reduction in total allowable headrope length

Initially, management efforts were confined to limiting entry and imposing controls on boat replacement through the 1977 and 1980 three-year plans. Adoption of A-units as the measure of capacity and B-units as the effective right for a boat to fish in 1984 was part of an attempt to control the increasing effort that resulted from replacement of old boats with new (AFMA, 1999). In 1986, data compiled by Australian Commonwealth Scientific and Research Organisation (CSIRO) showed a serious decline in brown tiger prawn stocks in the western Gulf of Carpentaria.

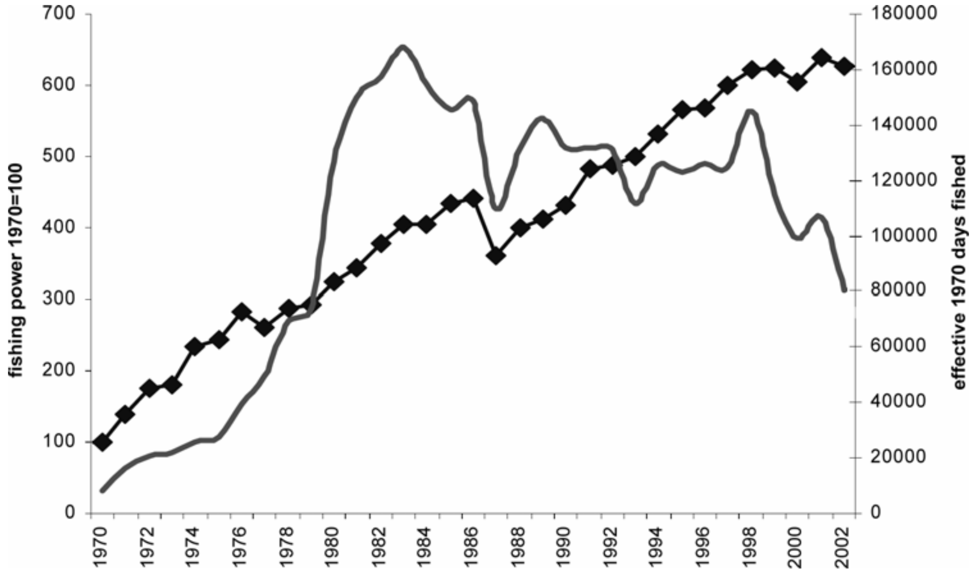
A voluntary adjustment scheme, involving buyback of A-units, was developed largely in response to that finding and a consequent CSIRO proposal for an immediate 25% cut in effort to protect prespawning tiger prawns (Pownall, 1994). Initially, the intent was to reduce total A-units in the fishery to 70,000 by the start of 1990 season. Any shortfall would be met by a compulsory acquisition at the start of the 1990 season. However, industry opposition and eventual rejection of the adjustment package by the Australian Senate eliminated the compulsory element of the buyback. The voluntary element was extended to the acquisition of B-units, thus effectively buying out the right to operate a boat in the fishery.

The voluntary buyback scheme was refinanced and extended in 1990. An initial target of 50,000 A-units by the beginning of 1993 was set, later amended to 53,844. In case the target was not reached through voluntary buyback, the residual was to be met by a proportional surrender of A-units. The target was met by a combination of voluntary and compulsory acquisition, with 53,844 A-units and 132 B-units remaining in the fishery on 1 April 1993. Those units were rolled over as class A and class B Statutory Fishing Rights (SFRs) (AFMA, 1999).

Throughout the period of the voluntary adjustment scheme, a series of other policy changes was implemented, in part, this was in recognition of the limited effectiveness of a slowly proceeding reduction in A-units. These changes included the introduction of gear restrictions and both daylight-trawling ban and mid-season closure for tiger prawns. Since 1993, three major changes in management have been implemented. In 1999, the basis for input constraint was changed from boat size and power (A-units) to head rope length (gear units), with a concurrent reduction in gear units of 15%. In 2002, gear units were reduced by a further 25% and the tiger prawn season length was further reduced. In 2005, there was an additional 25% cut in gear units due to concerns over stocks and 'effort creep'.

Several insights are notable about the sequence of management regimes in the fishery. Each of the changes was made in recognition that the system it replaced had failed to constrain fishing effort sufficiently to protect prawn stocks. Where effort was reduced by management change, the primary reduction appeared to be short lived. This effect, and one of the primary reasons for it, is illustrated in Figure 1. Fishing power, measured as the average catching ability of a boat in a day's fishing, compared with a 1970 base (Dichmont et al., 2003), has risen rapidly and consistently over time. The rise in fishing power is the result of continuous improvements in technology, input combinations and knowledge. The acquisition of improved scientific knowledge of the fishery, along with the observation of declining catches, has made it increasingly clear over the past few years that prawn stocks are not being conserved and catches are not being controlled. Figure 1 also shows that given the observed variance in effort, the major management target in this fishery, that effort itself has also not been controlled.

Figure 1 Fishing power (line with boxes) and effective effort (solid line) in the NPF. The fishing power series assumes the 'base high' case as designated by CSIRO



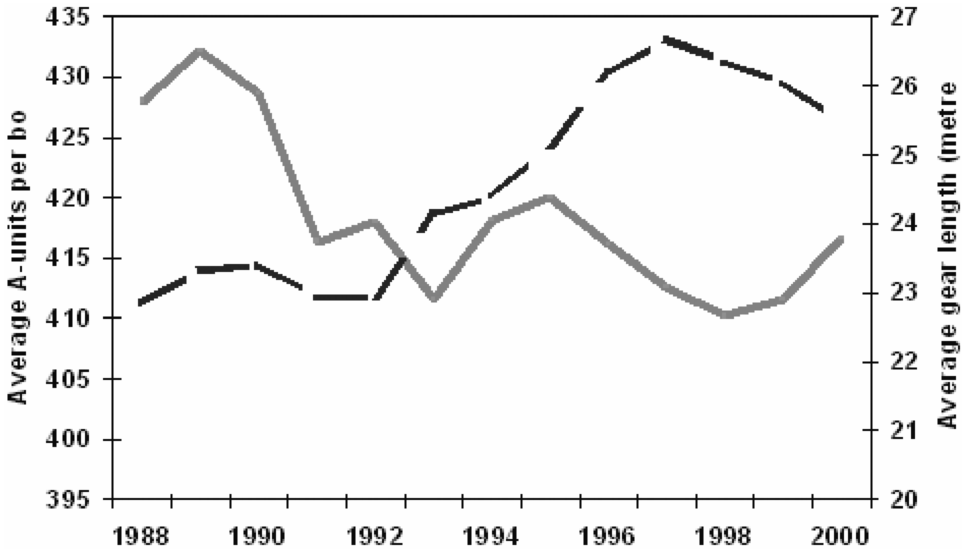
Source: Dichmont et al. (2003).

3.3 The impact of A-unit controls, total effort and MEY

Aspects of the impact of input controls and the reduction of A-units are examined in two studies of the technical efficiency of large samples of NPF boats surveyed between 1990 and 2000. Kompas and Che (2002) analyse the factors determining the level of technical efficiency in fishing for both banana and tiger prawns based on data for the period 1990 to 1996, from a sample of 37 boats. Kompas et al. (2004) analyse the factors contributing to technical efficiency in fishing, for banana prawns only, using separate sets of survey data for overlapping periods 1990–1996 and 1994–2000; the latter for every boat in the fishery.

Kompas and Che (2002) find that A-units contribute positively to technical efficiency and gear length contributes negatively for banana prawns. The findings are similar for tiger prawns, that is, gear length contributed negatively to technical efficiency and fuel use contributes positively. More importantly, the evidence suggests that restriction of A-units caused a substitution of a less efficient (and unregulated) input for boat size and power. In particular, the restriction induced operators to increase headrope length. Average headrope length increased steadily from 1993, across the sample. This substitution is illustrated in Figure 2. As a consequence of these changes in input use, technical efficiency declined from 1993. Average technical efficiency for banana prawn boats was 74.6% before 1993, dropping to 71.2% for the period from 1993 to 1996. These results are strengthened by the findings of Kompas et al. (2004) who find that for both the 1990–1996 and 1994–2000 dataset, there was a positive contribution of A-units to efficiency and the negative contribution of gear units – with a resulting and substantial decline in average technical efficiency over the period. Technical efficiency for the fleet as a whole fell from 75.1% in 1994 to 68.2% in 2000.

Figure 2 Input substitution in the NPF. The measures of A-units (solid line) and gear length (dashed line) are averages drawn from unbalanced panel data



The lesson here is clear: the problem with input controls is their inability (except in rare cases) to control effort in the first place. The moment control of a particular input becomes the policy instrument, operators have an incentive to substitute other inputs in a way that will change the relationship between effort and catch. As well, technological advance and improvements in knowledge provide other background reasons for the relationship to change, constantly. A manager relying on input controls is in constant competition with the imagination, energy and inventiveness of each operator in the fishery and the full technological backup of a modern economy.

More important to the general lack of success of input control management regimes are two characteristics of the incentives that they provide for operators in the fisheries. Firstly, controls on one or more inputs provide an immediate incentive for operators to substitute uncontrolled inputs. Secondly, input control regimes provide no sense of ownership or stewardship of the fisheries resource. There are no guarantees in any input control management regime except the right of access to the fishery under certain guidelines. Operators are encouraged by these rules to compete for catch within those guidelines and if one operator refuses to expand effort, while others do, that operator will be worse off. Unfortunately, if all operators increase effort, all are made worse off through a fall in profits and the fishery remains overexploited – the proverbial ‘tragedy of the commons’. The management response in this environment is to continuously and repeatedly find ways to cut effort (e.g. gear reductions, area and seasonal closures, vessel buyback schemes, etc.), ‘winding the fishery down’ over time to a small number of boats or days fished, all making zero (or near zero) profits.

The process of ‘winding the fishery down’ with a race to fish along the way is underscored by the extent to which the NPF is overcapitalised. This is best gauged by examining optimal results from a bioeconomic model of the fishery. As indicated in Table 1, a MEY target was adopted in the NPF in 2004. However, the fishery is far from its target. Results from Kompas and Che (2004), obtained from a stochastic optimal control model, maximising profits subject to a harvest equation and stock-recruitment relationship over a 50-year horizon, show that optimal total boat days (or the number of boats times nominal fishing days) for this NPF is 6460. This compares to 8503 boat-days in the actual fishery. Based on this result and combined with a technical efficiency study showing that vessels are less than 75% efficient (Grafton et al., 2006b; Kompas et al., 2004; Rose and Kompas, 2004), optimal fleet size in the NPF is estimated to be 56 boats compared to a fleet of 95 boats in 2004.

4 The Australian south east trawl fishery

It is not always the case the output controls combined with ITQs provide a solution to the fisheries overcapacity problem, especially when TAC is set incorrectly. The SETF fishery provides a good example for this.

4.1 Location and structure of the southeast trawl fishery

The SETF is one of Australia's oldest commercial fisheries. It is a multispecies and multigear fishery. The estimated gross value of production in the south east trawl fishery in 2004–2005 is roughly $43.6 US million, accounting for over 18% of the gross value of production from Australia's Commonwealth fisheries (ABARE, 2006). The major species caught in the fishery, measured in value terms, are orange roughy, blue grenadier, tiger flathead, ling and spotted warehou. These species account for 67% of the total value of landings in the fishery in 2004–2005.

The fishery covers an area of the Australian Fishing Zone extending southwards from Sandy Cape in southern Queensland, around the New South Wales, Victorian and Tasmanian coastlines to Cape Jervis in South Australia. The bulk of the catch in the fishery consists of twenty species or species groups managed by quota, but around a hundred species of finfish and deepwater crustaceans are commercially caught. Many of the fish species caught in the fishery are also caught in other Commonwealth and State managed fisheries and by recreational fishers. A range of methods is used to catch fish in the SETF, with vessels in the fishery classified into one of four subgroups: inshore trawl vessels, offshore vessels, Danish seine and factory trawlers. In 2001–2002, there were 57 inshore vessels, 18 offshore vessels, 22 Danish seine vessels and a small number of factory trawlers (Galeano et al., 2004).

4.2 Management and biological status of the fishery

Until the late 1970s, the SETF was primarily based on inner continental shelf species and was managed by the relevant state authorities (Newby et al., 2004). The fishery expanded into deeper grounds off the continental shelf margin and mid slope, coming under Commonwealth legislation with the release of the southeast trawl management plan in 1985.

In 1986 vessel 'unitisation' was introduced into the fishery with the establishment of a boat unit register for hull and engine units. This unitisation allowed for the development of a vessel replacement and upgrading policy in which these units could be transferred and operators could purchase units to cover the units of the proposed replacement vessels, plus a proportion to be forfeited to counter the increased fishing power of the replacement vessel. Unitisation and the vessel replacement policy failed to slow the rapid growth in fishing power as smaller vessels were purchased by other operators and used to introduce larger vessels with endorsements to fish anywhere. The rapid expansion in orange roughy catches and the decline in gemfish catch provided the rationale for the introduction of TACs in the late 1980s and the subsequent introduction of ITQ-based management for 16 species in the fishery in 1992 (AMC, 2000).

The fishery is currently managed with a combination of ITQs and input controls. The input controls include limited entry, mesh size and area restrictions. ITQ management of gemfish was introduced to the fishery in 1989. In 1992, a system of ITQ management was introduced across 16 different species in the fishery. Following litigation over the initial allocation, operators were at first only able to lease quota on a seasonal basis to other operators within the fishery. Full and permanent transferability of quota within the SETF has been permitted since January 1994.

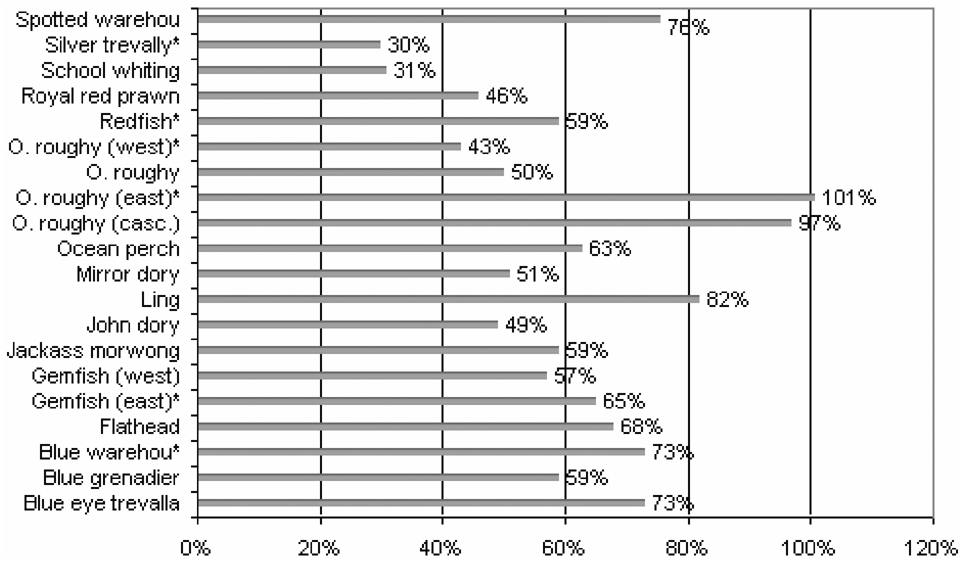
Since the adoption of ITQ management in the SETF in 1992, there has been some concern about the setting of TACs. Tilzey and Rowling (2001) indicate that fisheries scientists cautioned managers that there was inadequate information upon which to base most TACs, with yield estimates for only five of the 16 quota species available in 1991. More importantly, original TAC levels for most species were based on historical catch maxima, despite the fact that the fishery was characterised as having substantial excess fishing capacity, either static or declining catches and low levels of profitability immediately prior to the introduction of ITQ management (FERM, 2004).

4.3 Catch as a proportion of TAC, economic returns and MEY

Catch levels in the SETF have rarely reached the TACs set for the species managed under the quota management system. While it is not reasonable to expect that all TACs should be completely filled in a particular year, given the multispecies nature of the fishery, TACs should be set such that they are binding at some point (Squires et al., 1998). Over the period 1992–2005, the only TACs that have been largely filled are those for orange roughy in the eastern and cascade sectors. For most of the species currently assessed as overfished, in that stocks are below the level that maximises sustainable yield, TACs have not been binding historically (silver trevally, redfish, orange roughy (west and south zones), gemfish (east) and blue warehou) and are often not even close to binding, with the harvest of some species caught as low as 30% of TAC (see Figure 3). For the most part, the SETF thus operates as a limited-user 'open access' fishery (Wilen, 1979). Even when TAC is binding or close to binding, it is not clear that it is set correctly.

The limited entry 'open access' character of the SETF is confirmed by estimates of fishing effort, returns and biomass. Fishing effort in the SETF, measured as hours trawled, has increased over time, particularly since the introduction of ITQ management in 1992 (Elliston et al., 2004). Because hours trawled represents a measure of nominal effort, it is likely to understate the real level of effort in the fishery as the adoption of new fishing technology has improved the effectiveness of each hour trawled over time. This increase in fishing effort can be explained in part by the expansion of the blue grenadier fishery and the general pattern of increasing TAC and catch levels for this species since 1992 (Elliston et al., 2004). However, at the same time that fishing effort has been increasing, the total value of catch in the SETF has declined in real terms (ABARE, 2006). As a result, catch – measured either in tonnes or in inflation adjusted value terms – per hour trawled has declined since the mid 1980s. This result suggests that increasing effort in the SETF has been largely inefficient, dissipating the net returns to the fishery (Elliston et al., 2004). This is consistent with the findings of Galeano et al. (2004) that indicate persistently low net economic returns to the fishery. The net returns to the southeast trawl fishery for the period 1996–1997 to 2001–2002 are illustrated in Table 2. Returns, including management costs, are barely positive for most years.

Figure 3 Average yearly catch as a proportion of TAC, 1993–2005 (* indicates stocks assessed as overfished



Source: Caton and McLoughlin (2004).

Table 2 Net returns to the southeast trawl fishery, in millions of 2002–2003 US dollars

	Revenue	*Cash costs*	*Capital*	*Net returns (excluding management costs*	*Management costs*	*Net returns (including management costs)*
1996–1997	50.3	41.9	28.0	5.0	2.0	3.0
1997–1998	54.9	44.4	24.0	8.3	2.8	5.5
1998–1999	44.8	39.4	18.1	3.1	2.5	0.6
1999–2000	49.2	44.0	17.0	2.9	2.8	0.1
2000–2001	53.4	46.6	17.3	5.2	2.7	2.5
2001–2002	51.9	47.2	14.7	2.9	2.4	0.5

Source: Galeano et al. (2004).

Measures of MEY, drawn from a bioeconomic model for five species or zones in the fishery (Kompas and Che, 2006) and representing over 60% of the value of catch in the SETF, indicate the extent to which biomass is far below optimal values and how current harvest is greater than optimal TAC. In Table 3, B^* is the value of stock at steady state, B is the estimated value of current stock (or biomass) and B^*/B_{MSY} is the ratio of steady state to stock at MSY. In all cases, optimal results require a significant rebuilding of current stocks, that is, the ratio B^*/B is greater than one.

Table 3 Results for optimal harvest strategy and optimal stocks in the SETF

	Biological status and harvest strategy by species				
Species	B^*/B_{MSY}	B^*/B	h^{**} *(steady state)*	h^* *(TAC optimal)*	*h (harvest 2004)*
Orange roughy in the Eastern	1.15	1.29	703	520	600
Orange roughy in the Cascade	1.47	1.64	995	665	1600
Spotted warehou	1.08	1.30	4117	3114	4100
Ling (trawl)	1.29	1.80	1397	914	1073
Flathead	1.03	1.05	3850	2980	3200

Source: Kompas and Che (2006).

There are three different values of harvest reported in Table 3. The value h is current harvest in 2004. The value h^{**} is the optimal value of harvest at steady state, after the process of stock recovery and convergence to the steady state is completed. Finally, the value of h^* is the estimated initial value of TAC that is consistent with stock recovery, assuming a 'most rapid approach' path given by the dynamics of the model (see Clark, 1990). In all five cases, model TAC or optimal harvest is below current harvest h, implying unnecessary profit dissipation and stock depletion. In most cases, h^{**} is only slightly larger than current harvest (it is lower in the case of roughy in the Cascade region), indicating both substantial overfishing and that the current harvest is not sustainable.

5 Additional policy lessons from the NPF and SETF

The inevitability of effort creep and input distortion with input controls means that each management strategy must eventually be replaced. Experience from the NPF shows that this is a failed management regime. The costs of this failure are potentially enormous, not only as a result of effort creep and losses in efficiency, but as a result of the policy framework itself. Each policy change involves costs that are additional to those caused by the ongoing input distortion. There are at least three types of costs of such management change. Firstly, there are direct and indirect management costs. The costs to managers of developing policy, consulting with industry and implementing a new policy and the costs of research underlying that policy development are often substantial. Secondly, there are costs to the industry through individual operator and industry involvement in the policy development process. Thirdly, there are costs of obsolescence of boats, gear and knowledge. With each policy change, comes the need for investment in new equipment and ideas and premature scrapping of existing equipment and ideas.

Often what is involved is scrapping of substantial capacity developed in response to the incentives under the previous input management policy. Additionally, there may be costs to taxpayers, where the government provides funding for buybacks of capacity or licenses.

As experience in the NPF shows, effort will generally not be controlled by an input approach to management. Although it is difficult to set a TAC for banana prawns in the NPF, given the environmental variability, there is still a strong case to shift to output controls. At the moment, banana prawns are not managed separately in the fishery anyway (except for seasonal and area closures). A stock assessment for the tiger prawn fishery basically determines overall effort levels and fleet size throughout the NPF. A move to ITQs is thus a potential improvement to the status quo, even it is costly to monitor banana prawns in season or to do preseason sampling.

In practice, one clear advantage of individual output controls over input controls is the absence of an ongoing competition between managers and individual operators. Under individual harvest controls, potentially cost reducing improvements in technology lead directly to reductions in the unit cost of fishing and thus to higher net returns to the fishery as a whole. Technological improvement thus has a positive impact on economic performance. One possible exception is where the resulting cost reduction is sufficient to introduce a high-grading incentive, where none existed at the original level of fishing cost – or to strengthen a preexisting incentive to high-grade. However, high-grading occurs in only some circumstances. Those circumstances are often predictable, and provided that high-grading can be estimated, the TAC can be matched with desired mortality. Unless the relationship between fishing costs and the price differential between grades changes substantially, the match will be valid over time. This is simply a cost of management to be assessed against the other costs of management, as well as the benefits – and compared to the costs and benefits of other management instruments. More importantly, the level of high-grading enters the management decision once only. By contrast, the incentive for input substitution always exists under an input control regime, no matter what the controlled input.

For ITQs to be successful, there must be adequate monitoring and enforcement. This too can be costly, although there is no necessary reason for this cost to be a government responsibility. Under an ITQ system, fishers are keen to protect their secure property rights and it is not uncommon for monitoring to be at least partially funded by industry (Grafton et al., 2006a). Even when government pays for monitoring and enforcement, this cost is likely to be comparable to the cost of monitoring and enforcing effort controls, not to mention the cost of any resulting effort creep that goes with input restrictions.

The SETF shows that for ITQs to be successful, the TAC must be set correctly. In the SETF, the ITQ system was implemented to assist structural change in the fishery, improve economic returns and ensure sustainability. However, without binding TACs, the major benefits of an ITQ system are lost; quota simply becomes an allocation mechanism. Economic returns and effort levels in the SETF thus simply replicate a limited-user 'open access' outcome. In addition to maximising net economic returns to the fishery, appropriate TACs will ensure that correct signals are sent to operators within the fishery through the quota market. Confidence in the long-term sustainability of appropriate TAC levels is likely to increase the price that operators are willing to pay for the permanent transfer of quota, thus enabling less efficient operators to exit the fishery.

Further, where stocks have been overexploited, more appropriate TACs will enable stocks to rebuild, increasing returns to the fishery and the value of both quota and fishing permits.

5.1 Securing a fishing future

In November 2005, the Minister for Fisheries, Forestry and Conservation announced a 220 million Australian dollar package to secure Australia's fishing future. *Securing our Fishing Future* will provide a major one-off structural adjustment package and improved management measures to address concerns over the state of Australia's fish stocks, and the sustainability and profitability of the fishing industry. A sum of $150 million has been allocated to directly reduce fishing capacity in Commonwealth fisheries at risk or currently subject to over-fishing.

The structural adjustment package will allow fishers to participate in a voluntary tender process that will encourage them to exit the industry and reduce excess fishing capacity. All license holders in Commonwealth fisheries, with the exception of internationally and jointly managed fisheries, will be allowed to participate in the tender process. In NPF, funding is available for structural adjustment in conjunction with transition to a management system based on output controls and ITQs. If successful, this will permanently remove the input-controlled system with its inevitable effort creep, as well, ensure a quicker (and what would otherwise be more painful) adjustment to optimal fleet size. In the SETF, the structural adjustment package is being implemented at the same time as substantial reductions in TACs for some species, which should begin to remove the problems of overfishing and overcapacity in this fishery.

Nevertheless, for the structural adjustment package to be a success, AFMA needs to ensure that this planned reduction in fishing capacity goes hand-in-hand with targets and policies that guarantee economic efficiency. This normally means pursuing some form of MEY or finding catch and effort levels, along with the right number of boats and vessel capital, which maximise discounted returns from the fishery to the Australian community. AFMA now appears fully committed to this sort of target (AFMA, 2005). Ensuring that incentives for boat capacity to reenter the fishery do not exist – something that has happened in past structural adjustment programmes worldwide (Newby et al., 2004) – will be vital in maximising the long-term benefits of the structural adjustment package.

6 Concluding remarks

'Command and control' fisheries management has been a failure in the Australian northern prawn and southeast trawl fisheries. The NPF has the right target (MEY), but the wrong instrument (input controls). The SETF, on the other hand, has the right instrument (TACs and ITQs), but the wrong or rather no target. TAC is rarely binding and it is set at inappropriate values. In both cases, fisheries management basically replicates limited-user 'open access' outcomes, albeit with substantial management costs. In summary, these management measures have failed to provide the incentives for those who fish to do so efficiently and in a manner that gives the industry a long-term stake in the future of the fishery (Grafton et al., 2006a).

The Australian Commonwealth government has announced a structural adjustment package to help alleviate the problems of overcapacity and stock declines in selected fisheries. If combined, as planned, with the right targets and instruments, ones that get incentives right, there is hope for substantial improvement. If not, the failures from past experience in the northern prawn and southeast trawl fisheries will simply be repeated.

Acknowledgements

Thanks to Tuong Nhu Che, Steve Beare, Roger Rose and David Galeano of ABARE, Trysh Stone and Paula Shoulder of AFMA, R. Quentin Grafton at the ANU, Cathy Dichmont and Tony Smith of CSIRO, Annie Jarrett, Mike Smith and David Carter of NORMAC and two anonymous referees for helpful comments on this draft and the nature and performance of Australian Commonwealth fisheries in general. The views expressed in this paper are solely those of the authors, and are not necessarily shared by the individuals acknowledged here or by ABARE.

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