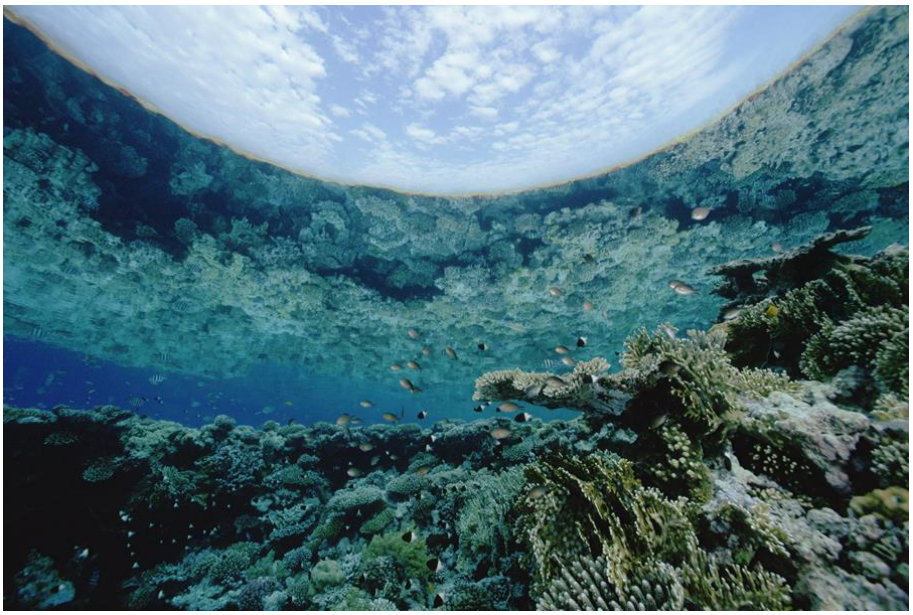
Deloitte Access Economics

Evaluation of CSIRO's research impacts

Sustainable Commercial Fisheries Case Study



Commonwealth Scientific and Industrial Research Organisation (CSIRO)

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Executive Summary

Introduction

Deloitte Access Economics (DAE) was commissioned by CSIRO to recommend, test and validate an appropriate framework and methodologies for the ex-post impact evaluation of CSIRO research. In Stage 1 of the project, DAE presented an ex-post impact evaluation framework, while Stage 2 focused on applying and validating the framework across diverse case studies. CSIRO, with the assistance of DAE, has selected four impact case studies to test the framework and undertake the ex-post impact evaluation. This report presents the 'Sustainable Commercial Fisheries' impact case study.

Impact case study: Sustainable Commercial Fisheries

CSIRO developed ecosystem-based management frameworks, along with scientific data, which are considered key to the development and implementation of the Harvest Strategy Policy (HSP), which was introduced in 2007 across Commonwealth fisheries. By leading to an outcome of more sustainable fisheries, the research has numerous impacts.

The ex-post research impact evaluation here estimated in monetary terms three key impacts of the new management policies at maturity (expected in 2025), namely improved ecological outcomes, production value of commercial fisheries and recreational value across Commonwealth fisheries.

- **Reduced ecological impact**: Assuming an average willingness to pay (WTP) for an improvement in fishing ecosystems of $5.1 per household per annum[1][1] in perpetuity (specifically, this value is the WTP for a 1% increase in fishing populations or species) and given a total number of households in Australia of 9.3 million[2], the impact of research into sustainable commercial fisheries attaining a 5% increase in fish stocks in the long-term is $236.2 million per annum at maturity.
- **Short-term reduction in volume of catch**: Based on an 18% reduction[3] in the volume of catch of Commonwealth fisheries species as a result of policy restrictions through quotas or catch limits for the first three years of the HSP and an average catch value of Commonwealth fisheries of $7,440 per tonne[4], the short-term loss associated with the introduction of a management policy is $39.7 million per annum for the first three years.

  This compares with $140 million for the Structural Adjustment Package involving the buy-back of 38% of vessels operating in the Northern Prawn Fishery, Eastern Tuna and Billfish Fishery, and the Southern and Eastern Scalefish and Shark Fishery[5], which is equivalent to $53.4 million per annum over three years.
- **Secured volume of catch in long-run:** Assuming that the management policy secures a long-term average catch of 62,000 tonnes per annum for Commonwealth fisheries in

[1] DAE estimate based on Rolfe and Windle (2012) and Morrison and Hatton (2010)

[2] DAE estimate based on ABS data (2013)

[3] DAFF (2013)

[4] Ibid

[5] Vieira et al. (2010)

2025 (compared with only 37,000 tonnes per annum under a 'no policy' scenario)[6] and given an average price of $7,740 per tonne of fish, the impact associated with a secured volume of catch in the long-term as a result of the policy is $203.7 million per annum at maturity.

- **Secured value of recreational fisheries:** Given a value of recreational fishing in Australia of $2.5 billion per annum[7] and assuming that the HSP will affect key target species, such as tuna, flathead, mackerel and whiting, accounting for 5.9% of the recreational catch nationally, the value of the policy is $55.3 million per annum at maturity. This benefit to recreational fisheries is quantified as a long-term impact with the value of recreational fisheries having changed proportionally to the value of commercial fisheries (i.e. without the HSP, the value of recreational fisheries are expected to decline in the same proportion commercial fisheries production would).

Other impacts identified but not estimated in monetary terms include a more secure income stream to commercial fisheries, improved public perception of fisheries which will support a social licence to operate for commercial fishing stakeholders and increased resilience of local fishing communities.

The impacts identified here are exclusive, meaning that they can be added together. The overall annual value of the impacts generated by the new management policies is $495.2 million at maturity. Of the total value, 80% is attributable to CSIRO[8], meaning that this research can generate $396.1 million per annum of value in the long term.

Major uncertainties affecting the estimates relate to underlying assumptions around the long-term increase in fish stocks with/without the policy, the extent to which overfishing or overfished species affect catch, the average per-tonne catch value across Commonwealth fisheries, the willingness-to-pay for an improvement in fishing ecosystems, the fish species group mixing between Commonwealth and State fisheries and attribution.

This case study is unique in that it illustrates the contribution of research through a new framework for fishery management and the provision of better data to inform policy development. The main challenges associated with this case study were establishing and quantifying the counterfactual and determining the effect of the research on fish populations – in particular putting numbers to the concept of 'more sustainable', and what it means to fish stocks in the long term. There was also a clear need to consider attribution in this case study.

[6] DAE estimates based on DAFF (2013) and ABS (2010)

[7] Henry and Lyle (2003)

[8] Based on workshop estimates provided by Flagship participants. The percentage attribution refers to the percentage of the research of outputs created by CSIRO, which enabled the outcomes and impacts.

Evaluation of research impacts: Sustainable Commercial Fisheries

1. Project context

Deloitte Access Economics (DAE) was commissioned by CSIRO to recommend, test and validate an appropriate framework and methodologies for the ex-post impact evaluation of CSIRO research. In the first stage of the project, DAE developed an ex-post impact evaluation framework in collaboration with CSIRO stakeholders and the Performance and Evaluation Team. Appendix A provides an overview of that framework, including the different framework steps and key considerations.

The second stage of the project focused on applying and validating the framework across diverse case studies. CSIRO, with the assistance of DAE, selected four impact case studies to test the framework and undertake the ex-post impact evaluation. This report presents the 'Sustainable Commercial Fisheries' impact case study.

2. Background: Sustainable Commercial Fisheries

CSIRO's Wealth from Oceans Flagship focuses on national challenges where oceans play a central role, and aims to provide enduring social, environmental and economic wealth from Australia's ocean territory. The Flagship takes a whole-of-system approach to managing Australia's ocean, focusing on delivery of triple-bottom-line benefits. As part of the Flagship, scientists combine expertise in fisheries and social sciences, biodiversity, conservation, and natural resource economics to deliver science and technology to help sustain life in Australia's oceans. The Wealth from Oceans Flagship goal is to "provide Australia with the knowledge and tools to protect coastal and ocean environments, increase their value to society and create a net economic benefit of $3 billion per annum" (CSIRO, 2012).

One of the outputs of the Flagship's research into sustainable ocean ecosystems and living resources is the provision of scientific advice to Commonwealth and State agencies responsible for managing Australia's ocean resources on how to manage commercial fisheries in the most sustainable way. This involves advice on sustainable fishing of commercial species and to increase certainty for the future of commercial fishing while aiming to ensure long-term economic profitability. CSIRO also contributes to state fisheries assessment and has had a long standing engagement with regional neighbours particularly capacity building and assessment of shared stocks.

Formal harvest strategies comprise three important components—monitoring, assessment, and decision rules (or harvest control rules). CSIRO's 'Sustainable Commercial Fisheries' research informed the development of key management policies, including their technical design and implementation. They include:

- the **Commonwealth Harvest Strategy Policy** (HSP), which is applicable across all domestic commercial fisheries, setting fishery catch limits according to agreed scientific and economic goals;
- the management arrangements for the **Northern Prawn Fishery** (NPF); and
- the management arrangements (quota) for the **Southern Bluefin Tuna** (SBT).

These management policies aim to ensure that key commercial fish species are managed for long-term biological sustainability and economic profitability. The HSP provides a framework that allows a strategic, science-based approach to setting total allowable catch levels in all Commonwealth fisheries on a fishery by fishery basis. The implementation guidelines provide practical advice on how to interpret and apply the harvest strategy policy to Australia's fisheries and contain details of the science behind the fisheries management decisions.

While the HSP was formally implemented in 2007, steps had already been taken to address the significant increase in overfishing of Commonwealth-managed fish species. These steps followed the 2005 statutory direction by the Federal Minister for Fisheries to recover overfished stocks and to prevent future overfishing in all Commonwealth fisheries. This direction was accompanied by a structural adjustment package to reduce fleet numbers in several fisheries with the aim of removing excess capacity, improving the profitability of the remaining fleet, and to assist in the implementation of a network of marine protected areas in the southeast Australian extended economic zone.

CSIRO work underpinning these fisheries management strategies includes the ecological risk assessment framework termed Ecological Risk Assessment for the Effects of Fishing (ERAEF) by Hobday et al. (2011). This framework seeks to implement an ecosystem approach rather than single-species fishery management. Ecosystem-based fisheries management (EBFM) was introduced gradually in Australia, requiring policy changes along with scientific and management tools to support practical implementation (Smith et al., 2007a).

Although no equivalent formal policies exist at the state level in Australia, several state fisheries jurisdictions have adopted formal harvest strategies for important commercial fisheries. At this stage, the approach to their application varies between jurisdictions. Although acknowledging these state trends, this impact assessment focuses on Commonwealth fisheries.

3. Purpose and audience for the evaluation

The evaluation assesses the outcomes and impacts derived from a range of CSIRO research projects to support accountability reporting, communication of impacts and continual improvement of their path to impact planning. The main purposes and audiences are:

- **Flagship Review:** The evaluation is to inform an external review of the Flagship, which includes an assessment of the Flagship's objectives and the rate of progress. The Sustainable Commercial Fisheries case study will be used as evidence of the social, environmental and economic impacts of the Flagship's research.
- **CSIRO review:** The evaluation is to inform CSIRO's (and other external party) reviews of its programs and activities, in particular in relation to achieving its objectives and

representing value for money. Audiences may include Ministers, CSIRO at all levels and the general public.

4. Status of research and adoption

Nature of the impacts

The Sustainable Commercial Fisheries case study has a variety of impacts, including reduced adverse ecological impacts, a secured volume of commercial catch and a secured value of recreational fisheries in the long-run. The following impacts of the new management policies were identified:

i **Reduced adverse ecological impact (environmental impact):** Sustainable fisheries management reduces impact on biodiversity through reduced fishing of commercial and non-commercial species as a result of reduced by-catch and ecological footprint. This impact is estimated in monetary terms through people's valuation for the conservation of marine biodiversity**.**

ii **Short-term reduction in volume of catch (economic impact):** This impact refers to the decrease in catch of commercial species, as a result of policy restrictions through quotas or catch limits. While this is an intentional outcome of the policy, it may be considered as a short term negative economic impact with longer term benefit. The short-term reduction in volume of catch can be compared with the value of the Structural Adjustment Package involving the buy-back of vessels operating in the Northern Prawn Fishery, Eastern Tuna and Billfish Fishery, and the Southern and Eastern Scalefish and Shark Fishery.

iii **Secured volume of commercial catch in long-run (economic impact):** This impact is the longer-term increase in catch for commercial fishing industries because of the increased sustainability of fish populations.

iv **Reduced effort per catch (economic impact):** A long-term reduction in overfishing can be linked to an increased volume of catch per fishing trip and relative to any of the inputs required (e.g. fuel, time, etc.). This impact can be considered as reduced effort per catch, or improved efficiency of fishing effort. Similar to the secured volume of commercial catch impact above, this value adds to the profitability of commercial fishing in the long run.

v **More secure income stream (economic impact):** Similar to the previous two impacts, this impact relates specifically to the increased security over the volume of catch in the long-run, meaning fishing businesses have more certainty around future production volumes. This enables them to make longer-term investment decisions for their business.

vi **Higher secured value for recreational fishing and tourism (social impact):** Other ecosystem services provided by Commonwealth fisheries such as recreational fishing and tourism will also be enhanced by more sustainable fisheries over the long-term.

vii **Increased resilience of local fishing communities (social impact):** Securing the volume of catch in the long-run helps fishing industries in fishing-dependent communities to remain viable, with local communities – especially those with fewer other employment options – benefitting from the industry.

Of the benefits identified, (i) to (iv) and (vi) were estimated in monetary terms, as discussed in Section 5. Other benefits such as reduced effort per catch, the secure income stream, increased resilience and improved public perception were not quantified due to lack of quantitative information that could be considered within the limited resources and time allocated to the consultancy.

Note that Section 5 presents the assessment of the impacts resulting from the research outputs (in this case the new management policies) more broadly. The impacts attributable to CSIRO research are discussed in the aggregation section (Section 6).

Counterfactual

The involvement of CSIRO was imperative to the development, implementation and testing of the Harvest Strategy Policy. Without CSIRO's depth and breadth of capability and applied experience within the fisheries field of research, the ecological data would not have been available. The calibre of CSIRO's fisheries researchers is evidenced by the numerous accolades received from national and international bodies, including awards such as the Japan Prize and the Order of Australia medal. In terms of publications, in the period between 2008 and 2012, CSIRO's fisheries publications were 59% more cited than the world average and 45% of CSIRO's fisheries publications were in first quartile journals based on the Impact Factor. In the absence of CSIRO's world-class research, it is likely that pre-2005 trends of overfishing and overfished populations would have continued (i.e. a continuous increase of overfishing and overfished species, as seen in international fisheries[9]).

Attribution

The research behind the sustainable management was a major contributor to the impact, but there were other activities required before the impact could be realised, including implementation of the policy. According to Flagship stakeholders, 80% of the research outputs can be attributed to CSIRO. The other 20% of research outputs were contributed by other research agencies. Note that the contribution of other organisations outside of research outputs was not considered, i.e. the significant contributions of organisations in developing and implementing the HSP. In this case, the impact estimates of CSIRO research will be apportioned using this share.

It is likely that other inputs (such as implementation and enforcement of the policy) are required to unlock the full impacts. However, insufficient information was available to refine the attribution estimate.

Adoption

The adoption level is measured in terms of the size of the marine fisheries covered by the Harvest Strategy Policy. Although the initial adoption (2005-2007) has been documented for the Southern and Eastern Scalefish and Shark Commonwealth Fishery (having many of the cases of overfishing), the analysis considers the impact of research across all Commonwealth fisheries after the HSP is introduced and focuses on long-term impacts at full maturity. However, it should be noted that considerable fisheries and ecological

[9] FAO (2012) Review of the state of world marine fisheries resources, Fig. A.11. http://www.fao.org/docrep/015/i2389e/i2389e.pdf

research had been undertaken previously that contributed to the implementation of this policy.

The adoption target is expected to be reached in 2025 for all Commonwealth fisheries directly regulated by federal legislation. These fisheries host about 50 stocks or species and cover the Antarctic Fishery, Bass Strait Central Zone Scallop Fishery, Coral Sea Fishery, Eastern Tuna and Billfish Fishery, Northern Prawn Fishery, North West Slope Trawl Fishery, Skipjack Fisheries, Small Pelagic Fishery, Southern and Eastern Scalefish and Shark Fishery, Southern Squid Jig Fishery, Western Deepwater Trawl Fishery, and Western Tuna and Billfish Fishery.

The outstanding Commonwealth fisheries that are subject to international laws or management strategies (e.g. Southern Bluefin Tuna, Torres Strait and Norfolk Island) are not directly regulated by this policy. However, in the impact analysis these fisheries are assumed to benefit equally from the ecological improvements in the other fisheries.

5. Assessment of the impacts

Quantified impacts

This section presents DAE's approach to quantify key impacts at maturity levels, based on the best data available to CSIRO for this analysis. Any assumptions and sources used in the analysis are outlined in the relevant tables with the impact calculation.

Reduced adverse ecological impact

The reduced adverse ecological impact can be understood as the value that Australian households place on environmental conservation of fisheries, above and beyond any commercial or recreational benefits they might enjoy. Environmental conservation in this context is the improved ecological health of marine ecosystems as a result of reduced by-catch from commercial fishing.

Assuming an average willingness to pay (WTP) for an improvement in fishing ecosystems of $5.1 per household per annum in perpetuity (specifically, this value is the WTP for a 1% increase in fishing populations or species) and given a total number of households in Australia of 9.3 million, the impact of research into sustainable commercial fisheries attaining a 5% increase in fish stocks in the long-term is $236.2 million per annum at maturity (expected in 2025). The underlying assumptions and sources are presented in Table 5.1.

Table 5.1: Impact calculation of reduced adverse ecological impact

	Measure	Value	Sources
	With CSIRO research		
A_R	Increase in fish stocks in the long-term across Commonwealth fisheries [% per annum]	5%	DAE estimate based on Barnes et al. (2011)
B_R	Number of Australian households	9,252,360	ABS (2013), ABS (2012)

	Measure	Value	Sources
C_R	Mean WTP estimate for 1% increase in fishing populations or species [$ per household per annum]	$5.1	DAE estimate based on Rolfe & Windle (2012), Morrison and Hatton (2010)
D_R	Benefits of ecological conservation under the HSP [$ per annum]	$= (A_R*100)*B_R*C_R$ = $236.2 m	
	Counterfactual		
A_C	Increase in fish stocks in the long-term across Commonwealth fisheries [% per annum]	0%	DAE assumption
D_c	Benefits of ecological conservation without HSP [$ per annum]	$= A_c*B_R*C_R$ = $0m	
	Impact: world with CSIRO research - counterfactual		
	Value of ecological benefits due to CSIRO research [$ per annum]	$= D_R - D_c$ = $236.2m	

Note: Monetary values are presented in 2013 $AUD.

Short-term reduction in volume of catch

Assuming an 18.0% reduction in the volume of catch of Commonwealth fisheries species as a result of policy restrictions through quotas or catch limits for the first three years and a catch value of Commonwealth fisheries of $7,440 per tonne prior to the HSP introduction, the short-term loss associated with the introduction of a management policy is $39.7 million per annum for the first three years. The assumptions and sources for this impact are outlined in Table 5.2.

Table 5.2: Impact calculation of short-term reduction in volume of catch

	Measure	Value	Sources
	With CSIRO research		
A_R	Total catch in 2004 prior to the HSP introduction [tonnes]	77,813.1	DAFF (2013)
B_R	Average value of catch across Commonwealth fisheries [$ per tonne]	$7,440.0	DAFF (2013)
C_R	Catch reduction in Commonwealth fisheries over 2005-2008 [%]	18.0%	DAFF (2013)
D_R	Catch value in commercial fishing observed after three years of the HSP [$]	$= A_R*B_R*(1-C_R)$ = $474.7m	
	Counterfactual		
C_c	Assumed change in commercial catch in Commonwealth fisheries over 2005-2008[1] [%]	0%	DAE assumption
D_c	Catch value in commercial fishing without the HSP [$]	$= A_R*B_R*(1-C_c)$ = $578.9m	
	Impact: world with CSIRO research - counterfactual		
	Production loss from reductions in catch after three years of the HSP introduction [$ per annum]	$= \frac{7\%*(D_R - D_C)}{1-(1+7\%)^3}$ = $39.7m	

Note: Monetary values are presented in 2013 $AUD. [1] Note that historical catch increased in commercial Commonwealth fisheries by 5% per year over 1993/94-2003/04, however catch levels peaked twice over that period, indicating that increasing catch rates may be unlikely to continue.

The $34.7 million loss per annum for the first three years compares with $140 million for the Structural Adjustment Package involving the buy-back of 38% of vessels operating in the Northern Prawn Fishery, Eastern Tuna and Billfish Fishery, and the Southern and Eastern Scalefish and Shark Fishery (Vieira et al., 2010). Over three years, the value of the Package is equivalent to $53.4 million per annum.

Secured volume of catch in long-run

Assuming that the management policy secures a long-term average catch of 62,000 tonnes per annum for Commonwealth fisheries (compared with only 37,000 tonnes per annum under a 'no policy' scenario) and given an average price of $7,740 per tonne of fish, the increased catch associated with the policy is valued at $203.7 million per annum at maturity. The assumptions and sources underlying these estimates are in Table 5.3 below.

The long-term average catch of 62,000 tonnes is approximately 80% of the maximum catch registered historically in 2004. Thus, it appears as a reasonable long-term commercial target for 2025, considering that the HSP was introduced in 2007 (note a harvest strategy framework was introduced in the Southern and Eastern Scalefish and Shark Fishery (SESSF) in 2005) and assuming that fishery stocks which were subject to overfishing start recovering from 2013 at a rate of 5% per annum (this indicative figure is based on CSIRO studies such as Barnes et al. (2011)). The detailed calculation for this impact is presented in Table 5.3.

Table 5.3: Impact calculation of secured volume of catch in long-run

	Measure	Value	Sources
	With CSIRO research		
A_R	Catch observed in 2011/12 [tonnes]	43,174.3	DAFF (2013)
B_R	Proportion of commercial catch with stocks overfished or subject to overfishing in 2003-05 [1]	40%	DAE assumption based on ABS (2010)
C_R	Total catch in 2004 prior to the HSP [tonnes]	77,813.1	DAFF (2013)
D_R	Annual catch increase over time after overfished/ overfishing species have rebuilt [% per annum]	5%	DAE estimate based on Barnes et al. (2011)
E_R	Tonnes of fish caught at maturity after overfished/ overfishing species have rebuilt over 2013 to 2025 [tonnes] [2]	$= A_R + B_R * C_R * D_R$ *12 years = 61,849.5	
F_R	Average catch value across Commonwealth fisheries [$ per tonne]	$7,440.0	DAFF (2013)
G_R	Annual value of Commonwealth commercial fisheries production in 2025 [$]	$= E_R * F_R$ = $460.2m	
	Counterfactual		
A_c	Overfished/overfishing annual rate increase between 1998 and 2005 [% per annum]	2.7%	ABS (2010)
B_c	Annual catch reduction observed historically between 1998-2005 [tonnes per annum]	2,064	DAFF (2013)
C_c	Reduction in catch per 1% increase in overfished/overfishing stocks [tonnes]	$= B_c/(A_c * 100)$ = 760	
D_c	Total catch in 2004 prior to the HSP [tonnes]	77,813.1	DAFF (2013)
E_c	Expected catch in 2025 [tonnes]	$= D_c - (A_c * 100) * C_c$ *21 years = 34,473	

	Measure	Value	Sources
F_c	Average catch value across Commonwealth fisheries [$ per tonne]	$7,440.0	DAFF (2013)
G_c	Annual value of Commonwealth commercial fisheries production in 2025 [$ per annum]	= E_c*F_c = $256.5m	
	Impact: world with CSIRO research - counterfactual		
	Additional catch obtained in 2025 due to the HSP [$ per annum]	= G_R - G_c = $203.7m	

Note: Monetary values are presented in 2013 $AUD. [1] 2005 had the highest proportion of fish stocks that were overfished or subject to overfishing (29%). [2]Assumes overfished/overfishing stocks in 2005 start rebuilding, with catch increasing from 2013 onwards.

Secured value of recreational fisheries

The recreational fishing value is based on 2000 survey data eliciting the anglers' spend and effort specifically related to their visit/trip for recreational fishing. The per-angler expenditure is assumed to reflect angler's WTP for their personal enjoyment of recreational fishing.

Even though the CSIRO research is focussed on Commonwealth fisheries, which are not the same fisheries typically targeted by recreational anglers, there will be some overlap between improved sustainability of Commonwealth fisheries and recreational fishing values. Improved sustainability of Commonwealth fisheries will improve recreational opportunities in mostly state managed recreational fisheries because of the mixing of populations and ecological links between Commonwealth and State fisheries.

There is no estimate of the degree to which this mixing occurs throughout all Australian fisheries – the effect on recreational fish populations (and hence recreational fishing values) as a function of the commercial fish catch increase – but for the purpose of this evaluation, the calculations were based on an assumption of 25.0%. This means, for every percentage unit increase in commercial catch because of HSP, recreational fishing opportunities from the same family of species (e.g. Whiting, Flathead, Mackerels, Tuna) experiences only one quarter of the same percentage increase.

Given a value of recreational fishing in Australia of $2.5 billion per annum and assuming that the HSP affects key target species accounting for 5.9% of the recreational catch nationally, the value of the contribution of CSIRO research to enhance recreational fishing is $55.3 million per annum at maturity. This benefit to recreational fisheries is quantified as a long-term impact, with the value of recreational fisheries having changed proportionally to the value of commercial fisheries (as both are driven by the same higher fish populations compared with the counterfactual). The detailed calculation for this impact is presented in Table 5.4.

Table 5.4: Impact calculation of secured value of recreational fisheries

	Measure	Value	Sources
	With CSIRO research		
A_R	Annual biomass harvest taken by Australian recreational fishers of key target species affected by the HSP: Whiting, Flathead, Mackerels, Tuna [%]	23.7%	Henry and Lyle (2003)

	Measure	Value	Sources
B_R	Fish species group mixing between Commonwealth and State fisheries	25.0%	CSIRO assumption
C_R	Share of recreational catch benefiting from the HSP	$= A_R * B_R$ =5.9%	
D_R	Annual value of recreational fishing across Australia[1] [$ per annum]	$2,567.9m	Henry and Lyle (2003)
E_R	Current value of recreational fishing affected by HSP [$ per annum]	$= C_R * D_R$ = $157.3m	
F_R	Annual commercial fishing production in 2025 as compared with pre-HSP levels [%]	=79.5%	Derived from Table 5.3 (E_R/C_R)
G_R	Value of recreational fishing in Commonwealth fisheries in 2025 [$ per annum]	$= E_R * F_R$ = $125.0m	
	Counterfactual		
F_c	Annual commercial fishing production in 2025 as compared with pre-HSP levels [%]	44.3%	Derived from Table 5.3 (E_c/D_c)
G_c	Value of recreational fishing affected by HSP in 2025 [$ per annum]	$= E_R * F_C$ = $69.7m	
	Impact: world with CSIRO research - counterfactual		
	Additional value of recreational fishing in 2025 due to HSP [$ per annum]	$= G_R - G_c$ = $55.3m	

Note: Monetary values are presented in 2013 $AUD. [1] Based on 3,360,000 anglers in Australia with average annual expenditure of $552 for recreational fishing in 2000, as discussed in Henry and Lyle (2003).

Further impacts

The following impacts were also considered and discussed during the workshop held with DAE and relevant Flagship members. This section provides an overview of the causal linkage from the adoption of the HSP to generate other impacts that could not be quantified, along with examples evidencing the extent to which they have been realised to date.

Reduced effort per catch

An increased volume of catch in commercial fisheries, as quantified before, can also be linked to a reduced effort per catch.

A recent report by Vieira et al. (2010) presents trends of the catch per unit effort (CPUE) of three key fisheries affected by the buyback from the structural adjustment package on 2007/08 – namely, the Northern Prawn Fishery, the Eastern Tuna and Billfish Fishery (ETBF) and the SESSF. In the case of the Northern Prawn Fishery the CPUE for tiger prawns decreased by 7% in 2008/09, while for banana prawns large fluctuations were observed, mainly due to environmental variability. In the Commonwealth trawl sector of the SESSF, the notable increase of CPUE over 2005/06 and 2007/08 for three key species (blue grenadier, flathead and silver warehou) drove increased profitability in this sector observed over the same period. In the case of stocks that are internationally shared, such as the ETBF, a reduction in catch and effort is not likely to have a strong positive influence on future catch rates.

Overall, there is no conclusive evidence indicating the HSP has led to a reduced effort per catch at this stage. Although, in most fisheries, the causes of changes in catch rates cannot

not be identified precisely (particularly, the effect of the HSP cannot be estimated within a short evaluation period following the policy introduction), it is expected that increasing the abundance of key fish stocks will lead to a reducation in costs per unit of catch. This in turn is likely to increase net economic returns in fisheries.

More secure income stream

Assuming that catch effort, fishing methods and environmental conditions remain constant, reducing overfishing will contribute to long-term viability of fisheries, which will then lead to reduced uncertainty in seafood supply and maintaining the fishing industries' employment contribution to the Australian economy.

There is not sufficient information to assess whether a more secured income has been in fact observed in fisheries with reduced overfishing rates following the policy introduction. A way to quantify this impact could be by assessing the effect of a risk premium on market prices. Alternatively, market entry and exit of fishing businesses may also be indicative of the risk perceived in the industry.

Increased resilience of local fishing communities

Port communities that are highly dependent on fishing industries are likely to benefit from sustainable fisheries management. At this stage, no disaggregated data are available to evaluate this impact following the HSP. Measuring resilience at the community level is not a straightforward task, but can be implemented by constructing an index that measures exposure and vulnerability of specific communities in relation to changes in fishing industries. This type of analysis has been previously applied in the context of water restrictions for agriculture.

Distributional effects

Distributional effects include:

- The main beneficiaries of the increased commercial catch are those fishing businesses remaining in the industry. In the short term, there is less competition for the catch as some exit the industry and, more importantly, in the long term the fish populations are higher because of the sustainability strategies. This allows them to either increase catch volume, or reduce costs for the same volume of catch.
- Potentially significant differences exist in the impacts on different types of fisheries and associated ecological impacts, long-term catch rates and value of recreational fisheries. Hence, in reality not all fisheries are expected to experience benefits to the same extent.
- While some fishing businesses are disadvantaged by the policy (but typically compensated through the Structural Adjustment Package), the remaining businesses will benefit from the prospect of a more secure volume in the long-run. For instance, small operators are more likely to exit the market in the short-term; those who would benefit from increased catch rates in the long-term are large vessel operators.

Externalities or other flow-on/spillover effects on non-users

Externalities in terms of the benefits to ecosystems are directly valued through Impact (i). However, other externalities are more difficult to measure. For instance, State managed fisheries may benefit from the HSP and its impacts on commercial fisheries. There may also be regional migration benefits from Australian policy, with fisheries in other countries set to benefit from Australia's management policy.

HSP has flow-on effects on upstream and downstream businesses in the supply chain. Initially, the structural adjustment package provided compensation for reduced economic activity through buy-backs, which flowed through the value chain in commercial fishing. Economic flow-on impacts (e.g. in terms of value added and employment) from decreased/reduced commercial fishing activity from impacts (ii) and (iv) can be calculated using standard economic modelling, such as an Input-Output multiplier analysis.

A flow-on effect of recreational fishing could also include tourism activity. As such, anglers travelling from different location may be willing to combine their fishing experience with a holiday in coastal areas with their families. This represents an additional contribution to areas attracting recreational fishing by stimulating further economic activity, typically measured in terms of any expenditure made at the destination. Tourism may also support building more resilient fishing communities.

6. Aggregation of research impacts

Aggregation of impacts and attribution to CSIRO research

The impacts identified in this case study present a wide range of benefits to society in terms of reduced ecological impact, secured production volume of commercial fisheries and recreational value across Commonwealth fisheries. CSIRO's research and data are considered to be key enablers for the introduction and development of the HSP. Thus, without CSIRO research it is assumed that historical trends in volume of catch and overfishing rates would have continued. In this context, the costs of the implementation of the HSP, e.g. in terms of data generation requirements, should be also incorporated in the analysis, if such data are available.

Impacts are likely to vary over time and assumptions were required about the expected response for fishing stocks to rebuild and recover over time, as overfishing can be corrected immediately but overfished stocks take many years to recover. For consistency, this case study assumes that all Commonwealth fisheries will benefit equally from the HSP.

Some of the impacts identified here are exclusive, meaning that they can be added together. The overall annual value of the impacts generated by the new management policies is – which is the sum of impacts (i), (iii) and (vi) as shown in Table 6.1 – is $495.2 million at maturity. Of the total value, 80% is attributable to CSIRO, meaning that this research can generate $396.1 million per annum of value nationally in the long term.

Table 6.1: Summary of impacts from Sustainable Commercial Fisheries impacts at full maturity ($ per annum)

	Impact	Quantified in monetary terms?	Type	Annual value
i	Reduced adverse ecological impact	yes	Environmental	$236.2m
ii	Short-term reduction in volume of catch (assessed between 2005 and 2008)	yes	Economic	$39.7m
iii	Secured volume of catch in long run (evaluated in 2025)	yes	Economic	$203.7m
iv	Reduced effort per catch	no	Economic	-
v	More secure income stream	no	Economic	-
vi	Secured value of recreational fisheries (linked to volume of catch in 2025)	yes	Social	$55.3m
vii	Increased resilience of local fishing communities	no	Social	-
	TOTAL (long-term impacts i, iii and vi only)			**$495.2m**
	TOTAL ATTRIBUTABLE TO CSIRO (80%)			**$396.1m**

Note: Monetary values are presented in 2013 $AUD.

This analysis assumes that the HSP will be the main driver in fish stock changes in Commonwealth fisheries and the quantification has limited the impacts to this boundary. However, the distinction between Commonwealth and State managed fisheries is artificial for fishing populations. In this way, benefits in Commonwealth fisheries will impact positively on State managed fisheries, but such flow-on effects have not been incorporated. Similarly, existing management in wild State fisheries may enhance or counteract the expected effects in Commonwealth fisheries. Thus, for this case study it would be important to note whether adoption is feasible and has started already across states, so the impacts are extrapolated at the national level.

Risks and uncertainties

Estimates are surrounded by a significant degree of uncertainty. Some of the most significant risks and issues affecting the impact estimates include variations to the assumptions around:

- Long-term increase in fish stocks as a result of the policy (this estimate is based on modelling studies for specific fisheries only) and extent to which overfishing or overfished species affect catch;
- Long-term change in fish stocks without the policy (the current estimate assumes that they remain unchanged) and the impact on catch;
- Average per-tonne catch value across Commonwealth fisheries (the current estimates assumes this to be constant);
- Willingness-to-pay for an improvement in fishing ecosystems (the current estimate is based on specific fishing areas rather than Commonwealth fisheries more broadly);
- Fish species group mixing between Commonwealth and State fisheries (currently based on CSIRO discussions with research scientists); and
- Attribution (the current estimate does not take into account all other inputs required to realise the impacts).

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Appendix A: Evaluation framework

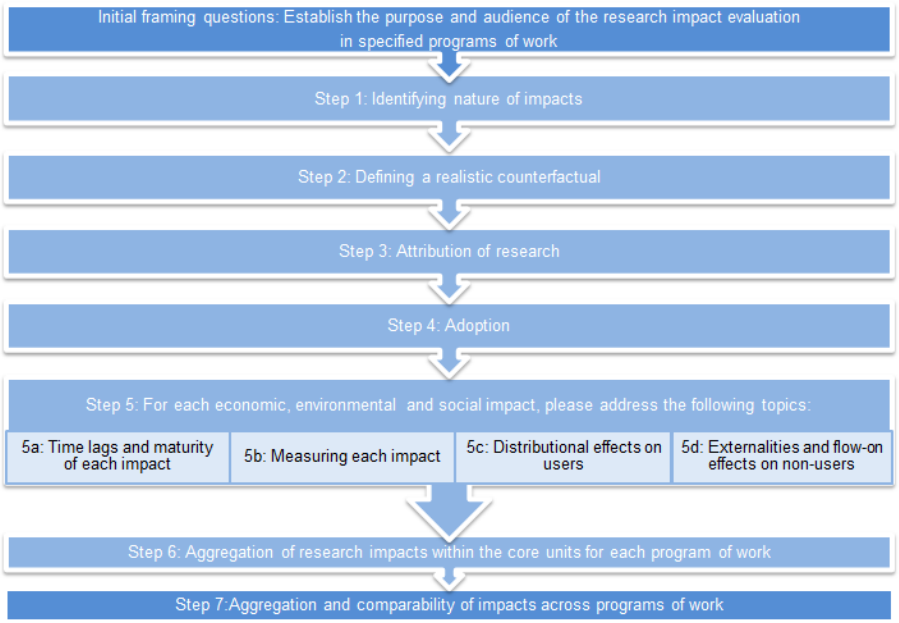
Ex-post impact evaluation framework

In order to comprehensively and consistently evaluate research impacts, and taking into account CSIRO's methodological challenges, DAE developed a framework that consists of the following four groups of steps:

- **Initial framing – Purpose and audience of the impact evaluation**: The starting point is to identify the primary purpose and audience of the ex-post impact evaluation. This needs to be clarified early on as it will determine the most appropriate methodologies and the types of impacts to focus on.
- **Steps 1-4 – Status of research and adoption**: These steps are used to identify the nature of the main impacts from the research being evaluated and the status of adoption.
- **Step 5 – Assessment of the impacts**: This step quantifies and estimates impacts in monetary terms, where possible.
- **Steps 6-7 – Aggregation of research impacts and comparability**: These steps aggregate diverse impacts from individual programs of works to a single evaluation measure or indicator when appropriate.

The four parts, which consist of the seven more detailed evaluation steps as outlined in Figure A.1, comprise the framework structure [and are explained in more detail in Deloitte Access Economics *Decision making framework for ex-post impact evaluation of CSIRO's research impact – Stage 1* (DAE, 2013).

Figure A.1: Steps in the ex-post research impact evaluation framework



To ensure a consistent understanding of the framework and its application, this section outlines a number of key considerations underpinning the evaluation framework.

What does 'ex-post' mean in the context of the framework?

An ***ex-post*** evaluation refers to the assessment of a program of research, such as of an individual flagship, theme, or a group of individual projects, after it has occurred. As such, an '***ex-post research impact evaluation'*** refers to the evaluation of the impact attributable to a program of research after the research has been completed and outputs have occurred. In order to be ex-post, while research has to be complete, adoption may be incomplete and some impacts may be still be in the future. Ex-post impact evaluation contrasts with 'ex-ante impact evaluation', which refers to the evaluation of prospective impacts and is undertaken before the research has produced outputs.

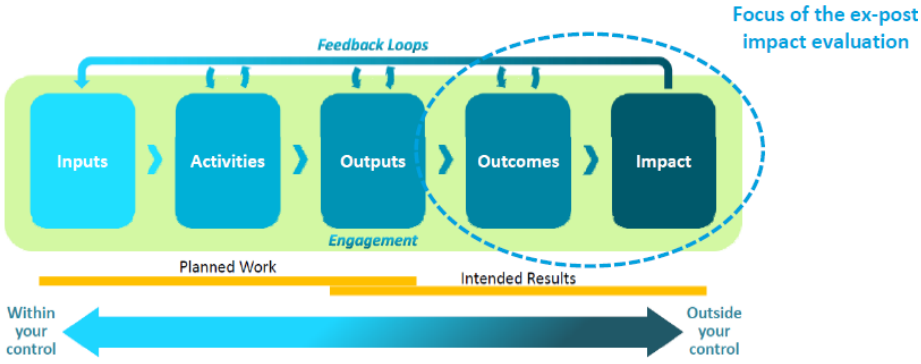
What are 'impacts' in the context of this framework?

In an ex-post impact evaluation of research, CSIRO (2013) has defined **impact** as:

> *An effect on, change or benefit to the economy, society or environment, beyond those contributions to academic knowledge. Impact includes, but is not limited to an effect on, change or benefit to the activity, attitude, awareness, behaviour, capacity, opportunity, performance, policy, practice, process or understanding of an audience, beneficiary, community, constituency, organisation or individuals in any geographic location whether locally, regionally, nationally or internationally. Impact also includes the reduction, avoidance or prevention of harm, risk, cost or other negative effects.*

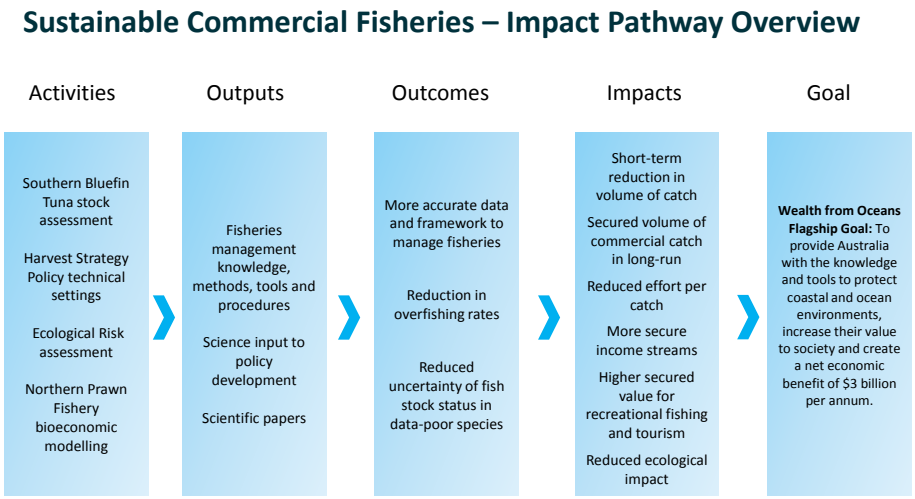
An impact is typically an external effect or change beyond the organisation that produced it. It is the culmination of the CSIRO's impact pathway, as illustrated in Figure A.2.

Figure A.2: CSIRO's Impact Pathway



An Impact Pathway diagrams for the Sustainable Commercial Fisheries impact case study is provided below. It illustrates the process by which planned research work translate into tangible outcomes and impacts to society.

Figure A.3: CSIRO's Impact Pathway for the Sustainable Commercial Fisheries case study



What types of impacts are being evaluated under the framework?

The ex-post impact evaluation framework guides the evaluation of the effects, changes or benefits generated by completed research to the economy, society and the environment. It includes the **valuation of realised and projected economic, social and environmental impacts**. It excludes the valuation of potential impacts that cannot yet be expected or realistically projected, as well as the valuation of other research aspects such as research quality.

Stage 1 of the project presented the following definitions for economic, social and environmental impacts in line with latest GRI Performance Indicators (2011):

- **Economic impacts**: Economic impacts are impacts on an economic system at a local, national or global level such as changes in revenue, operating costs, profitability, gross domestic product (GDP), employment or investment returns.
- **Social impacts**: Social impact refers to how an activity affects the surrounding community. This includes impacts on health, community engagement, skills and labour practices.
- **Environmental impacts**: Environmental impacts are impacts on living and non-living natural systems, including ecosystems, land, air and water.

What is being evaluated?

Research at CSIRO is organised in a matrix in which groups, programs or divisions provide research capabilities to address research priorities defined in national flagships. Research projects are the smallest component within research portfolios, however most single projects are unlikely to lead to an impact in their own right. For this reason, the core unit of research evaluation for CSIRO is a **'program of works'**, which refers to related activities in a portfolio of research activity leading to the one outcome. A program of works encompass entire themes or flagships, group of projects, or those programs of work whose planned impact is summarised in Impact Statements (DAE, 2013; CSIRO, 2013).

Limitation of our work

General use restriction

The report has been prepared at the request of CSIRO for the purpose of demonstrating the value of CSIRO's research through ex-post impact evaluation. This report may be released into the public domain, but we accept no duty of care to any other person or entity who chooses to rely on this report other than CSIRO.

Contact us

Deloitte Access Economics
ACN: 149 633 116

Level 1
9 Sydney Avenue
Barton ACT 2600
PO Box 6334
Kingston ACT 2604 Australia

Tel: +61 2 6175 2000
Fax: +61 2 6175 2001

www.deloitteaccesseconomics.com.au

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