

(DRAFT)

**Cost-Effectiveness Analysis for the Introduction of Mandatory Vessel
Monitoring Systems on Commercial Fishing Vessels Operating and
Transiting in Australian Marine Parks.**

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Cost Effectiveness Analysis for the Introduction of Mandatory Vessel Monitoring Systems on Commercial Fishing Vessels Operating and Transiting in Australian Marine Parks. (DRAFT)

1 Summary

Australian Marine Parks cover more than 3.5 million km² of Australia's ocean ecosystems. Their success depends largely on effective compliance; however, their sheer size and remoteness present a significant challenge for enforcing marine park rules and preventing illegal fishing. Effective compliance involves prevention, deterrence and detection of illegal fishing. The detection of illegal fishing relies on the ability to know where and when commercial boats are fishing. Critical to achieving this is adequate surveillance coverage.

In 2021-22, Parks Australia made available \$5.5 million in grant funding to state and NT fisheries management authorities to increase the uptake of remote electronic and vessel monitoring systems (VMS) for commercial fishing vessels active in Australian Marine Parks. The Director of National Parks is now investigating a proposal to make VMS mandatory for all commercial fishers operating and transiting in Australian Marine Parks no sooner than 2024.

Although several surveillance tools are available to Parks Australia, including vessel-based patrols and aircraft, VMS is the only tool that can provide complete coverage of all commercial fishing vessels in Australian Marine Parks. VMS is a well-established management tool in Australian fisheries and a proven compliance measure for enforcing Australian Marine Parks fishing rules. Approximately 60 per cent of commercial fishing vessels in Australian Marine Parks already have VMS installed as a fisheries management agency requirement. The Australian Fisheries Management Authority has also established a national VMS platform, providing support and a uniform approach to VMS use for all jurisdictions. The introduction of mandatory VMS by the Great Barrier Reef Marine Park Authority in 2019 has proved highly successful, resulting in increased detection of illegal commercial fishing.

A cost-effectiveness analysis and benefits assessment for the introduction of mandatory VMS on commercial fishing vessels operating and transiting in Australian Marine Parks are required for the Director of National Parks to make an informed decision on the policy and the impacts on and benefits for affected stakeholders.

The most important impact of the options under investigation is the benefit to marine park values from compliance with commercial fishing rules. Because of the significant diversity of marine park values across the Australian Marine Park estate, the range of gear types and impacts of commercial fishing and the lack of information on commercial fishing use in Australian Marine Parks, it is not possible to cost these benefits. For this reason, a cost-effectiveness analysis and a qualitative assessment of the costs and benefits of options were undertaken.

This cost-effectiveness analysis compares four options that improve compliance and enforceability with fishing rules in Australian Marine Parks through improved monitoring and surveillance:

- Option One is the regulatory proposal to mandate VMS.
- Option Two is status quo compliance monitoring and surveillance.
- Option Three is increased aerial and vessel-based surveillance.
- Option Four is manual vessel position reporting.

The cost-effectiveness analysis considered the costs of the options on commercial fishing businesses, state and territory fisheries management agencies and Parks Australia. Sensitivity tests were performed to understand the impact of assumptions and uncertainties.

The qualitative analysis of non-monetised benefits is essential for determining the preferred option. This analysis indicates that Option One provides the most benefits compared to other options. These benefits include improved compliance with fishing rules and management outcomes for Parks Australia and fishery management agencies. Option One also benefits fishers with an enhanced social licence to operate in Australian Marine Parks, as well as having access to the Australian Marine Park Alert Service, which has proved to prevent non-compliance, save litigation costs and avoid impacts on Australian Marine Park values.

The cost-effectiveness analysis also indicates that Option One is preferred, being the least cost and most cost-effective of the options. Option One is three times more cost-effective than Option Four and 19 times more cost-effective than Option Three. The impact spread of Option One was concluded to be distributed fairly and equitably across users, with costs incurred by those that make commercial gains from Australian Marine Parks and by government agencies that provide for the management of fisheries and marine parks. There are no costs to other sectors of the community.

2 Introduction

The Australian Marine Parks (marine parks)¹ cover more than one-third (3.5 million km²) of Australia's ocean ecosystems, consisting of many large-scale multiple-use marine parks. Effective management is essential to protect their values and ensure sustainable use outcomes. However, the sheer size and remoteness of the marine parks present a serious challenge for their management, in particular, providing for effective compliance and enforcement of fishing rules [1].

Under marine park management plans, the Director of National Parks (the Director) may, after consulting with industry, require all commercial fishing vessels transiting or conducting fishing activities in a marine park to carry an operating Vessel Identification and Monitoring System (VMS)². VMS is internationally regarded for compliance monitoring, particularly for fisheries and marine protected areas. In 2021-22, Parks Australia made available \$5.5 million in grant funding to state and NT fisheries management agencies (FMAs) for Electronic and Vessel Monitoring System uptake. The Director is now investigating the costs and benefits of making VMS mandatory for all commercial fishers operating and transiting in marine parks no sooner than 2024 [2, 3].

Although several surveillance measures are available to Parks Australia, including vessel-based patrols and aircraft, all of which have unique merits, VMS was identified for examination in the marine park management plan actions as it:

- Provides complete coverage of the fishing location of all commercial fishing vessels in marine parks.
- Is widely used in Australia and internationally
- Has a significant cost advantage over other types of surveillance [4-6].

¹ Australian Marine Parks are located in Australian Commonwealth waters, which extend from state waters at three nautical miles from the coastline to the outer limit of the Exclusive Economic Zone, 200 nautical miles from coastlines.

²Vessel Monitoring Systems (VMS) use small onboard satellite transceivers (units) to regularly log a vessel's position and upload this information to a land-based server.

Complete coverage of all vessels in marine parks will provide the necessary information to prevent, deter and detect illegal fishing.

A cost-effectiveness analysis³ is required for the Director to decide on the new policy and its impacts and benefits on affected stakeholders, i.e., commercial fishers and businesses, state and Territory FMAs, the broader community, and the Australian Government.

The analysis compares four options:

- Option One – The introduction of a new regulation requiring VMS on commercial fishing vessels operating in or transiting marine parks.
- Option Two – Status quo compliance monitoring and surveillance.
- Option Three – Increased aerial and vessel-based surveillance.
- Option Four – The introduction of manual reporting of fishing vessel locations.

This report details the proposal's objectives and describes the set of options, the economic analysis approach and outcome. The cost-effectiveness analysis identifies the costs over the life of the options (20 years). The report also provides a qualitative assessment of their benefits. Partial sensitivity tests are performed on discount rate variations and uncertain variables.

3 Context

3.1 Marine Park Management and Compliance

Sixty-one marine parks have been declared under the *Environment Protection and Biodiversity Conservation Act 1999*⁴. Sixty of these parks are managed by Parks Australia for the Director and are grouped into five marine park networks, and two extensive marine parks – the Coral Sea Marine Park and the new Christmas Island Marine Park and Cocos (Keeling) Islands Marine Park [1]. They cover an area of 3.5 million km², representing over one-third of Australia's ocean ecosystems and comprising an enormous range and quantity of socio-economic, cultural and nationally significant marine conservation values⁵ [1, 7, 8].

³ A Cost-Effectiveness Analysis (CEA) is an economic evaluation technique that compares the cost of the intervention with a unit of effectiveness. It differs from a Cost-Benefit Analysis where the costs and benefits are measured by monetary units to determine the net monetary benefit outcome. A Cost-benefit Analysis informs the Regulatory Impact Statement required by the Australian Government Office of Best Practice Regulation to introduce new policies and regulations. Where benefits cannot be monetised, a CEA is an appropriate alternative.

⁴ The Australian Antarctic Division of the Department of Agriculture, Water and the Environment manages the Heard Island and the McDonald Islands Marine Reserve on behalf of the Director of National Parks and is not included in this report. The Great Barrier Reef Marine Park is managed by the Great Barrier Reef Marine Park Authority under separate legislation.

⁵ National Values of Significance include Key Ecological Features (regional important for either the region's biodiversity or ecosystem function and integrity), Biological Important Areas (areas that are particularly important for the conservation of protected species and where aggregations of individuals display biologically important behaviour, such as breeding, foraging, resting or migration), and protected species and places (threatened, migratory, cetaceans, listed species).

Each Network and the Coral Sea Marine Park are managed under their respective management plans (and the EPBC Act and EPBC Regulations 1999). Management plans have been in place for ten years and are created and reviewed through a public consultation process. Their objectives are to provide for:

- a) the protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks in the Network; and
- b) ecologically sustainable use and enjoyment of the natural resources within those marine parks, but only where this is consistent with the first objective [1, 7].

Marine parks protect natural values such as the habitats, species and ecological communities and the processes that support their connectivity, productivity and function. The cultural values in the marine parks are the living and cultural heritage recognising Indigenous beliefs, practices and obligations for country, places of cultural significance and cultural heritage sites. Heritage values are the non-Indigenous heritage with aesthetic, historic, scientific or social significance.

The Australian Government created the marine park networks as extensive scientific research demonstrated that well-managed marine protected areas would support a range of ecosystem benefits, including increased species diversity and biomass. Managing pressures within marine protected areas may also support the resilience of marine environments to withstand and recover from other pressures in the future. Now that the marine parks are declared, under the EPBC Act the Director has an obligation to protect, conserve and manage biodiversity and heritage in the marine parks.

Most marine parks allow for multiple uses and are divided into spatial zones that define what activities can be undertaken. For example, sanctuary zone, national park zone, recreational use zone, habitat protection zone, multiple-use zone, and special-purpose zones allow for different activities and support different levels of conservation outcomes. Management plans detail what activities can and cannot occur within these zones and the assessment and authorisation requirements for allowing activities to operate. For example, permits, licences, class approvals and leases [7]. They also describe the management programs and actions designed to protect the marine environment, improve scientific understanding, support tourism, enhance awareness and appreciation of marine parks, work with Indigenous people, assess and authorise activities, and ensure people comply with the rules. Most management actions are undertaken in partnership with Commonwealth, the state and Territory FMAs, marine park users, stakeholders and traditional owners [7].

Park Australia's compliance management program aims to achieve high compliance by marine park users. Compliance and enforcement⁶ are assisted by monitoring, control and surveillance measures, involving the analysis of activities, use of regulatory controls and educational advice and delivery of surveillance measures to ensure marine park access rules are observed and enforced.

Surveillance is a critical element of Parks Australia's compliance management program and is undertaken collaboratively with Australian, state and Territory FMAs by sharing assets and information. Surveillance measures include aerial surveillance, vessel patrols and VMS data for roughly half of Australia's fishing vessels supplied by the Australian Fisheries Management Authority and from state and Territory government partnership agreements. Direct reporting from marine

⁶ Compliance is defined as the state of conformity with the law. Enforcement is the set of actions that a management agency takes to correct or halt behaviour that fails to conform to the law.

park users and other FMAs also assists [9]. Passive acoustic monitoring (e.g., sound traps) is limited across the networks and the Coral Sea Marine Park and is primarily used for monitoring and compliance planning purposes [10].

In relation to domestic activities, commercial fishing makes up 35 per cent of compliance incidents in marine parks, all detected by VMS⁷ [11]. Based on 982 vessels operating without VMS⁸, there are over 18,000 fishing days in marine parks unaccounted. Consequently, it is likely that more incidents would be detected by widening the coverage of VMS to the remaining Australian commercial fishing vessels who do not carry VMS.

3.2 Commercial fishing in Marine Parks

Commercial fishing in marine parks is diverse, both in fishing practices and their jurisdictional management. Commonwealth fisheries are managed by the Australian Fisheries Management Authority and include 18 fisheries consisting of approximately 316 vessels that potentially operate in or transit marine parks. State and Territory managed fisheries operating adjacent to their jurisdictions also extend to offshore fishing grounds, including marine parks. Collectively, these involve around 90 fisheries, consisting of approximately 3078 vessels that potentially operate in or transit marine parks (Table 1 and Appendix A).

Table 1 Estimated number of commercial fisheries and fishing vessels potentially operating in or transiting marine parks.

Jurisdiction	No. fisheries intersecting with marine parks	Potential no. vessels in marine parks	% Fisheries with VMS	% Vessels with VMS
NSW	3	383	0	0
VIC	8	266	75	89
TAS	6	216	100	100
SA	10	712	10	6
WA	40	647	46	39
NT	7	29	100	100
QLD	16	527	100	100
CTH	18	399	100	100

Note: This information is indicative and has not been used to calculate costs.

Commercial fishing in marine parks is access regulated (spatial and temporally). Whilst multiple use zones allow for a broad range of commercial fishing activities it is not permitted in sanctuary zones or national park zones and is restricted in habitat protection zones. In addition, some zones have time controls on access to protect migratory species.

Restrictions on fishing activities by zone type are described in each marine park network and the Coral Sea Marine Park management plans. Commercial fishers with Commonwealth or state and Territory government FMA licences are authorised to operate in marine parks under 'class approvals' and do not have to apply for individual licences [7]. Class approvals for commercial fishing

⁷ Note that in general the majority of compliance incidents are identified by the surveillance work by the Australian Border Force and the Maritime Border Command in detecting foreign fishing vessels in northern Australian waters, more than 90 per cent of surveillance effort and incident detection in marine parks.

⁸ This estimation is based on vessels funded for new VMS units under the Electronic and Vessel Monitoring Systems Assistance Program.

in marine parks are made under each network and the Coral Sea Marine Park management plan and emulate the requirements of the plans, listing the methods and areas where commercial fishing can occur (and are excluded from), rules for transiting and anchoring, and requirements to provide monitoring information on request to the Director [12].

3.3 Other sectors and interests

Sectors potentially affected by the proposal to mandate VMS to improve compliance include commercial tourism (e.g., charter fishing, scuba diving and nature watching tours), recreational users and marine science and also Traditional Owners. These groups rely on marine park natural and cultural values being sustainably used (i.e., rules complied with) and protected (See Appendix B for more detail on these groups and their relationship to marine park values and commercial fishing).

4 Objectives and Rationale of the Proposal

4.1 Objectives

The primary objective of marine park management plans is to protect and conserve biodiversity and other natural, cultural and heritage values of marine parks while supporting ecologically sustainable use [7]. It follows that an ancillary objective is to ensure they are effectively managed. Compliance is regarded as a crucial factor in ensuring success. Without its effective implementation, marine parks will not achieve their objectives [1, 13-16].

Ensuring compliance in marine parks underpins the attainment of all management objectives [17, 18] as non-compliance can rapidly erode any potential conservation effects of marine parks [19]. Being remote and large, both in size and number, effective compliance in marine parks largely depends on the successful detection and management of non-compliance.

With a low probability of detection, there is an increased likelihood of illegal fishing. While most illegal fishing incidences in marine parks are thought to be inadvertent, the primary motivation for illegal activities is the low risk of detection [20]. Although it is impossible to detect all non-compliance activities in marine parks, adequate surveillance can identify and address high-risk incidents. Improving the effectiveness of surveillance is considered by Parks Australia as being essential to improve compliance with marine park management plans and enforcement of illegal activities.

4.2 Rationale

Despite world-class fisheries management, led by Commonwealth, state and territory governments, fishing is an identified pressure on marine park values. In particular, illegal, unregulated and unreported fishing can modify the natural populations of target species. Bycatch of non-target species and physical disturbance to habitats from certain fishing methods potentially impact marine park values. Marine Park management plans, manage these pressures by using zoning and other regulations. Illegal fishing in zones that do not allow for these activities can significantly impact park values and undermine their management. Some fishing techniques have greater consequences than others. For example, fishing techniques that impact habitat and biodiversity, such as trawling, longlining and fish trapping [21].

The risk of commercial fishing on marine park values is a product of the frequency (likelihood) of illegal activities (non-compliance) and the consequences (impacts) of these activities on marine park values (including biodiversity, economic, social and heritage). Determining the type and range of

consequences of fishing activities incorporates literature examination, observations over time, expert opinion and, in some cases, specific experimentation. Determining the likelihood of an illegal activity considers the likelihood of the event occurring that can result in an actual consequence. On the other hand, if the likelihood is certain and the consequence is major, then urgent, significant management effort is warranted to reduce this high risk.

Determining the likelihood of illegal fishing activities involves examining previous legal activities of fisheries at national and marine park levels, considering intelligence information derived from fishing authorities and experts and information on the effectiveness of risk controls. At the national level, considerable uncertainty is associated with data on risk, particularly the frequency of non-compliance. This uncertainty is a significant concern to the Director of National Parks and is the major reason the Director proposes mandating VMS in all marine parks. With VMS coverage in marine parks, this level of uncertainty would be known, together with improved knowledge of compliance risk and effectiveness [8]. VMS is a key tool that can provide 100 per cent coverage of fishing vessels and enable the detection of non-compliance. VMS provides relatively reliable and accurate information on the location of vessels at all times and a reasonable probability of where the fishing activity occurs [8, 9].

Current surveillance measures in marine parks do not provide enough information to measure compliance with zoning, except for those fisheries with VMS requirements. The marine parks managed by Parks Australia have inherent challenges that require a tailored approach to compliance. Typical approaches to marine compliance, such as maintaining uniformed officer presence to deter violations, and frequent and quick response patrols, are simply not feasible for these large offshore areas, even over the most high-risk parks [22]. This issue was highlighted by the 2015 by the Australian Marine Park Review Panel, which expressed concerns that the new marine parks would fail from the perspective of adequate biodiversity protection and public confidence if there were poor compliance. The Panel recommended the Australian Government facilitate a requirement for the installation and operation of VMS on all fishing vessels licensed in state or Territory managed fisheries that operate in Commonwealth waters as a proven, cost-effective compliance and enforcement tool (Recommendation 7.4)[23].

For large and remote marine parks, the adoption of VMS is regarded as a cost-effective surveillance solution over vessel patrols and aerial surveillance, which are generally considered ineffective for these areas [11-15]. For example, the National Oceanic and Atmospheric Administration estimated VMS to be around one per cent of aerial or vessel surveillance costs and much more effective [15]. For the Coral Sea Marine Park alone, it has been estimated that adequate surveillance cover without VMS would cost \$8.08 million [24]. Despite having a high deterrent value, vessel and aerial surveillance are costly, and their surveillance coverage is low. For example, the estimated coverage of United Kingdom fisheries aerial and vessel surveillance is 0.026 to 0.05 per cent of fishing effort [25]. Alternatively, VMS can monitor 100 per cent of fishing effort.

One of the most compelling reasons for adopting VMS as a mandatory requirement in marine parks is that it is well established in Australian fisheries and is already a proven compliance measure for marine parks. Approximately one-half of commercial fishing vessels operating in marine parks have VMS installed as an FMA requirement⁹. With the support of the Australian Fisheries Management Authority, Parks Australia has co-developed a near real-time alert service using VMS, which alerts fishers when entering zones where their gear type is not allowed [10]. The 'Marine Park Alert

⁹Since the early 1990s, VMS prevalence has exponentially grown and is now a requirement for many fisheries around the globe, including the European Union, U.S, Pacific, Canadian, Indian, Malaysian, and most New Zealand and Australian fisheries.

Service' has demonstrated the capacity to prevent non-compliance, avoid costs associated with enforcement and litigation and avoid potential impacts on marine park values [22].

Since 2002, the Australian Fisheries Management Authority has required mandatory VMS on all Commonwealth fishing vessels [7]. Recently, the Northern Territory (2017) and Queensland (2019) FMAs also mandated VMS, aided by Commonwealth Government grants to support fishers complying with the new regulations. Not all state fisheries have VMS, leaving substantial gaps in marine parks surveillance [3]. The VMS uptake by Australian jurisdictions has led to the establishment of a National Vessel Monitoring System by the Australian Fisheries Management Authority. The national system provides a pivotal platform for a uniform approach to VMS use across Australia, with jurisdictions benefiting from cost savings (from economies of scale), specialised support services and data sharing [3, 26].

Of relevance is the recent introduction of mandatory VMS on all commercial fishing vessels by the Great Barrier Reef Marine Park Authority in 2019. The Authority achieved this result, in part, by supporting QLD Fisheries with \$3 million grant funding to offset the establishment costs of VMS, considered a major hurdle for its introduction in the state [27]. With the introduction of VMS, the Authority has detected a level of non-compliance previously unknown. For example, VMS detected an increase in the number of offences in the Coral Reef Fin Fishery, from a previous average of 24.5 offences yearly to 145, of which 16 per cent indicated illegal fishing [28, 29].

In 2021-22, Parks Australia made available a similar grant of \$5.5 million for state and territory FMAs to expand electronic monitoring and VMS uptake on state and NT commercial fishing vessels that operate or transit in marine parks and help fishers prepare for the possible introduction of VMS no sooner than 2024¹⁰ [2, 3].

4.3 Challenges

In most cases, the adoption of VMS in fisheries management has been controversial, primarily due to fishers' concerns about the establishment and ongoing equipment costs, security of information associated with fishing ground locations, and costs associated with non-compliance [30]. To address any financial hardship of establishment costs, the Parks Australia Electronic and Vessel Monitoring Systems Assistance Program will directly benefit fishers through respective FMAs, resulting in no capital and installation costs to fishers and up to two years of funding for registration and ongoing use charges¹¹.

Parks Australia has had access to Australian Fisheries Management Authority managed fisheries VMS data through formal data-sharing agreements negotiated annually since 2011 [22]. Parks Australia has expanded access to VMS data through formal data-sharing agreements with state and Territory FMAs, including NT, SA and QLD. It has established the Alert Service wherever possible, based on the VMS technology available. These data-sharing agreements are necessary to give Parks Australia real-time access to VMS for fishing vessels in marine parks. However, the reliance on state and Territory FMAs to support ongoing data-sharing agreements is also a challenge as this data sharing is a concern to fishers for data security reasons. These concerns were recently reported to the QLD Ombudsman, which resulted in the FMA launching a review of the VMS rollout [30]. In this regard,

¹⁰ The Australian Marine Parks Electronic and Vessel Monitoring Systems Assistance Program is funded by the Department of Agriculture, Water and the Environment and contributes to the Portfolio Budget Statement.

¹¹ Note that this benefit flow will depend on the scope of the grant application from the FMA for their fisheries.

Parks Australia has over ten years of experience with handling and securing VMS data, and its established partnerships demonstrate that security issues are well-managed [3, 22].

5 Option One – The Policy Proposal

Option One introduces a policy to mandate operational VMS on any domestic, commercial fishing vessel operating in or transiting a marine park. This policy would be introduced no sooner than 2024 [9].

To give effect to the new policy, class approvals for commercial fishing would be amended to include conditions that make it a requirement to have a registered and operational VMS installed on the fishing vessel as a condition of access to any marine park. The policy is proposed to be implemented through the support of Commonwealth, state and Territory FMAs.

The proposal will result in all commercial fishing vessels operating in or transiting marine parks having a VMS installed and approved. This involves the purchase of approved VMS equipment. The Electronic and Vessel Monitoring Systems Assistance Program guides the VMS capabilities that are supported by the funding. As the Marine Park Alert Service requires two-way VMS units, which are programmable remotely and provide automatic notifications, these units are preferred. Preference is also given to units that are approved for use across multiple jurisdictions and or are E-monitoring ready (e.g., ORBCOMM ST 6100 and CLS Triton Advanced)¹². Most FMAs have adopted two-way VMS units¹³.

FMAs will support VMS installation, and certain conditions are likely to be applied to meet requirements. For example, ensuring appropriate electrical connections and setting software access restrictions. The VMS commissioning process involves the vessel operator, the equipment supplier/installer, the service provider and the FMA. With the support of the installer, the vessel operator usually is responsible for ensuring commissioning procedures are completed and the installation is certified [33].

The Australian Fisheries Management Authority has experienced high reliability with VMS equipment, airtime, and satellite providers. Maintenance (including replacement) is the responsibility of the vessel operator. Generally, authorised agents deal with maintenance issues. VMS unit check-ups by an authorised technician are recommended.

Under the proposal, approximately 982 commercial fishing vessels¹⁴ across four jurisdictions would require VMS installation, incurring establishment and ongoing costs for VMS provision, airtime and maintenance.

¹² Electronic monitoring is a system of video cameras and sensors capable of monitoring and recording fishing activities can be reviewed later to verify what fishers report in their fishing logbooks.

¹³ Simple vessel monitoring units that have no direct land to vessel communication capabilities and are not remotely programmable have been adopted in some fisheries. Still, it is understood that associated fishing vessels are more likely to transit marine parks than to fish in them.

¹⁴ The number of fishing businesses that operate more than one fishing vessel is uncertain. The cost-effectiveness analysis assumes that the number of vessels is equivalent to the number of fishing businesses. Businesses with more than one vessel would receive cost efficiencies in start-up costs. Consequently, the estimated cost to business would likely be less in practice.

6 Other Options

6.1 Option Two – Status quo compliance monitoring and surveillance.

This option provides a baseline for comparison with other options and is a standard inclusion in cost-effectiveness analysis methodology. 'Status quo' compliance monitoring and surveillance means there are no adjustments to current activities other than those that might really change over the next ten to twenty years.

Parks Australia does not own fixed assets for surveillance assets for aerial or vessel-based surveillance and contracts these services, most commonly to state and Territory FMAs. Australian Maritime Safety Authority aircraft is sometimes contracted, particularly for remote marine parks, such as the Coral Sea Marine Park. For nearshore marine parks, aerial surveillance is regularly contracted to private operators, involving a fixed-winged aeroplane and pilot and Parks Australia compliance staff observers. Parks Australia has access to VMS information (at varying degrees) from state and Territory FMAs on commercial fishing vessels entering marine parks.

Commercial fishing in marine parks does not occur every day of the year. The number of days fishing depend on many variables, including weather, management arrangements (e.g., quota and day restrictions and fishing seasons), location and type of fishery. Data from the vessels with VMS can be used to estimate how many days vessels fish in marine parks. For example, in 2021, approximately 9380 days were spent commercial fishing in marine parks by 324 vessels with VMS from NT, SA and the Australian Fisheries Management Authority fisheries (involving 64 per cent of vessels with VMS)¹⁵. If we assume non-VMS vessels, fish in marine parks at the same rate as the NT, SA and AFMA fishers, based on 982 vessels operating without VMS, there are over 18,000 fishing days in marine parks unaccounted¹⁶.

Approximately 350 surveillance effort days (combined aerial and vessel-based) are apportioned each year to 58 marine parks (a contract cost of \$1.6 million, with average aerial and vessel-based costs of \$2,300/marine park and \$3,600/marine park, respectively).

VMS information from NT, SA, QLD and AFMA fisheries is the primary surveillance measure responsible for detecting potential commercial fishing incidents, with 14 potential breaches detected yearly.

On average, the Marine Park Alert Service sends 3,209 alert messages per year (based on 2019-21 data). The alerts are sent automatically to the vessel and/or as an SMS to a nominated phone whenever a vessel enters a zone where it is not allowed to fish. This number of alerts is estimated to avert potentially more than 20 serious compliance incidents yearly [22].

Parks Australia's Compliance Unit comprises specialist staff engaged in operations and strategy teams. The approximate staffing cost associated at the current level is \$1.1m/yr (approximately 8.6 Full-Time Equivalents). Operations include incident management, administration of sanctions, operational liaison, duty officer functions, surveillance tasking, VMS and analysis. Strategy functions involve investigations, policy development, risk assessment, compliance planning, contract management and reporting. Note that resourcing of a Compliance Unit is a standard feature of all options covered in this report.

¹⁵ Information provided by Parks Australia is based on 2021 VMS polling data from NT, SA and AFMA fleets. It does not include QLD, VIC, WA or TAS VMS fleets.

¹⁶ Assuming 64 per cent of all vessels fish 29 days in marine parks/yr.

6.2 Option Three – Increased aerial and vessel-based surveillance

Option Three aims to increase surveillance of commercial fishing to a level that would markedly improve Parks Australia's understanding of non-compliance and detection capability in marine parks without additional regulation¹⁷.

To be commensurate with Option One's level of detection, aerial surveillance and vessel patrols would need to be present in all marine parks every time fishing vessels were present¹⁸. A daily surveillance presence in each marine park would require over 21,000 aerial flights and vessel patrols per year. This level of surveillance is not feasible due to cost and asset availability¹⁹.

Alternatively, extra surveillance can be estimated using compliance risk information [24]. Parks Australia undertakes compliance risk assessments biannually and applies information from various sources to estimate the frequency of non-compliance and potential impact on marine park values by location. Risk types are categorised and prioritised for compliance treatments. Higher levels of surveillance are often allocated to fisheries that are not required to use VMS due to the uncertainty of non-compliance. This risk approach can estimate the extra surveillance needs for these fisheries and locations. For this report, the data has been aggregated on a national basis to not compromise surveillance locations and frequencies²⁰.

Option Three involves an increase of 560 surveillance visits/year, including 250 aerial surveillance flights and 310 vessel-based surveillance visits²¹ in marine parks with non-VMS vessels operating (representing approximately 5.5 per cent surveillance coverage over high-risk marine parks). This is a modest increase only, maximises asset capability, and is plausible from a funding perspective. Although this option does not provide the same coverage achieved by Option One (i.e., 100 per cent of the time), it gives a justifiable premise to compare costs and benefits with the proposal.

Marine park vessel patrols are currently undertaken by FMAs using in-house patrol vessels and staffing. These are limited resources, and the proposed increase in surveillance effort may not be viable without an investment in additional surveillance craft and operators. It is also understood that the market for charter vessels and experienced operators for patrol purposes is limited and would require staffing by authorised officers. For the cost-effectiveness analysis, it is assumed that asset resources are available to undertake additional surveillance activities.

Increased procurement work and potential detections of illegal fishing activities would require additional staffing for procurement management, incident management, investigation, and reporting functions (approximately three full-time equivalent positions/yr).

¹⁷The Australian Government Cost-Benefit Analysis Guideline requires genuine and viable alternatives to be analysed, of which one must be non-regulatory 34. Department of the Prime Minister and Cabinet, 2020. Cost-benefit analysis - Guidance Note, Canberra, pp 15.

¹⁸Note that comparing different types of monitoring is not comparing like with like, as each has differing capabilities and levels of effectiveness. For example, the presence of visible vessel-based patrols is a potent deterrent and effective in locations regularly visited.

¹⁹Note that the roles of MBC and ADF are assumed to be one of national security, focussing on foreign fishing, illegal entry and imports. Although considered in estimating Option Three, surveillance effort associated with MBC activities is not included in the CBA estimates.

²⁰ Current surveillance effort (and locations) is highly sensitive information and cannot be reported in detail due to compliance security. Consequently, data is aggregated or averaged, where appropriate.

²¹Daily surveillance is one trip per day to the marine park using vessel-based or aerial surveillance. Aerial surveillance is short duration, depending on the size of the marine park. Vessel-based patrols range in duration. For example, if no vessels are observed on radar the surveillance time will be minimal. The surveillance effort/marine park does not imply that the whole park is visited. For example, the Coral Sea Marine Park is equivalent in size to a network of marine parks. A single visit could not cover the entire park. As most fishing vessels operating in the marine park have VMS, the increase in surveillance for non-VMS vessels is contained to known fishing grounds.

6.3 Option Four – Introduction of manual reporting of vessel locations.

Option Four involves the manual reporting of locations by fishers in marine parks. Manual reporting (and voluntary uptake of VMS) was identified as a potential option in the cost-benefit analyses prepared by Victoria, Queensland and NZ FMAs to introduce VMS (see Appendix C) [27, 35, 36]. In all cases voluntary reporting and tracking resulted in an insufficient capability to ensure compliance. Option Four differs from these in that manual reporting would be mandatory.

Marine Park class approvals for commercial fishing currently allow the Director to require monitoring information on request. This information may include the course, speed and position of vessels used to conduct the activities and fishing catch, such as species caught in individual marine parks and zones. The requirement for speed, course and position is satisfied under class approvals, where vessel identification and monitoring system information is available to the Director from either the Australian Fisheries Management Authority or state and Territory FMAs [12].

Option Four involves the Director making a formal request to report manually to all commercial fishers conducting approved activities in marine parks that do not have a VMS. Failure to report would be a breach of the class approval.

Manual reporting allowances are provided by FMAs where the VMS is not operating²². For example, the Australian Fisheries Management Authority requires a skipper to record the vessel's position every four hours and report positions at the end of each day. Each report includes the vessel name, distinguishing symbol, time and date of positions, and positions in latitude and longitude. Manual reports are made either phoning or emailing the Australian Fisheries Management Authority [37]. QLD Fisheries has similar arrangements, requiring the skipper of the vessel to manually report their position every hour for the East Coast Trawl Fishery and every four hours for other fisheries [38]. Option Four requires reporting of the position, course, and speed information on an hourly basis to Parks Australia in a daily report.

Approximately 982 commercial fishing vessels do not carry VMS that potentially fish or transit marine parks. Based on VMS polling information from NT, SA and the Australian Fisheries Management Authority FMAs, about 324 vessels fished in marine parks in 2021, totalling approximately 9380 fishing days (involving 64 per cent of vessels with VMS – with an average fishing effort of 29 fishing days/vessel)²³. At this level of fishing effort, for the non- VMS vessels, manual reporting would result in 18,226 daily reports be submitted to Parks Australia each year (a total of approximately 437,424 hourly data entries – including vessel name/date/time/position data).

7 Economic Analysis

Relevant examples of cost-benefit analysis and regulatory impact statements on the introduction of VMS provide benchmarks (and standards) for the proposal to mandate VMS on commercial fishing vessels in marine parks and are summarised in Appendix C.

The cost-effectiveness analysis process involves measuring the costs and effectiveness of each option. The analysis converts current and future costs into the Present Value Cost (NPC), which allows for the weighting of impacts that occur in different years over the policy's life. In this analysis,

²²An allowance for manual reporting is a formal process and receiving approval for manual reporting is not automatic. Approval and conditions depend on the location of the fishing vessel at the time the VMS becomes non-operational, and the level of risk the fishing activity or operator presents to the FMA.

²³SA fisheries data indicates fishing days average between 16-29 days/yr. This range suggests a degree of uncertainty requiring sensitivity testing for Option Four costing.

a discount rate of seven per cent is applied, which is the Australian Government's default rate over 20 years²⁴.

7.1 Cost-Effective Analysis vs Cost Benefit Analysis

The expected costs of the proposal are relatively straightforward to measure. They include initial capital costs; equipment that needs to be replaced during the project's life; operating and maintenance (e.g., airtime costs and labour costs) over 20 years. There are no identified costs which cannot be valued in money terms. However, the benefits of the surveillance measures are problematic to measure in monetary terms, essentially because the total number of violations is unknown in marine parks. As a result, the effectiveness of the surveillance activities can only be measured against recognised targets [39].

Effective surveillance of fishing vessels aims to detect illegal fishing and enforce laws that protect marine park values. For fishers an increased probability of detection results in better compliance over time. As the rate of illegal fishing approaches zero, the protection of the marine park values is maximised. Surveillance detects offences, but significantly also deters offences because the probability of detection increases and the decision not to comply becomes less motivating. Consequently, the regulation reduces the probability of offences occurring over time. Unfortunately, because there is no accurate understanding of the level of non-compliance, the likelihood of illegal fishing cannot be determined, nor can the positive impact of more compliance be valued as the amount is unknown [40].

Studies that have attempted to measure the benefits of surveillance have found that cost-benefit analysis is not preferred, given the interdependent relationships of compliance measures and the inability to monetise benefits (see Appendix C) [39].

Surveillance benefits can potentially be valued, in monetary terms, using a 'cost avoidance approach'. For example, the cost avoidance of not requiring manual reporting to achieve the same level of surveillance (i.e., a comparison between Option One and Option Four) or the costs avoided from not increasing aerial and vessel-based surveillance (comparison between Option One and Option Three), which translates into benefits. These avoided costs, however are features of the least-cost method and are similar in outcome to a cost-effectiveness analysis [34].

The Australian Government Handbook for Cost-Benefit Analysis informs there are several contexts in which cost-effectiveness analysis is appropriate and relevant. A precondition of cost-effectiveness analysis is that compared options must have a common primary effect [40]. Cost-effectiveness analysis is applicable when the problem involves the optimal use of fixed resources and where it is necessary to prioritise alternative expenditure options. It is also suitable for existing programs that are expected to continue, not necessarily in their current form, but within a framework of the policy objectives.

The Parks Australia proposal meets the above preconditions for cost-effectiveness analysis, with all options having principal outputs involving the detection of non-compliance. The context is also appropriate for the compliance program continuing as an existing function, integral to the success of marine parks and protecting marine park values.

²⁴There is considerable uncertainty forecasting costs and benefits of the proposal beyond 20-years, particularly with new satellite technology emerging. A sensitivity analysis to determine the influence of the discount rate is recommended by the OBPR, at 3 per cent and 10 per cent (see Section 8).

Cost-effectiveness analysis can be regarded as a form of cost-benefit analysis, in which the policy outcome is already known (in this case, the detection of non-compliance with fishing rules), and the analysis aims to identify the least-cost means for achieving the outcome (i.e., the least-cost option to providing a given level of surveillance) [70].

Cost-effectiveness analysis, however, differs from cost-benefit analysis in several respects. Fundamentally, it measures the benefits in units rather than in monetary terms [41]. It is understood that the cost-effectiveness analysis can only rank and decide between options, as it does not provide a measure for acceptance or rejection of the policy [42]. As the Australian Government has chosen to protect the values of the marine parks, adequate surveillance is required, and choosing between the options is subsequent.

All options, apart from the status quo, attain levels of improved surveillance, using different approaches and ensuing costs. In this case, the cost-effectiveness analysis is appropriate, as it considers the costs associated with other means of achieving the same goal [71].

Measuring and ranking the cost-effectiveness of the policy and options is calculated using a cost per unit effectiveness ratio (CE). The lowest cost per unit effectiveness ratio is the more cost-effective option.

A simplified equation of the ratio is shown below [40]:

$$CE = PV(\Sigma C)/E$$

Where:

CE is the cost-effectiveness of the Option.

PV(ΣC) is the sum of all costs (in present value) of the Option

E is the effectiveness (measured in units) of the Option

The Present Value Cost is calculated as follows:

$$PV(C) \sum^T = (C_t)/(1+r)^t$$

Where:

C_t is the cost at time t .

r is the discount rate.

T is the number years which future costs are expected to occur.

7.2 Identification of Costs

This section identifies the costs (impacts) and their distribution for each option. Costs are considered over and above status quo costs. Consequently, Option Two costs are not calculated. It is noted that variables and costs may change for status quo operations. Still, it is unlikely that future improvements in surveillance coverage will eventuate within a reasonable time. For example, improvements and access to drones may increase over the next 10-20 years resulting in improved surveillance capacity; however, the extent to which surveillance coverage would improve is considered marginal over the policy's life. Accordingly, the status quo base case is considered relatively stable over the policy period.

Impacts are distributed to fishing businesses and FMAs supporting Parks Australia's surveillance policies. Indirect costs to consumers (and the general public), other marine park stakeholders, businesses and communities are not expected. It is unlikely that ongoing costs associated with VMS

would be transferred to consumers, for example higher fish prices, as the costs to fishing businesses are relatively small to other operational costs (e.g., vessel and gear maintenance and fuel costs) and amount to around \$2/day per vessel.

7.2.1 Costs to Commercial Fishing Businesses

7.2.1.1 Option One

A total of 982 commercial fishing vessels are assumed to be affected by the proposed regulation. For this report, it is assumed that each vessel equals one business (in reality 982 vessels may actually represent 500-600 fishing businesses). Australian fishing businesses operate in a range of sizes – from well-established large operations with multiple vessels and hundreds of staff to family operations with one vessel that may employ three to four staff. VMS cost for individual vessels or businesses is assumed to be the same.

Table 2 shows the estimated costs to individual fishing businesses for Option One. It is important to note that start-up costs and year one and two airtime charges are offset by the Parks Australia's grant. This is reflected in the calculation of actual costs in Appendix D.

Table 2 Estimated Costs to Individual Fishing Businesses (N=982) for Option One

Cost Description	Cost \$/yr	Cost Category	Source and Assumptions	Reliability/ Accuracy
VMS transmitter, mounting and cable*	1,200	Yr 1 & 10	Market price of ST6100 two-way unit ²⁵	High
Installation cost* (technician cost)	250	Yr 1 & 10	Based on Victoria Fisheries Authority allowance [43, 44]. (The cost may be higher in remote areas)	High
VMS activation*	42	Yr 1 & 10	Provider estimate	High
Education and Training *	225	Year 1 only	Estimate lost time using average weekly earnings /work related labour cost and weighting \$73.05/hr [45]. Includes time with technician and travelling.	Medium/High
Airtime and management*	625	Ongoing	Provider market price (for up to 15 min. polling)	High
Hardware and service maintenance support**	112	Ongoing	Estimate lost time \$73.05/hr.	Medium
VMS trouble shooting	75	Ongoing	As above. It is assumed that majority of this cost is paid for by the FMA.	Medium

* Costs are fully or partially offset by the Electronic Vessel Monitoring System Assistance Program and is included in PV(C) calculation (see Appendix D)

** Service maintenance is considered minor requiring checking and cleaning as needed. Malfunctioning units are replaced under warranty which are generally for a period of two years.

7.2.1.2 Option Three

There are no costs to commercial fishing businesses. Parks Australia does not have a policy to recover costs from marine park compliance activities.

7.2.1.3 Option Four

A total of 628 commercial fishing businesses are assumed to be affected by Option Four (i.e., 64 per cent of 982 businesses fish in marine parks/yr). It is also assumed that all fishers continue to manually report whilst fishing in marine parks over the 20-year period²⁶, and on average, each vessel reports 29 days/yr (based on the average number of fishing days per vessel described in Option Three). Each report consists of 24 entries (one/hr), including vessel name, date, time, position (Lat./Long.) and fishing status. The estimated cost (lost time) for an individual fishing business is \$4,070/yr (Table 3). The estimated total cost to fishing businesses is \$2,556,000/yr (i.e., \$4070 X 628).

Table 3 Estimated Costs to Individual Fishing Businesses (N=628) for Option Four.

Cost Description	Cost \$/yr	Cost Category	Source and Assumptions	Reliability/ Accuracy
Report preparation and messaging	4,070	ongoing	29 reports/vessel/yr. Each report takes 1.92 hrs (based on 4.8 min/entry), total lost time report including messaging @ 73.05/hr	Medium

7.2.2 Costs to Government – State and Northern Territory FMAs and Parks Australia

7.2.2.1 Option One

Costs to governments involve FMAs supporting the implementation of Parks Australia's policy. These are the respective Fisheries Divisions of the NSW Department of Primary Industries, the SA Department of Primary Industries and Regions, the WA Department of Primary Industries and Regional Development and the NT Department of Industry, Tourism and Trade. Other FMAs already have VMS requirements for all fisheries that intersect with marine parks and provide this information to Parks Australia under data-sharing agreements. SA, WA and NT have partial VMS coverage over their fisheries (Table 1).

Option One involves NSW, SA, WA, and NT FMAs overseeing VMS installation and operation, in some cases establishing laws and providing compliance for their continued use. Individual fishers will undertake the purchase, installation, and registration with FMAs. These FMAs have partnerships with the Australian Fisheries Management Authority (or soon to be) for software and VMS services.

The introduction of VMS requirements will require planning, communication, and in some cases, the development of VMS regulations. This is an add-on to current business for some jurisdictions, and new regulations will be relatively straightforward to develop and enforce. For others, it is a new business, and more set-up costs would be expected depending on how it is approached. Accordingly, each jurisdiction is likely to experience different costs.

The National Vessel Monitoring System Program, managed by the Australian Fisheries Management Authority, provides a single platform for VMS licensing and services across Australia. Partner FMAs benefit from cost savings from economies of scales, reduced tender costs, and comprehensive fleet monitoring and data sharing [2, 26]. Under these arrangements, the Australian Fisheries Management Authority is charged an annual service fee by the VMS software provider for the VMS a licence subscription (\$111,461 licence fee, 2022 rate charge) and a yearly support service fee (\$329,170, based on \$7570 x bundle 50 units, 2022 rate charge). At the end of each financial year,

²⁶ Many fishers may be willing to pay for VMS to avoid the inconvenience of manually reporting.

the Australian Fisheries Management Authority passes on an annual average cost to each FMA based on their proportion of VMS fleet size.

The contract holder and administrator are responsible for day-to-day management (e.g., billing and contracts, system development, and administrator training) of the system, and partner FMAs pay set rates for these services, calculated on the average number of active VMS units in operation by each FMA/FY (50 unit lots/ year). The Australian Fisheries Management Authority provides maintenance and support services, including system maintenance and FMA support. Administrator services include user training, audits, general administration, outage support and troubleshooting. These costs are based on \$2,000/50 units for maintenance and \$4,000/50 units for administration [26]. Estimated costs by jurisdiction are provided in Table 4. Due to changes in proportions of VMS across the country, some jurisdictions benefit from reduced costs on business-as-usual with efficiencies from the increased number of VMS from other jurisdictions. The Australian Fisheries Management Authority, QLD, VIC and NT FMAs benefit from new jurisdictions and added VMS units. Fisheries management agencies also received offsets for education and communications and support for provider fees for new start-up arrangements under the Electronic and Vessel Monitoring Systems Assistance Program [2]. Table 5 summaries of the estimated costs to be borne by Government agencies (and Parks Australia) per year for Option One (see Appendix E).

Parks Australia will incur ongoing operational costs for contracts to access VMS data from FMAs via the National VMS Program platform (i.e., WA, TAS, NSW and VIC). This is an ancillary cost as this information is available to the Director by direction if needed. A small cost is also expected for increased polling rates when vessels are in marine parks over that required by FMAs²⁷.

As a consequence of improved detection, Parks Australia is likely to incur costs associated with reporting and enforcement, particularly in the initial period [28]. Contractor costs will be incurred for establishing and operating the Marine Park Alert Service for new VMS fisheries; however, these new costs are not tied to the regulation and are offset by the benefits of the alert service. Additionally, geofence infrastructure for all marine parks is already in place.

Table 4 Estimated costs to jurisdiction for VMS provider and Australian Fisheries Management Authority Management

(Noting that whether the agency chooses to cost recover through their industry is a policy matter for their consideration)

Jurisdiction	Provider Licence and Service Fee	Australian Fisheries Management Authority Management Charge	TOTAL COST**
AFMA	25960	N/A	+25,960
QLD	87513	-6000	+81,513
NSW	-56863	-60000	-116,863
TAS	-18686	-24000	-42,686
VIC	9913	0*	+9,913
SA	-53761	-54000	-107,761
WA	-157	-6000	-6157
NT	3886	0*	+3,886

*No additional cost due to bundle (50 unit) rounding

** AFMA, QLD, VIC and NT reduce costs with the addition of more jurisdictions sharing overall licencing fees

²⁷ Polling at intervals of 15 - 30 minutes would achieve more precise estimates of incidents and impacts, resulting in an extra cost of \$400 per 5000 polls. 46. Lambert, G.I., et al., 2012. *Implications of using alternative methods of vessel monitoring system (VMS) data analysis to describe fishing activities and impacts*. ICES Journal of Marine Science, 69(4): p. 682-693.

Table 5 Summary of Estimated Delivery Costs for Government Agencies – Option One

Cost Description	NSW DPI Fisheries \$/yr	SA DPIR Fisheries \$/yr	WA DPIRD Fisheries \$/yr	NT DITT Fisheries \$/yr	Parks Australia \$/yr
Policy and regulation development (start-up)**	-	22,900	22,900	4,600	18,300
Education material and training (start-up)**	75,700 15,000*	30,000 15,000*	20,000 15,000*	4,600	4,600
Engagement and consultation (start-up)**	20,000	20,000	31,300	4,800	26,000
Provision of day-to-day information (ongoing)	4,000	2,000	2,000	2,000	0
Administration of AFMA contract and project management (ongoing)	29,700	0	0	0	0
Compliance and enforcement (ongoing)	133,900	29,700	29,700	0	139,000
AFMA management and provider charges (ongoing)	116,900	107,800	6,200	(3,900)	59,000

*Provision for updates

** Start-up costs are offset by the Electronic Vessel Monitoring System Assistance Program – costs are included in PV(C) calculation (see Appendix D)

7.2.2.2 Option 3

The proposed increase provides for 560 surveillance visits/year, consisting of 240 aerial surveillance flights and 320 vessel-based patrols (approximately 60 per cent increase on status quo surveillance effort), with average aerial and vessel-based costs of \$2,300/marine park visit and \$3,600/marine park/visit, respectively). Currently, Parks Australia contracts these forms of surveillance to state and Territory FMAs. Costs for Option Three are shown in Table 6.

Table 6 Estimated Parks Australia Costs for Option Three

Cost Description	Cost \$/yr	Cost Category	Source and Assumptions	Reliability/ Accuracy
Procurement, administration, and reporting	59,500	ongoing	Consultant experience. @ 0.5 X APS6 \$118,894 pa	Medium
Compliance and enforcement	138,900	ongoing	Consultant Based on @ 1 x APS6 \$118,894 pa & \$20,000 pa	Medium/high
Supply of aerial surveillance	552,000	ongoing	240 flights @ \$2,300	
Supply of vessel-based surveillance	1,152,000	ongoing	320 patrols @\$3,600	

7.2.2.3 Option 4

Approximately 628 commercial fishing vessels are affected by Option Four, resulting in 18,226 daily reports processed by Parks Australia each year (based on 29 reports per vessel/yr). Each report has 24 x one-hour entries, consisting of vessel name, date, time, position, and fishing status.

Approximately 76 reports would need to be processed each working day by Parks Australia (based on 240 working days/yr).

Additional surveillance would be necessary to detect non-compliance with manual reporting and is estimated at 25 per cent required for Option Three, involving aerial surveillance only. Total costs to Parks Australia are shown in Table 7 below.

Table 7 Cost to Government – Parks Australia Costs for Option Four

Cost Description	Cost \$/yr	Cost Category	Source and Assumptions	Reliability/Accuracy
Development software	250,000	One-off and ongoing support	Consultant experience. Purchase price, and customisation.	Medium
Correspondence, information material, including website information.	15,000	One-off	Consultant experience. Based on six weeks @ APS6 \$118,894 pa and stationery /postage	Medium
Engagement and consultation	20,000	One-off	Consultant experience. Based on two weeks salary for two staff @ APS6 \$118,894 pa and travel costs.	Medium
Compliance and enforcement	400,000	ongoing	Consultant and GBRMPA experiences. Based on 2 x APS6 \$118,894 pa & 1 x APS5 \$102,063 & operations \$20,000 pa/staff	Medium/high
Procurement, administration of manual reports, analyses and reporting	221,000	ongoing	Consultant experience. Based on 1 x APS6 \$118,894 pa & 1 x APS5 \$102,063	Medium
Supply of aerial surveillance	322,000	ongoing	140 flights @ \$2,300	Low-Medium

7.2.3 Present Value of Costs

The total PV Costs for Options One, Three and Four are calculated at an annual real discount of seven per cent for 20 years. Sensitivity to discounting is also tested with real discount rates of three per cent and ten per cent. Table 8 shows the PV cost for each option (see Appendix D for PV costs by option by year).

The least expensive is Option One (\$16.56 million over 20 years) with Option Four (\$39.95 million over 20 years) being the most costly, being more than double to cost of Option One, a similar outcome to the NZ estimate that the cost of electronic reporting is around 50 per cent less than paper-based reporting [35]. Option Three is about 25 per cent more costly than Option One (\$ 21.56 million over 20 years).

Although there is a large range across the three discount rates, it does not result in any changes to the order of least cost and the outcome is not sensitive to the discount variable. At a discount rate of 10 per cent, Option One and Three become more equivalent.

Table 8 Present Value Cost of Options

	PRESENT VALUE COST		
	Discount Rate 3%	Discount Rate 7%	Discount Rate 10%
Option One	\$22,414,000	\$16,563,000	\$13,657,000
Option Three	\$29,152,000	\$21,565,000	\$17,816,000
Option Four	\$53,903,000	\$39,948,000	\$33,053,000

7.3 Cost Effectiveness of Options

The effectiveness of each option is a measure of their increased surveillance coverage above the status quo level (i.e., Option Two). Option One provides for VMS on an extra 982 vessels, which is an additional 46 per cent coverage of vessels that may travel into marine parks (based on the status quo of 1127 vessels²⁸), bringing the coverage close to 100 per cent²⁹.

Option Three does not increase VMS and instead increases aerial and vessel-patrol coverage by 560 surveillance visits. Comparing this surveillance coverage to VMS is problematic and requires some gross assumptions. It can be approached in a few ways for comparison purposes. The first approach is to assume it is possible to calculate a VMS equivalence using the time spent by aerial and vessel-based surveillance per visit.

Accurate radar coverage for vessel and aerial surveillance is approximately 30-55nm. One surveillance visit is roughly equivalent to 4-6 hrs presence (i.e., the time it would take a vessel to cross the distance of the radar radius at 6-10 knots. The assumed equivalence is 0.25 days, or six polls/vessel/visit³⁰. This assumption is the same for all marine parks but is problematic for large marine parks. For example, the Coral Sea Marine Park's size makes it impossible for one surveillance visit to observe all vessels in the marine park in 0.25 days. Thus, the assumption of six polls/vessel/marine park/day is a gross overestimate. Applying this approach results in Option Three being equivalent to 3360 polls (6 X 560 visits) an increase of 0.8 per cent coverage³¹.

An alternative approach is to calculate the percentage of additional total fishing days under surveillance, i.e., 560 surveillance visits/18,212 fishing days (628 vessels x 29 days/yr fishing and transiting), which equals three per cent. Finally, the figure included in the Option Three of 5.5 per cent can also be used (Section 6.2). These three approaches indicate the surveillance coverage for Option Three ranges from 0.8 – 3 – 5.5 per cent, with an average of 3.1 per cent additional coverage.

Option Four is similar to Option One in that it reports vessels in marine parks every 24 hours but focuses on providing coverage of an assumed 628 vessels fishing 29 days fishing per year. It does not provide for all vessels without VMS in marine parks, potentially 982 vessels.

²⁸Includes an estimate of 80 QLD vessels, as most QLD fisheries operate in or nearshore (*pers comms Parks Australia, 22 April 202*).

²⁹VMS can fail, and some VMS non-compliance does occur in practice. AFMA aims at 97 per cent compliance, which approximates to 97 per cent coverage and is what might be expected for Option One.

³⁰VMS polling rates differ by jurisdiction and by the fishery. The rate for measuring effectiveness is taken to be 24 polls/day.

³¹Percentage based on 628 vessels (64 per cent of the 982) being monitored for 29 days in marine parks (437,088 polls/year).

There is a range of calculations to determine the measure of surveillance coverage for Option Four. The first approach assumes that 628 vessels fishing for 29 days is 100 per cent effective surveillance. After factoring in an allowance of 15 per cent non-compliance with the manual reporting observed in international fisheries, the resultant coverage of around 85 per cent of Option One [47].

Another way to determine the coverage of Option Four is to calculate the proportion of vessels affected by manual reporting over the total number of vessels without VMS (i.e., 628/982), which equals 64 per cent of Option One (without factoring in non-compliance). The two approaches result in 29.4 to 39.1 per cent (34.3 average) of additional coverage of vessels that may fish in a marine park³².

Table 9 shows the calculated cost-effectiveness ratios (CE) for Options One, Three and Four. After factoring in the effectiveness units for each costed option, a new ranking order is evident. Option One is the most cost-effective, three times more cost-effective than Option Four and 19 times more cost-effective than Option Three. The least cost-effective is now Option Three.

Table 9 Cost-effectiveness and ranking of options

Option	PV Cost	Effectiveness measure	CE Ratio (x10 ⁴)	Ranking
1	16,563,000	46	36.0	1
2	21,565,000	3.1	695.6	3
3	39,948,000	34.3	116.5	2

7.3.1 Cost Sensitivity Testing

Sensitivity testing provides information about how changes in values will affect the overall costs of the policy proposal compared with the other options [48]. For example, it shows how sensitive uncertain variables are to changes in assumptions and whether the uncertainty of a particular value matters to the outcome ranking. Importantly, it helps uncover critical assumptions and be informed of the robustness of the analysis in supporting decision-making.

Sensitivity testing for a range of real discount rates is a requirement of the Australian Government Office of Best Practice Regulation for new regulations (see Table 8). The testing three, seven and ten per cent discount rates indicates that the costs remain proportionate without changing cost rankings. This is expected because benefits are not costed in the analysis. Several assumptions in the analysis have a degree of uncertainty that warrants partial sensitivity testing, i.e., varying one assumption at a time while keeping all other variables the same. Table 10 lists uncertain assumptions and testing values.

Table 10 Sensitivity testing values for commercial fisheries and fishing vessels potentially operating in or transiting marine parks.

Assumption	CEA Value	Comments/Issues	Sensitivity Test Values/Range
ST1. Number of days fished by a vessel in a marine park per year.	29 days	This is based on a subset of NT, SA and Australian Fisheries Management Authority fisheries polling information in 2021. It is	16 days

³² 29.4 – 39.1 per cent = (46 X 0.64) – (46 X 0.85), based on business-as-usual of 1127 vessels.

		possible that Australian Fisheries Management Authority managed fisheries, which operate predominately offshore compared to state and Territory fisheries has skewed this figure. SA Fisheries polling indicates a potential average of 16 days (range 0 – 60) in marine parks.	
ST2. Percentage of fishing vessels that operate or transit marine parks	64%	This is based on a subset of NT, SA and Australian Fisheries Management Authority fisheries polling information in 2021. It is possible that Australian Fisheries Management Authority managed fisheries, which operate predominately offshore compared to state and Territory fisheries has skewed this figure. A test range of half this level is tested.	33-50%
ST3. Time taken for an operator to prepare a daily manual report	1.92 hrs	This time is based on recording 24 position entries/day, including data, time, vessel name, fishing status at 4.8 (<5) minutes an entry. It includes sending the report and time to go to the wheelhouse and record information. Depending on individual operator capabilities, recording time could potentially be reduced by one half to 2.4 (<2.5) min/entry.	58 min (<1 hr)
ST4. VMS polling equivalence to an aerial or vessel-based surveillance visit.	6 polls	This is based on the time it takes for a vessel to travel the radius of 30-55 nm at cruising speed. It also assumes that all vessels in the area at that time would be observed, no matter how large the marine park. Given that most marine parks are large, equating six polls per surveillance visit is a gross over-estimate, a reduction to two polls/visit equivalence is tested	2 polls

Sensitivity Test 1 (ST1) - Changing the number of days fished results in cost reductions to individual fishers in Option Four, from \$4070 to \$2244 pa for manual reporting and to Parks Australia, in the order of \$51,000 pa in salary cost savings (0.5 FTE). It also affects the efficiency measure for Option Three from 3.1 to 4 per cent, keeping all other assumptions the same. ST1 reduces Option Four costs to \$26,370,835, with the CE = 76.6×10^4 . Option Three CE is improved = 539.1×10^4 . The results indicate that the analysis is not sensitive to reducing the number of days fished in marine parks to 16 days/year, as either the cost or the cost-efficiency rankings are altered.

Sensitivity Test 2 (ST2) - Changing the percentage of fishing vessels that operate or transit marine parks to 50 per cent results in cost reductions to the fishing sector in Option Four from \$2,556,000 (N=628 vessels) to \$1,998,370 (N=491 vessels) and Parks Australia in the order of \$26,000 pa in salary cost savings (0.25 FTE). It also affects the efficiency measures for Option Three from 3.1 to 3.4 per cent and for Option Four from 34.4 to 26 per cent. ST2 reduces Option Four to \$33,105,742, with the CE changing to 127.3×10^4 . Option Three CE is improved = 634.3×10^4 . The results indicate that the analysis is not sensitive to reducing the percentage of fishing vessels to 50 per cent in marine parks, as either the cost or the cost-efficiency rankings are altered.

Reducing the percentage of vessels operating to one-third of all vessels results in cost reductions to the fishing sector in Option Four from \$2,556,000 (N=628 vessels) to \$1,391,940 (N=324 vessels) and Parks Australia in the order of \$102,000 pa in salary cost savings (1 FTE). It also affects the efficiency measures for Option Three from 3.1 to 4.3 per cent and for Option Four from 34.4 to 22.25 per cent. ST2 reduces Option Four to \$25,074,564, with the CE changing to 112.7×10^4 . Option Three CE is

improved = 501.5×10^4 . The results indicate that the analysis is not sensitive at 33 per cent of fishing vessels fishing in marine parks, as neither the cost nor the cost-efficiency rankings are altered.

Sensitivity Test 3 (ST3) Changing the time for an operator to prepare a daily manual report results in cost reductions to individual fishers, from \$4070 - \$2038 pa. in Option Four only. ST3 reduces Option Four costs to \$23,804,116), with the CE changing to 69.2×10^4 . The results indicate the analysis is not sensitive to reducing the time it takes to fill out the daily reports by 50%, as either the cost or the cost-efficiency rankings are altered.

Sensitivity Test 4 (ST4) Reducing the poll equivalence to surveillance visits affects the efficiency score of Option Four only, reducing from 3.1 to 2.9 and resulting in a CE = 743×10^4 . The results indicate that the analysis is not sensitive to the poll reduction, as either the cost or the cost-efficiency rankings are altered.

Despite the assumptions having uncertain values, the cost-effectiveness analysis is not largely affected by changing their values individually. In all tests, the outcome rankings of the cost and cost-effectiveness remain unchanged, with Option One ranked first.

7.3.2 Who Bears the Costs?

The economic analysis aggregates all known costs across individuals, businesses, and jurisdictions and determines the efficiency of the options without regard to their distributional effects. However, in calculating the total costs, the analysis identifies the quantity of impact on the various groups. For example, Option One costs have a 57:43 distribution across fishers and government, Option Three has a 0:100 distribution, with only government being impacted, and Option Four has a 72:27 distribution with fishers paying the majority of ongoing costs proportionally.

It is arguable that Option Four is more favourable from the taxpayer's viewpoint, as it promotes equity and is an extension of the user pays principle, i.e., ensuring those that gain from a government service or contribute to the need of the government service (in this case compliance surveillance) pay the associated costs. This is a moot point and complex as the service provided is associated with non-compliance and not with those that are compliant. Option One's impacts are weighted more towards fishers but relatively evenly allocated, reflecting an equitable distribution.

8 Qualitative Assessment of Non-Monetarised Benefits

8.1 Identification of Benefits

This section describes qualitative benefits from the four options to fishers, government, marine park users and the community [34]. As explained, qualified benefits are difficult to value and monetise and were a key reason a cost-effectiveness analysis is used to compare the options³³.

The primary benefit (and principal measure of effectiveness) of all options is increased surveillance coverage of commercial fishing activities. Improved surveillance coverage leads to better detection, deterrence, and prevention of compliance incidences. As all options have indirect benefits, apart from improved surveillance, these need to be considered in the final ranking to inform decision-making and understand if there are contrasting choices between cost-effectiveness and derived

³³Survey tools to establish willingness to pay was out of scope for this study, e.g., revealed preference and stated preference techniques (choice modelling). Assigning benefit valuations from secondary sources (i.e., benefit transfer) was not applicable, with no suitable secondary source being identified.

benefits [34]. Consequently, the least cost-effective option does not necessarily imply the preferred choice [67, 69, 70].

Marine parks benefit from more extensive and effective surveillance through:

- Improved compliance (and access to the Marine Park Alert Service).
- Improved enforcement.
- Improved fisheries management and sustainability.
- Improved marine park and fisheries science.
- Improved fishing operations and industry social licence.

Ultimately, the outcome sought is to protect marine park ecological, economic, social and cultural values and ensure sustainable fishing use.

8.1.1 Improved Compliance

Increased surveillance coverage increases the likelihood of detection of illegal fishing. This detection, in turn, encourages operators to comply, being more aware that activities are being monitored and the possibility of detection becomes a deterrent to non-compliance.

Parks Australia will benefit from improved surveillance coverage, understanding the level of compliance and the locations of high compliance risks. For example, the introduction of VMS has resulted in a significantly improved knowledge of illegal fishing in the Great Barrier Reef Marine Park Authority and Hawaiian fisheries [28, 49].

VMS enables other surveillance measures, such as aerial and vessel-based surveillance, to be more efficient and effective. Real time and consolidated data analysis allow for a stronger focus on targeting higher risk non-compliance activities leading to improved compliance at a lower relative cost and enhanced information on use for compliance planning [47, 50].

Compliance monitoring and reporting are significantly improved with universal surveillance effort. Compliance rates can be measured without factorising surveillance effort, providing accurate information on compliance trends and performance [15]. Ongoing quantification of non-compliance is important for understanding marine park ecological performance and guiding adaptive management [5, 51]. Reporting and data management are improved with cost savings associated with data management.

8.1.1.1 Access to the Marine Parks Alert Service

A benefit of the widespread use of VMS units is the further reach of the Marine Park Alert Service. When a vessel with VMS is set up for this service, an automatic alert message is sent to the vessel when it enters a zone that does not allow for the vessel's licenced fishing method. A study by Parks Australia on the Alert Service's effectiveness showed it aided a high level of compliance with marine park rules and potentially averted serious compliance incidents³⁴ (23 serious and 39 minor incidents from 3307 alerts). The litigation and penalty cost saving of these incidents was estimated to be \$3.5 million for the government and industry³⁵ [22].

³⁴A serious compliance incident is defined as being likely litigated, e.g., illegal fishing and taking in an Australian Marine Park.

³⁵Estimated costs savings is based on \$150,000 per case.

The most significant benefit from the Alert Service is protecting marine park values and preventing environmental damage. The substantial ecological benefits of averting serious incidents has been illustrated, including preventing the impact of trawling on hectares of protected deep-water coral habitat, capturing of tonnes shark and fish species, and impacting natural processes in protected zones [22].

Between 2014 and 2021, more than 17,000 alerts were sent to fishers (across 324 fishing vessels) to help them comply with marine park zoning rules (*Parks Australia 2022, pers. comm., 22 May*). Option Two, on average, results in 3,200 alerts to fishers, preventing potentially 20 serious incidents/yr (based on the Parks Australia Study, 2019). If VMS was universally applied (Option One) and all fishing businesses opted to receive the Alert Service, it is estimated that the number of alerts/yr could triple, preventing an additional 40 serious incidents per year over Option Two (status quo), avoiding litigation costs to industry in the order of \$6 million/yr³⁶. Although Options Three and Four result in higher levels of detection and deterrence of non-compliance incidents (and consequently enhanced prevention) above that of the status quo, they do not support access to the Alert Service, which has demonstrated to prevent incidents from occurring.

8.1.2 Improved Enforcement

VMS data strengthens the evidential information for litigation. Experience has shown that VMS data has assisted litigation with illegal fishing in marine parks (*Parks Australia 2022, pers. comm., May 19*). The evidentiary probity of VMS data has been tested in fisheries cases and is proven to strengthen the evidential case of the prosecution. The types of fishery cases in which VMS data has been accepted include unlawful entry into a restricted area, failure to maintain the logbook properly, illegal fishing, tampering with VMS equipment, and provision of false information [4, 6, 43, 52].

8.1.3 Improved Fisheries Management and Sustainable Use

VMS benefits FMAs in several ways for the sustainable management of fish stocks. These include compliance with fisheries rules by providing information on vessels' position and collection of effort data [4]. FMAs benefit from VMS outside marine parks with improved compliance and enforcement [4, 6, 43, 52]. Real-time fishing activity and vessel location information improve the effectiveness of sea patrols and port inspections. In addition, automatic monitoring saves time and resources and helps plan targeted inspections [6].

Regarding effort data, FMAs benefit from VMS with improved accuracy of logbook position information, and advanced capacity for catch reporting, through real-time information and potential for e-reporting (e.g. linking VMS data structures necessary for electronic catch reporting).

The evidentiary probity of VMS data has been tested in fisheries cases and is proven to strengthen the evidential case of the prosecution. The types of fishery cases in which VMS data has been accepted include unlawful entry into a restricted area, failure to maintain the logbook properly, illegal fishing, tampering with VMS equipment, and provision of false information [4, 6, 43, 52].

FMAs benefit from monitoring fleet activities effectively, particularly with monitoring fishing zones and restricted areas. VMS provides more reliable and sufficient information for studies on fleet dynamics, which can be used to cross-check and verify catch rate estimations in the fisheries [53].

³⁶This estimate is an extrapolation of the current number of average alerts/yr/fishing days and is based on an increase of 982 vessels with VMS, fishing 64 per cent in marine parks, 29 days/yr/vessel. It is considered that litigation savings would decline each year with increased deterrence from litigation.

This information can also benefit the industry by improving and implementing finer-scale spatial management, such as spawning and nursery area controls, potentially resulting in more product and better market value [50].

Efficiencies derived from VMS include improvements in the timeliness of delivery of data, resulting in data management cost savings [4].

8.1.4 Improved Marine Park and Fisheries Science

VMS technology provides accurate and continuous vessel location information in near-real time. Better quality and more comprehensive data will increase capacity for more reliable use monitoring, which ultimately improves fisheries research and the sustainable management of fish stocks [47, 53].

Marine park research is hampered by not having an adequate understanding of compliance in areas where research monitoring is taking place. Cause and effect studies may be skewed and result in tentative conclusions when illegal fishing may occur in the vicinity of these studies [54]. To understand if management is effective, we need to be confident that the rules are being followed.

8.1.5 Improved Fishing Operations and Social licence

VMS has the potential to reduce the administrative and reporting burden of fishers and associated costs. Some manual reporting obligations can be replaced by VMS reporting [6]. For example, the removal of prior-reporting alerts and pre-landing reports in Victorian fisheries [36]. Improved surveillance and access to digital reporting have also been shown to reduce the number of inspections [3, 36, 43].

Benefits to fishers and the fishing industry of VMS and access to accurate data also include improved finer-scale fishery management leading to sustainable fish stocks[36].

Improved transparency and integrity of fishery information can help the industry improve its public perception of the impact of seafood products on the environment and fishing in marine parks. Demand by retailers for sustainable seafood is driving change in fishing practices and requiring improved documentation and traceability of seafood supply. High compliance with marine parks will result in greater community confidence that commercial fisheries are sustainably managed [36]. It may also assist with fishery certification and credibly marketed products (i.e., enhanced social licence to operate) [47, 55-57].

Improved confidence in commercial fishing operations will help fishers gain support from Indigenous communities and traditional owners who seek insurance that they are complying with marine park rules and that marine park cultural values are being protected [58].

8.2 Assessment of Benefits

Tables 11-15 lists and rates potential benefits to beneficiaries for each option using a simple Delphi scale, where: 0 = no benefit (or cost), 1 = low benefit, 2=medium benefit and 3 = high benefit [35, 47, 59]. A benefit is taken to be desirable by those affected (including time and cost savings) above status quo (Option Two).

Although fishing businesses appear to benefit the least by increased surveillance, Option One provides significantly improved community and government confidence in their operations. This social licence is becoming increasingly important for business operations and security [56, 57]. VMS

acceptance ensures accurate and transparent information is available for management. It also demonstrates trust and maturity in management and compliance to protect marine park values and sustain fisheries resources. These criteria are the foundations for community acceptance of commercial fishing in marine parks.

Option One also provides fishers with access to the Marine Parks Alert Service. All fishers benefit from high compliance levels, supporting sustainable fisheries and economic returns and aiding social acceptance of operating in marine parks. Ongoing levels of uncertainty about compliance and advertised non-compliance negatively affect the fishing sector, putting pressure on future marine park management to restrict access. Commercial fishers will benefit from cost savings from FMA efficiencies, such as reduced reporting requirements and improved fisheries management outcomes, in turn improving the effectiveness of fishing operations [43, 52].

Option One delivers benefits to FMAs, with significant fisheries compliance benefits. Fisheries management is also improved with administration efficiencies and robust and real-time automated data for fisheries science and ecological management [4, 35, 53, 60]. Other marine park surveillance options do not benefit FMAs.

All options benefit Parks Australia over status quo practice; however, Option One provides the most significant benefits. Option One results in improved protection of biological and conservation features through superior compliance outcomes, notably better detection, deterrence, prevention and monitoring, and improved science. Although Option Four provides for the universal tracking of all fishing vessels in marine parks, it is inferior to Option One in many ways, including:

- Reporting is not automatic and is not in real-time.
- Detection of non-compliance is not in real-time.
- Reporting is subject to human error (intentional or otherwise).
- Reporting is hourly compared to polling every 15-30 minutes.
- Non-reporting may not be detected, consequently the level of compliance with marine park zones is uncertain.
- Additional surveillance is needed to detect non-compliance with manual reporting.
- Additional enforcement is required for vessels that fail to report.
- Additional staff and systems are needed to process reports.

Marine Park users and Indigenous communities benefit from increased surveillance with improved protection of marine park values. Improved compliance and sustainable fishing improve charter fishing and recreational fishing opportunities, support scuba-diving interests, and aid Indigenous communities in knowing that cultural values are being protected and that commercial fishers comply with marine park rules. These benefits arise mainly from Option One, which provides universal surveillance coverage and accurate information.

Table 11 Fishing Business Non-Monetarised Benefit Scores by Option

Benefit	Description	Option One	Option Three	Option Four
Improved compliance	Access to the Marine Park Alert Service helps fishers comply with zoning rules and avoid inadvertent non-compliance incidents, averting litigation and saving legal costs [3].	3	0	0
	Cost savings from reducing reporting	2	1	0

Improved fisheries management and sustainable use	Reduced number of inspections. Management of fisheries improve from having access to better data, reducing impacts (costs) on fishing operations [47].	2	0	0
Improved marine park and fisheries science	Surveillance information supports FMAs with fisheries science, supporting sustainable and more productive fisheries [47].	2	0	0
Improved fishing operations and industry social licence	Reduced FMA reporting requirements result in cost savings from reduced administration involved in FMA manual reporting requirements e.g., effort reports, pre-notification reports, obligations on designated ports could be replaced by VMS [43].	2	0	0
	Improved fishing opportunities with improvements in vessel information and reporting will aid individual businesses fine tune their fishing operation [35].	1	0	0
	Improved community and government confidence. Social licence to operate in marine parks through transparent and accurate information about use and data sharing. Knowledge that fishers are complying with marine park rules [35].	3	0	2

Table 12 Fishing Management Agency Non-Monetarised Benefit Scores by Option

Benefit	Description	Option One	Option Three	Option Four
Improved compliance	Reductions in non-compliance due to a deterrence effect	3	0	0
	Improved compliance monitoring. Assists with monitoring compliance with fishing zones and area and seasonal closures and catch entitlements.	3	0	0
	Efficiency gains with lowered surveillance costs and better planning and targeting of MCS.	3	0	0
	Accurate and real-time information and monitoring improves the potential to detect incidents.	3	0	0
	Improved analyses and reporting of compliance performance. Savings in administrative costs due to the automation.	2	0	0
Improved enforcement	Provides reliable evidence to support investigations.	3	0	0
Improved fisheries management and sustainable use	Information supports fisheries management, leading to sustainable fishing and more productive fisheries.	2	0	0
	Supports logbook data validation of fishing logbook data.	2	0	0
	Improved effectiveness of management system, with administration savings.	2	0	0
Improved marine park and fisheries science	Improved research and monitoring confidence with high quality data supporting research and monitoring.	2	0	0

Table 13 Parks Australia Non-Monetarised Benefit Scores by Option

Benefit	Description	Option One	Option Three	Option Four
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Improved compliance	Access to the Marine Park Alert Service helps avoid compliance incident and protects ecological, social and cultural marine park values.	3	0	0
	Reductions in non-compliance due to a deterrence effect	3	2	1
	Improved analyses and reporting of compliance performance. Better quality and more comprehensive data. Savings in administrative costs due to the automation.	3	0	0
	Improved compliance monitoring. Assists with monitoring compliance with fishing zones and area and seasonal closures and catch entitlements.	3	0	0
	Accurate and real-time information and monitoring improves the potential to detect incidents.	3	1	0
	Improved compliance monitoring, with real-time data and intelligence to strengthen awareness of fishing activities.	3	0	0
Improved enforcement	Improved evidence to support incident response and prosecutions.	3	2	0
Improved marine park and fisheries science	Improved adequacy, transparency, and integrity of fishing information to support research and monitoring.	2	1	1

Table 14 Other Marine Park Users Non-Monetarised Benefit Scores by Option

Benefit	Description	Option One	Option Three	Option Four
Improved compliance	Knowledge that fishers are complying with marine park rules and that marine park values are protected, including ecological, social economic and cultural values.	3	1	1
	Improved satisfaction and enjoyment from clients with improved business opportunities and returns, with clients enjoying visits to marine parks that are effectively managed – maintaining a supply of fish and other marine life, healthy habitats and species diversity, and cultural services from contact with nature, including aesthetic and spiritual benefits and recreational activities.	2	0	1

Table 15 Indigenous Communities Non-Monetarised Benefit Scores by Option

Benefit	Description	Option One	Option Three	Option Four
Improved compliance	Improved confidence in commercial fishing operations with Knowledge that fishers are complying with marine park rules and that marine park cultural values are being protected	2	1	0

9 Conclusion

Effective compliance in marine parks is critical for successfully protecting their environmental, heritage and social values. A solid rationale prevails to introducing mandatory VMS on commercial fishing vessels transiting or fishing in marine parks to improve surveillance. The \$5.5 million Electronic and Vessel Monitoring Systems Assistance Program Grant has provided an impetus and

the necessary funding to offset fishers and FMAs with the establishment and early operational costs, significantly reducing the regulatory burden.

Approximately half of the Australian commercial fishing fleet already uses VMS, and most FMAs can expand VMS to fishing that might encounter marine parks. The introduction of VMS in marine parks is timely with the maturing of the National VMS program set up by the Australian Fisheries Management Authority, which supports FMAs and the effective use of VMS for commercial fishing in Australia. The Great Barrier Reef Marine Park Authority has also mandated VMS and is realising the compliance benefits of this decision.

International examples of cost-benefit and cost-effectiveness analyses have shown VMS to be the most cost-effective way of monitoring fishing vessels. This is particularly evident for large and remote marine parks. Although the benefits of VMS are problematic to monetarise, effective surveillance will lead to high levels of compliance and, in turn, ensure the protection of marine parks values.

There are several contexts in which cost-effectiveness analysis is appropriate, and it is a precondition that the options being compared have a common primary effect. The Parks Australia analysis meets this precondition, with all options having outputs (benefits) involving the detection of non-compliance. The context is also appropriate for the compliance program, which is continuing and existing functions being integral to the success of marine parks.

The cost-effectiveness analysis shows the introduction of VMS (Option One) to be the least-cost and preferred solution for Parks Australia to ensure effective compliance. Introducing mandatory VMS in marine parks is 19 times more cost-effective than increasing aerial and vessel-based surveillance (Option Three) and three times more cost-effective than directing all commercial fishing vessels to report manually whilst operating in marine parks (Option Four). The distributional impacts of Option One are also relatively equitable, with costs incurred by those that make commercial gains from marine parks and government agencies that provide for the management of fisheries and marine parks. There are no costs to other sectors of the community.

The analysis of qualitative benefits indicates that VMS results in the most benefits compared to other options. The primary benefits are improved compliance and effective management outcomes for Parks Australia and FMAs. Fishers benefit from having an enhanced social licence to operate marine parks and access to the Marine Parks Alert Service, which is proven to help prevent non-compliance, save litigation costs and avoid impacts on marine park values.

The new VMS regulation involves a simple amendment to existing class approvals for commercial fishing authorised under marine park Network management plans. These amendments would require VMS to be installed, registered, and operational.

The Australian Fisheries Management Authority and international fisheries highlight that VMS is only truly effective when universally applied. Consequently, robust deterrence needs to be in place, with well-dispersed enforcement to ensure compliance with VMS requirements.

The Director for National Parks intends to undertake industry and government consultation on the proposed regulatory change to implement VMS, which is intended to come into effect no earlier than mid 2024. This transition period will allow time for fine-tuning arrangements with FMAs and resolving any outstanding issues. It will also provide a reasonable time allowance for VMS installation and fisher awareness and understanding of the marine park requirements.

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Appendix A - Estimated number of domestic commercial fisheries and fishing vessels operating in or transiting marine parks.

JURISDICTION	Number of Fishing Vessels	VMS Requirement
SA Fishery		
Abalone - Central Zone	6	N
Abalone - Western Zone	22	N
Marine Scalefish	206	N
Marine Scalefish	60	N
Marine Scalefish	146	N
Miscellaneous	12	N
Prawn - Western Zone	3	N
Rock Lobster - Northern Zone	63	Y
Rock Lobster - Southern Zone	180	N
Sardine	14	Y
TOTAL	712	10%
TAS Fisheries		
Abalone	20	Y
Giant Crab	5	Y
Rock Lobster	165	Y
Scallop	0	Y
Shellfish	8	Y
TOTAL	198	100%
Commonwealth Fisheries		
Bass Strait Central Zone Scallop	12	Y
Coral Sea	6	Y
Eastern tuna and Billfish	57	Y
High Seas	N/A	Y
Norfolk Island	1	Y
Northwest Slope Trawl	2	Y
Northern Prawn	52	Y
SESSF – East Coast Deepwater Trawl	3	Y
SESSF – Gillnet, Hook and Trap Sectors	83	Y
SESSF – Great Australian Bight Trawl	4	Y
SESSF Commonwealth Trawl	55	Y
Skipjack Tuna	3	Y
Small Pelagic	5	Y
Southern Bluefin Tuna	17	Y
Southern Squid Jig	7	Y
Western Deepwater Trawl	3	Y
Western Skipjack	2	Y
Western Tuna and Billfish	4	Y
TOTAL	316	100%
NSW Fisheries		

Traps, pots	10	N
Demersal fish traps and lines	255	N
Trawl	118	N
TOTAL	383	0%
NT Fisheries		
Demersal	5	Y
Eastern Grey Mackerel Management Zone	0	Y
Giant Clam Aquaculture Trail	0	Y
Offshore Net and Line	8	Y
Spanish Mackerel Fishery	10	Y
Squid Jigging Fishery	0	Y
Timor Reef Fishery	6	Y
TOTAL	29	100%
VIC Fisheries		
Abalone	73	Y
Bait	0	N
Giant Crab	2	Y- Electronic Monitoring
Octopus	10	Y
Rock Lobster	60	Y
Scallop	91	Y
Wrasse	22	N
Sea Urchin	8	Y
TOTAL	266	75%
QLD Fisheries		
Blue Swimmer Crab	0	Y
Coral Reef Fin Fish	0	Y
Deepwater Multiple Hook	0	Y
Deepwater finfish	4	Y
East Coast Otter Trawl	340	Y
East Coast Pearl	0	Y
East Coast Spanish Mackerel	0	Y
Fin Fish (Stout Whiting) Trawl	0	Y
Carpentaria Developmental Fish Trawl	2	Y
Gulf of Carpentaria Inshore Fin Fish	82	Y
Gulf of Carpentaria Line and QFJA Line	27	Y
Harvest fishery	38	Y
Marine Aquarium Fish	34	Y
Mud Crab	0	Y
Sea Cucumber (East Coast)	0	Y
Spanner Crab	0	Y
TOTAL	527	100%

WA fisheries		
Abalone	0	N
Abrolhos Island and Mid-West Scallop Trawl	6	Y
Beche de Mer	0	N
Broome Prawn	0	Y
Exmouth Gulf Prawn	0	Y
Gascoyne Demersal Scalefish	20	Y
Southern Demersal Gillnet and Demersal Longline	18	Y
Kimberley Crab	3	Y
Kimberley Prawn	13	Y
Mackerel	23	Y
Marine Aquarium Fish	11	N
Nickol Bay Prawn	3	Y
North Coast Shark	0	Y
Northern Demersal Scalefish	7	Y
Octopus Interim	25	N
Onslow Prawn	3	Y
Pearl Oyster	51	N
Pilbara Crab	1	N
Pilbara Line	7	N
Pilbara Trap	3	Y
Pilbara Trawl	4	Y
Shark Bay Crab	0	N
Shark Bay Prawn	0	Y
Shark Bay Scallop	0	Y
South Coast Crustacean	18	Y/N
South Coast Purse Seine	0	N
South Coast Salmon	0	N
South Coast Trap and Line	93	Y/N
South Coast Trawl	4	Y
South West Trawl	3	Y
Southwest Coast Salmon	0	N
Specimen Shell	18	N
West Coast Deep Sea Crustacean	3	N
West Coast Demersal Gillnet and Demersal Longline	7	Y
West Coast Demersal Scalefish	26	Y
West Coast Purse Seine	5	N
Western Rock Lobster	275	N
TOTAL	647	46%

Appendix B - Sectors in marine parks potentially affected by commercial fishing

Traditional owners have an ancient affinity with Sea country within marine park regions. Sea country is valued for its cultural identity, health and wellbeing. They use marine parks for fishing and hunting and maintaining culture and heritage through rituals, stories, and traditional knowledge. Indigenous communities also have responsibilities for sea country in many marine parks and are regularly consulted in assessing licences and permits [7].

Marine park management programs specifically provide for tourism and visitor experience [7]. Commercial tourism operators offer unique experiences for visitors to enjoy natural marine park values, such as offshore reefs, islands, cays and deep-water environments. Commercial tour operator activities are assessed and licenced by the Director. A total of 55 licences are active (as of March 2022). Licence holders must report on their activities quarterly, providing detailed information on visited locations and time spent in marine parks and the number of passengers per trip. Non-extractive commercial tourism operators, such as scuba diving and nature watching, are permitted in all zones except sanctuary zones [7].

Commercial tourism operators are regulated and managed by state and Territory FMAs and are permitted to operate in marine parks in the same zones as commercial fishing. From survey information, charter fishing catch and effort in marine parks are likely significantly less than recreational fishing [61]. Vessel tracking is not a requirement for charter fishing in any jurisdiction. VMS has been trialled with Commercial tourism operators in the Lord Howe Island Marine Park under a cooperative agreement between Parks Australia and operators since 2015. The proposal does not affect it (*Parks Australia 2022, pers. comm., 22 May*).

Recreational activities, such as island visiting, snorkelling, diving, sailing, boating and fishing, are widespread in marine parks. However, given the offshore locations of marine parks, recreational fishing is likely to be the most significant activity in terms of frequency of use and economic contribution. The extent and distribution of recreational fisheries in marine parks are unknown but more prevalent at accessible and nearshore island and reef locations and on weekends and holidays. A recent study commissioned by the National Environmental Science Program on recreational fishing in marine parks found an annual fishing effort between 14,245 – 21,160 boat days per year in the Ningaloo Marine Park alone, indicating that recreational use is significant when tallied with all marine parks [61].

Marine science provides scientific knowledge and understanding of marine park values, pressures, and effectiveness of marine park management measures. This information is critical for adaptive management and future planning. Research activities require a permit and can be undertaken in any zone, subject to permit conditions. Currently, there are around 170 active permits in marine parks. The research sector is a significant economic contributor to marine parks, generating millions in spending and revenue. For example, in the Great Barrier Marine Park this contribution is comparable to commercial fishing [62].

Appendix C – International and National Economic Studies for the use of Vessel Monitoring Systems.

International and national examples of economic studies relevant to valuing the costs and benefits of Vessel Monitoring Systems (VMS) provide relative benchmarks (and standards) for the proposal to mandate VMS on commercial fishing vessels in Australian Marine Parks (marine parks). They assist with identifying costs and benefits (and values) and help decide on the methodology to value and address benefits. Lessons learned from these studies are also beneficial to ensure they are not repeated and that recommendations to improve analyses are considered.

Cost-Benefit Analysis of Compliance Measures

Several studies have looked at the costs and benefits of compliance measures and compared their respective utilities. It is well-known to compliance officers that there is no single solution to achieve effective compliance and that several measures, in combination, are required – monitoring, control and surveillance measures. The optimal combination of these measures depends on many factors. For marine parks, the main factors are their remoteness, large size, uses and threats, with the limiting factor being the allocated funding for compliance, which is prioritised with other management actions.

In 1998, the UN Food and Agriculture Organisation published technical guidelines for VMS. These guidelines provided details on VMS use and compared the costs and benefits to other types of surveillance – noting that obtaining the best return from compliance measures is a fundamental decision for compliance managers. Understanding what constituted effective management (i.e., effective monitoring, control and surveillance) was deemed critical to evaluate whether effective management was being achieved [4]. The UN Food and Agriculture Organisation submitted that if effective management included a requirement to track vessel movements continuously, then VMS would have a significant cost advantage over others due to the high cost of patrol craft. VMS was also appealing because it was suited for cost-recovery or user-pay arrangements, an important consideration given limited compliance budgets.

In 2002, the economics of monitoring, control and surveillance measures were expanded upon by the UN Food and Agriculture Organisation, focussing on optimum compliance by assessing the benefits of different combinations of measures [39]. The UN Food and Agriculture Organisation concluded that cost-benefit analysis suffered difficulties in establishing and valuing the benefits of compliance activities, as the activities were highly interdependent (e.g., surveillance depends on vessel licensing), and assessing compliance measures in isolation was questionable as benefits accrued from a suite of measures that could not be assigned to any single activity. Cost-effectiveness analysis was a superior method in this case – finding the least-cost solution to providing a given level of monitoring, control and surveillance [39]. This method involved determining the level of non-compliance to be achieved; however, given this is unknown, targets were substituted (e.g., patrols/day, number of offences detected/patrol).

In 2014, the Indonesian Ministry for Marine Affairs and Fisheries completed a cost-benefit analysis to introduce improvements in VMS. Their premise was that monitoring fishing activities would positively impact business productivity and fisher incomes – noting that illegal fishing in Indonesia was a national issue, with approximately 10 per cent of at-sea inspections resulting in court proceedings [63]. The costs consisted of government set-up, planning, hardware and software expenses. Several broad assumptions were made to address data gaps to value benefits. For example, the economic loss of illegal fishing was assumed to be the same as the world percentage (7.6 per cent), and VMS would reduce illegal fishing by 50 per cent over the ten years. Catch per

average fish price was set over ten years, and it was estimated that 4000 illegal vessels were in operation. The study determined a benefit/cost ratio of 15:1 [63].

In 2016, the UN Food and Agriculture Organisation assisted with a report on the cost and benefits of applying an MCS system in Sri Lankan fisheries [59]. The cost-benefit analysis aimed to inform and identify the best possible ways to minimise the cost of monitoring, control and surveillance and strengthen its capacity. The cost benefit analysis derived the net present value using the benefit gained from the fisheries within the Economic Exclusive Zone. Environmental and social benefits (non-financial benefits) were treated qualitatively. Using derived benefits from fishery landings, the cost-benefit analysis calculated a resource rent of 18.7 per cent, with a positive benefit/cost ratio of 1.28, indicating that monitoring, control and surveillance were beneficial and should be strengthened.

In 2016, a study identified the costs and benefits of introducing electronic systems in the Western and Central Pacific Ocean Tuna Fishery, including information on the benefits of electronic tracking using [47]. The study quantified both costs and benefits, the majority being cost savings and opportunity costs from not using manual data collection methods and observers and savings from lost revenue through non-compliance, such as under-reporting. Where benefits were not quantified, they were qualitatively compared. Benefits of electronic tracking included improved compliance and reporting (e.g., improved compliance monitoring, detection, improved number of successful prosecutions and targeting higher risks with efficiencies in lowered surveillance costs and more efficient deployment of surveillance assets), improved fisheries sustainability (including improved quality in stock assessment), improved industry conditions and safety. In addition, the electronic systems allowed for earlier availability of critical data in near real or real-time and better quality of data from closed systems that eliminated human errors. The findings demonstrated that the benefits significantly outweigh the costs [47].

Regulatory Impact Statements

Regulatory Impact Statements are required by many governments when proposing new regulations. Regulatory Impact Statements featuring VMS related regulations are relevant to the cost-benefit analysis for insight into costs, issues, impacts and implementation. Of particular relevance are the RISs prepared by the QLD Department of Agriculture and Fisheries in 2019 to introduce mandatory VMS on 884 commercial fishing vessels [64], the Victoria Fisheries Authority for new VMS regulations in 2019 [36], and the NZ Ministry for Primary Industries proposed introduction of mandatory Integrated Electronic Monitoring and Reporting in 2017 [35].

The Victorian Fisheries Authority impact assessment justified the need for the regulation and its anticipated costs and benefits. The comparison alternative was to introduce voluntary VMS, which was assessed as not providing a capability to ensure compliance with management arrangements and detracting from the Victoria Fisheries Authority's ability to provide responsive and sustainable management. It determined that the only regulatory cost was an ongoing expense of approximately \$30-40 mths to each fishing vessel, as set up costs (e.g., purchase of VMS and installation) were entirely offset by an Australian Government grant (\$3 million from the Great Barrier Reef Marine Park Authority). The primary benefit was that VMS enabled real-time monitoring of commercial fishing fleets and more responsive and evidence-based decision-making. Benefits were not quantified or compared [64].

The Victorian Fisheries Authority introduced new fishing regulations in 2019 requiring mandatory VMS. The regulatory impact statement considered three options – an option with VMS, a business-as-usual option, and a 'no restrictions' option [8]. The benefits of VMS were described as providing

more efficient enforcement operations through expanding mandatory use, reduced compliance costs for licence holders (removing the need for certain notifications), reduction in at-sea compliance inspections and increased community confidence that commercial fisheries are sustainably managed (i.e., supporting social licence). The regulatory compliance cost for 185 additional boats to have VMS was approximately \$1.14 million over ten years (an annualised cost of \$114,000/yr). A qualitative assessment was undertaken for benefits that ranked the preferred option [36].

The New Zealand Ministry of Primary Industries RIS supported the introduction of mandatory Electronic-monitoring and reporting, including VMS in their commercial fisheries. Their regulation aimed to provide accurate, integrated and timely reporting and monitoring data on commercial fishing activity to manage fisheries resources while ensuring sustainability [35]. Alternative options included maintaining the status quo (with existing levels of VMS reporting), mandatory VMS for all fisheries, and mandatory VMS with the addition of electronic monitoring (EM) being phased in for all operators. An option to introduce voluntary measures was ruled out for the same reasons the Victoria Fisheries Authority and QLD Department of Agriculture and Fisheries concluded – that it could not satisfy policy objectives, and 100% uptake of electronic reporting was necessary for it to be effective. Costs for each option were determined (cost-effectiveness), and non-monetised benefits were described but not valued. A qualitative analysis of the options was also applied using decision criteria (i.e., likely effectiveness in achieving objectives; the certainty that new regulations would be clear and enforceable and complied with; costs to industry; and consumer, stakeholder and public confidence in the commercial fisheries management).

Valuing Marine Protected Areas

Valuing the costs and benefits of marine protected areas is relevant to Parks Australia's proposal, primarily from demonstrating the cost of effective compliance compared to the beneficial services provided by marine parks. There is also potential to use these valuations to monetise VMS benefits in protecting marine park values (e.g., biodiversity, social and cultural values). These values provide a range of benefits such as tourism and recreational and non-use benefits (e.g., existence, bequest and option values). Many studies and reviews from around the globe have shown that the benefits derived from marine protected areas (thematic and existing) are substantial [65-75].

Notable work on valuing the economic and natural capital contributions is associated with the Great Barrier Marine Park [62, 71, 76-78]. Most of these studies have valued the Great Barrier Marine Park using the economic contributions of commercial fishing, tourism and recreational use, with varying degrees of non-market values from overseas studies (i.e., benefit transfer methods). More recent valuations have included environmental and social asset values (direct and indirect use and non-use values) using a range of economic survey methods to monetise non-market values (e.g., travel-cost based choice experiments and attribute-based contingent valuation methods). For example, in 2017, Deloitte Access Economics valued the Great Barrier Reef Marine Park economic, social and icon asset at \$37-77 billion over 33 years³⁷ [62].

There is an underlying view in the literature indicating that valuations of marine environments (and marine protected areas) have many limitations, particularly for deep water locations where the biodiversity and ecosystem services are not well understood [79, 80]. For example, databases designed to assist with environmental valuations do not capture this information (including the Economics of Ecosystems and Biodiversity valuation database (TEEB), Environmental Benefits from Nature Tool, Natural Capital Atlases, Natural Capital Register and Account Tool, MESER, and Environmental Valuation Reference Inventory) [81-84].

³⁷ The Deloitte Access Economics valuation did not include some ecosystem services or cultural values.

A review of literature by the NSW Marine Parks Authority in 2004 found that the lack of available data at the local level limited the ability to value the system of NSW Marine Parks sensibly. Their review found little empirical work that quantified the direct and indirect uses of marine parks, and most valuations failed to capture the marginal change in resource use and the actual value of protection [79].

Similarly, there are significant gaps in data to value marine parks. In a valuation of the proposed system of marine parks by the Centre for Policy Development in 2011, only six out of 20 ecosystem services could be used due to the lack of scientific and valuation literature. The Centre used a benefit transfer technique with the value of ecosystem services (\$/hectare/yr) and applied values to national park zones only. The study estimated these zones had an ecosystem service value of \$1.2 billion/yr, similar to the natural asset value of the Great Barrier Reef Marine Park [72].

Appendix D - Present Value Costs for Options by Year

OPTION ONE				
		Net Present Cost		
Year	Costs	3%	7%	10%
1	\$1,451,784	\$1,451,784	\$1,451,784	\$1,451,784
2	\$1,380,684	\$1,340,470	\$1,290,359	\$1,255,167
3	\$1,380,684	\$1,301,427	\$1,205,943	\$1,141,061
4	\$1,380,684	\$1,263,521	\$1,127,049	\$1,037,328
5	\$1,380,684	\$1,226,720	\$1,053,317	\$943,026
6	\$1,380,684	\$1,190,990	\$984,409	\$857,296
7	\$1,380,684	\$1,156,301	\$920,008	\$779,360
8	\$1,380,684	\$1,122,622	\$859,821	\$708,509
9	\$1,380,684	\$1,089,925	\$803,571	\$644,099
10	\$2,927,528	\$2,243,706	\$1,592,381	\$1,241,558
11	\$1,380,684	\$1,027,359	\$701,870	\$532,313
12	\$1,380,684	\$997,435	\$655,953	\$483,921
13	\$1,380,684	\$968,384	\$613,040	\$439,928
14	\$1,380,684	\$940,179	\$572,935	\$399,935
15	\$1,380,684	\$912,795	\$535,453	\$363,577
16	\$1,380,684	\$886,209	\$500,423	\$330,525
17	\$1,380,684	\$860,397	\$467,685	\$300,477
18	\$1,380,684	\$835,337	\$437,089	\$273,161
19	\$1,380,684	\$811,006	\$408,495	\$248,328
20	\$1,380,684	\$787,385	\$381,771	\$225,753
TOTAL		\$22,413,951	\$16,563,356	\$13,657,108

OPTION THREE				
		Net Present Cost		
Year	Costs	3%	7%	10%
1	\$1,902,400	\$1,902,400	\$1,902,400	\$1,902,400
2	\$1,902,400	\$1,846,990	\$1,777,944	\$1,729,455
3	\$1,902,400	\$1,793,194	\$1,661,630	\$1,572,231
4	\$1,902,400	\$1,740,965	\$1,552,925	\$1,429,301
5	\$1,902,400	\$1,690,258	\$1,451,332	\$1,299,365
6	\$1,902,400	\$1,641,027	\$1,356,385	\$1,181,241
7	\$1,902,400	\$1,593,230	\$1,267,649	\$1,073,855
8	\$1,902,400	\$1,546,825	\$1,184,719	\$976,232
9	\$1,902,400	\$1,501,772	\$1,107,214	\$887,484
10	\$1,902,400	\$1,458,031	\$1,034,780	\$806,803
11	\$1,902,400	\$1,415,564	\$967,084	\$733,458

12	\$1,902,400	\$1,374,334	\$903,817	\$666,780
13	\$1,902,400	\$1,334,305	\$844,688	\$606,163
14	\$1,902,400	\$1,295,442	\$789,428	\$551,058
15	\$1,902,400	\$1,257,711	\$737,784	\$500,961
16	\$1,902,400	\$1,221,078	\$689,517	\$455,419
17	\$1,902,400	\$1,185,513	\$644,409	\$414,018
18	\$1,902,400	\$1,150,983	\$602,251	\$376,380
19	\$1,902,400	\$1,117,460	\$562,852	\$342,163
20	\$1,902,400	\$1,084,912	\$526,029	\$311,058
TOTAL		\$29,151,995	\$21,564,836	\$17,815,824

OPTION FOUR				
		Net Present Cost		
Year	Costs	3%	7%	10%
1	\$3,784,000	\$3,784,000	\$3,784,000	\$3,784,000
2	\$3,499,000	\$3,397,087	\$3,270,093	\$3,180,909
3	\$3,499,000	\$3,298,143	\$3,056,162	\$2,891,736
4	\$3,499,000	\$3,202,081	\$2,856,226	\$2,628,850
5	\$3,499,000	\$3,108,816	\$2,669,370	\$2,389,864
6	\$3,499,000	\$3,018,268	\$2,494,739	\$2,172,604
7	\$3,499,000	\$2,930,357	\$2,331,531	\$1,975,094
8	\$3,499,000	\$2,845,007	\$2,179,001	\$1,795,540
9	\$3,499,000	\$2,762,143	\$2,036,450	\$1,632,309
10	\$3,499,000	\$2,681,692	\$1,903,224	\$1,483,918
11	\$3,499,000	\$2,603,585	\$1,778,714	\$1,349,016
12	\$3,499,000	\$2,527,752	\$1,662,350	\$1,226,378
13	\$3,499,000	\$2,454,128	\$1,553,598	\$1,114,889
14	\$3,499,000	\$2,382,649	\$1,451,961	\$1,013,536
15	\$3,499,000	\$2,313,251	\$1,356,973	\$921,396
16	\$3,499,000	\$2,245,875	\$1,268,199	\$837,633
17	\$3,499,000	\$2,180,461	\$1,185,232	\$761,484
18	\$3,499,000	\$2,116,953	\$1,107,694	\$692,258
19	\$3,499,000	\$2,055,294	\$1,035,228	\$629,326
20	\$3,499,000	\$1,995,431	\$967,503	\$572,114
TOTAL		\$53,902,973	\$39,948,248	\$33,052,856

Appendix E - Estimated Costs by Government Agency per year for Option One.

NSW Department of Primary Industries – Fisheries Costs (Option One)

Cost Description	Cost \$/yr	Cost Category	Source and Assumptions	Reliability/ Accuracy
Education material and training	75,700 15,000	One-off and four updates	Consultant experience. Based on 10 weeks @ APS6 \$118,894 & printing and training. Offset (\$100,000) *	Medium
Engagement and consultation (peak body and stakeholder engagement)	20,000	One-off	Consultant experience. Based on 5 weeks @ APS6 \$118,894 x 1.22 CF & \$8,500 for venue hire, travel and catering.	Medium
Provision of day-to-day information	4,000	ongoing	Consultant experience. Based on one/hr/wk, reducing to 0.5/hr/wk, in second year and onwards @73.05/hr. Assumes no additional IT or office space.	Medium
Administration of AFMA contract and project management	29,700	ongoing	Consultant experience. Based on 0.25 x @ APS6 \$118,894	Medium
Compliance and enforcement	133,900	ongoing	Consultant experience. Based on 1 x @ APS6 \$118,894 & \$15,000 pa operational budget	Medium
AFMA management and provider charges	116,900	ongoing	Known market amount Offset (\$270,000) two years	High

*Salaries include X 1.22 conversion factor for IT, office, superannuation.

SA Department of Primary Industries and Regions – Fisheries Costs (Option One)

Cost Description	Cost \$/yr	Cost Category	Source and Assumptions	Reliability/ Accuracy
Development of Policy	22,900	One-off	Consultant experience. Based on 10 weeks @ APS6 \$118,894 (noting policy is in place for other fisheries)	Medium
Education material and training	30,000 15,000	One-off and four updates	Consultant experience. Based on 10 weeks @ APS6 \$118,894 & printing and training. Offset (\$100,000)	Medium
Engagement and consultation	20,000	One-off	Consultant experience. Based on 5 weeks @ APS6 \$118,894 & \$8,500 for venue hire, travel and catering.	Medium
Provision of day-to-day information	2,000	ongoing	Consultant experience and based on 0.5/hr/wk, reducing to 0.25/hr/wk, in second year and onwards @73.05/hr. Assumes no additional IT or office space.	Medium
Administration of AFMA contract and project management	0	ongoing	Additional VMS will not increase project management burden above business-as-usual.	Medium
Compliance and enforcement	29,700	ongoing	Consultant experience and based on 0.25 x Consultant experience.	Medium

			Based on 5 weeks @ APS6 \$118,894	
AFMA management and provider charges	107,800	ongoing	Known market amount	High

WA Department of Primary Industries and Regional Development – Fisheries Costs (Option One)

Cost Description	Cost \$\$/yr	Cost Category	Source and Assumptions	Reliability/Accuracy
Development of Policy	22,900	One-off	Consultant experience. Based on 10 weeks salary @ APS6 \$118,894 (noting policy is in place for other fisheries)	Medium
Education material and training	20,000 15,000	One-off and four updates	Consultant experience. Based on 10 weeks @ APS6 \$118,894 Offset (\$100,000)	Medium
Engagement and consultation	31,300	One-off	Consultant experience. Based on 5 weeks 2 X @APS6 \$118,894 & \$8,500 for venue hire and catering and travel	Medium
Provision of day-to-day information	2,000	ongoing	Consultant experience and based on 0.5/hr/wk reducing to 0.25/hr/wk in second year and onwards @73.05/hr. Assumes no additional IT or office space.	Medium
Administration of AFMA contract and project management	0	ongoing	Additional VMS will not increase project management burden above business-as-usual.	Medium
Compliance and enforcement	29,700	ongoing	Consultant experience and based on 0.25 x @ APS6 \$118,894	Medium
AFMA management and provider charges	6,200	ongoing	Known market amount	High

NT Department of Industry, Tourism and Trade – Fisheries Costs (Option One)

Cost Description	Cost \$\$/yr	Cost Category	Source and Assumptions	Reliability/Accuracy
Development of Policy	4,600	One-off	Consultant experience. Based on two weeks @ APS6 \$118,894 (noting policy is in place for other fisheries)	Medium
Education material and training	4,600	One-off and four repeats	Consultant experience. Based on two weeks @ APS6 \$118,894 (noting training material is in place for other fisheries)	Medium
Engagement and consultation	4,800	One-off	Consultant experience. Based on one week salary @ APS6 \$118,894 venue hire and workshop catering (\$2550) offset	Medium
Provision of day-to-day information	2,000	ongoing	Consultant experience and based on 0.5/hr/wk, reducing to 0.25/hr/wk, in second year and onwards @73.05/hr. Assumes no additional IT or office space.	Medium

Administration of AFMA contract and project and business management	0	ongoing	Additional VMS will not increase project management burden above business-as-usual.	Medium
Compliance, inspection and enforcement	0	ongoing	Additional VMS is unlikely to increase compliance burden above business-as-usual.	Medium
AFMA management and provider charges	(3,900)	Ongoing	Known market amount. Cost reduced due to national efficiencies.	High

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Parks Australia Costs (Option One)

Cost Description	Cost \$/yr	Cost Category	Source and Assumptions	Reliability/ Accuracy
Development of policy, including revised class approvals.	18,300	One-off	Consultant experience. Based on eight weeks @ APS6 \$118,894	Medium
Education material, including website information.	4,600	One-off and four repeats	Consultant experience. Based on two weeks @ APS6 \$118,894	Medium
Engagement and consultation	26,000	One-off	Consultant experience. Based on two weeks salary for three staff @ 2 X APS6 \$118,894, 1 X APS5 \$102,063 & travel costs.	Medium
Provision of day-to-day information	0	N/A	Consultant experience. Additional VMS will only marginally increase provision of information above business-as-usual.	Medium
Administration of AFMA contract and project and business management	0	N/A	Additional VMS will not increase project management burden above business-as-usual.	Medium
Compliance and enforcement	139,000	ongoing	Consultant and GBRMPA experiences. @ 1 x APS6 \$118,894 & \$20,000 pa operations	Medium/high
AFMA management	59,000	ongoing	Market based. Includes costs for case management support \$5,000 (2 cases/yr), polling \$5,000 (15-30min intervals), and ancillary cost to provide Marine Park Alert Service to 982 vessels pa. \$49,100 pa (\$2,500/50 units).	Medium/High