

**Measurement of Fisheries
Compliance Outcomes:
A Preliminary National Study
FRDC Project No 2014/206
FRDC Final Report**

E. Price, R. Melville-Smith, D. King, T. Green, W. Dixon,
S. Lambert, T. Spencer



Government of Western Australia
Department of Fisheries



Fisheries Research Division

Western Australian Fisheries and Marine Research Laboratories
PO Box 20 NORTH BEACH, Western Australia 6920

© 2016 Fisheries Research and Development Corporation.
All rights reserved.

Measurement of Fisheries Compliance Outcomes: A Preliminary National Study
Project No. 2014/206
October 2016

Ownership of Intellectual property rights

Unless otherwise noted, copyright (and any other intellectual property rights, if any) in this publication is owned by the Fisheries Research and Development Corporation

This publication (and any information sourced from it) should be attributed to ***E. Price, R. Melville-Smith, D. King, T. Green, W. Dixon, S. Lambert, T. Spencer (2016), Measurement of Fisheries Compliance Outcomes: A preliminary National Study. Perth, Australia, October 2016.***

Creative Commons licence

All material in this publication is licensed under a Creative Commons Attribution 3.0 Australia Licence, save for content supplied by third parties, logos and the Commonwealth Coat of Arms.



Creative Commons Attribution 3.0 Australia Licence is a standard form licence agreement that allows you to copy, distribute, transmit and adapt this publication provided you attribute the work. A summary of the licence terms is available from creativecommons.org/licenses/by/3.0/au/deed.en. The full licence terms are available from creativecommons.org/licenses/by/3.0/au/legalcode.

Inquiries regarding the licence and any use of this document should be sent to: frdc@frdc.gov.au.

Disclaimer

The authors do not warrant that the information in this document is free from errors or omissions. The authors do not accept any form of liability, be it contractual, tortious, or otherwise, for the contents of this document or for any consequences arising from its use or any reliance placed upon it. The information, opinions and advice contained in this document may not relate, or be relevant, to a readers particular circumstances. Opinions expressed by the authors are the individual opinions expressed by those persons and are not necessarily those of the publisher, research provider or the FRDC.

The Fisheries Research and Development Corporation plans, invests in and manages fisheries research and development throughout Australia. It is a statutory authority within the portfolio of the federal Minister for Agriculture, Fisheries and Forestry, jointly funded by the Australian Government and the fishing industry.

Researcher Contact Details

Name: Timothy J Green
Address: PO Box 20
North Beach
WA 6920
Phone: (08) 9203 0234
Email: Timothy.Green@fish.wa.gov.au

FRDC Contact Details

Address: 25 Geils Court
Deakin ACT 2600
Phone: 02 6285 0400
Fax: 02 6285 0499
Email: frdc@frdc.com.au
Web: www.frdc.com.au

In submitting this report, the researcher has agreed to FRDC publishing this material in its edited form.

© Department of Fisheries, Western Australia. October 2016.

ISSN: 1035-4549 (Print) ISBN: 978-1-877098-50-5 (Print)
ISSN: 2202-5758 (Online) ISBN: 978-1-877098-51-2 (Online)

Table of Contents

Abbreviations.....	1
Acknowledgements.....	2
Executive Summary.....	4
Overview	4
Literature review.....	5
Survey.....	7
Workshop.....	7
Conclusions	8
1 Introduction	11
1.1 What are compliance outcomes?.....	11
1.2 What are the functional units that generally make up a fisheries compliance force?	13
1.3 What makes developing compliance outcome measures difficult?	14
2 Objectives.....	16
3 Methods	16
3.1 Literature review: methodologies to assess effectiveness of compliance programs and measure compliance outcomes	16
3.2 Survey on aspects relating to output and outcome indicators collected by a limited sample of fisheries compliance agencies.....	18
3.3 Workshop to review findings of the desktop study and add expert input	18
4 Results/Discussion.....	19
4.1 Literature review: methodologies to assess effectiveness of compliance programs and measure compliance outcomes	19
4.1.1 Compliance Theory	21
4.1.2 Methods to measure fishing non-compliance and illegal activity.....	26
4.1.3 Measuring compliance outcomes.....	47
4.1.4 Fisheries compliance outcome measurement systems developed or in use.....	61

4.2	Survey on aspects relating to output and outcome indicators collected by a limited sample of fisheries compliance agencies.....	68
4.2.1	Survey Section 1: Your agency.....	69
4.2.2	Survey Section 2: Your role in your agency	70
4.2.3	Survey Section 3: Working relationships with your law enforcement/compliance branch or division	71
4.2.4	Survey Section 4: Your agency’s enforcement and its enforcement performance measurement	73
4.2.5	Survey Section 5: Your agency’s enforcement tools and capabilities	77
4.2.6	Survey Section 6: Level of interest in compliance outcomes measurement.....	78
4.2.7	Survey Section 7: Measures of successful compliance or enforcement activity.....	78
4.3	Workshop to review findings of the desktop study and add expert input	81
4.4	Documenting best practice	82
5	Conclusion.....	83
6	Implications.....	86
7	Recommendations	87
8	Extension and Adoption	91
	Appendix A: Intellectual Property.....	93
	Appendix B: Staff.....	94
	Appendix C: Workshop Agenda: Measuring Fisheries Compliance Outcomes.....	95
	Appendix D: The Affiliations of Attendees at the workshop: Measuring Fisheries Compliance Outcomes	96
	Appendix E: Survey form providing insight into compliance outcomes nationally and internationally	97
	Appendix F: References	108

Abbreviations

Abbreviation	Explanation
ACC	Australian Crime Commission
AFMA	Australian Fisheries Management Authority
ATO	Australian Taxation Office
BCA	Benefit cost analysis – synonymous with Cost Benefit Analysis (CBA)
BISEP	Business, industry, sociological, economic and psychological
CL	Carapace length
CPUE	Catch per unit effort
CPUPE	Catch per unit of policing effort
DEPI	Department of Primary Industries, Victoria
DoFWA	Department of Fisheries Western Australia
EEZ	Exclusive economic zone
ESD	Ecologically Sustainable Development
FAO	Fisheries and Agricultural Organisation
FTE	Full time equivalent (staff)
GVP	Gross value of production
IMCS	International Monitoring, Control and Surveillance (network)
INECE	International Network for Environmental Compliance and Enforcement
IUU	Illegal, unreported and unregulated
LMS	Legal minimum size
LFB	Licensed fishing boat
MSC	Marine Stewardship Council
MCS	Monitoring, Control and Surveillance (activities)
NEGF	Northeast Ground fish fishery
NFCC	National Fisheries Compliance Committee
NOAA	National Oceanic and Atmospheric Administration
NSW	New South Wales
OECD	Organization for Economic Cooperation and Development
PMS	Performance Measurement System
RFID	Radio frequency identification
ROI	Return on investment

RRT	Randomised response technique
SA	South Australia
SMART	Specific, Measurable, Achievable, Relevant and Timed
TRAFFIC	A non-governmental wildlife trade monitoring network established in 1976.
USCG	United States Coast Guard
VAG	Victorian Auditor-General
VMS	Vessel monitoring system
WA	Western Australia

Acknowledgements

We acknowledge the forethought of the Australian National Fisheries Compliance Committee in seeing outcome-based management as an area worthy of research and supporting this project from inception to conclusion.

Over and above the co-investigators on this project, there have been many fisheries compliance staff from states around Australia and internationally who have contributed in one form or another. This includes with the completion of the national/international survey, pointing us towards or supplying us with documents and websites useful to the project and/or, presenting on case studies from their jurisdictions at our workshop on measuring fisheries compliance outcomes. In this regard we thank John Looby and Phil Shaw (Department of Fisheries, Western Australia), Lars Olsen and Ian Parks (Fisheries Victoria), Peter Dietman (Primary Industries South Australia), Patrick Tully (Fisheries New South Wales), Tracey Scott-Holland (Queensland Boating and Fishing Patrol), Phil Ravenello and Peter Venslovas (Australian Fisheries Management Authority). We also thank John Slaughter (Ministry of Primary Industries, New Zealand), Richard Vermette (Fisheries and Oceans, Canada), Thord Monsen (Fiskeridirektoratet, Norway), Cephas Ralph (Marine Scotland), Héctor Villa González (Ministerio de Agricultura, Alimentación y Medio Ambiente, Spain) and the IMCS secretariat for providing support to the project.

We thank Lisa Young and Katie Willis (Australian Crime Commission), Melinda Stinziani (Australian Taxation Office), Graeme Bremner (Director, Quadrat NZ Ltd) and Charl Crous (Western Australian Police) for discussion over the course of the project, sending us documents useful to the report or for attending and presenting at our workshop on measuring fisheries compliance outcomes.

The Principal Investigator would like to acknowledge helpful early discussions with Prof Jon Sutinen (retired), Professor Ken Pollock (Department of Applied Ecology, North Carolina State University), Dr

Maria Hauck (Department of Environmental and Geographical Sciences, University of Cape Town), Dr Rachel Baird (Queensland University of Technology) and Dr Samantha Bricknell (Australian Institute of Criminology).

Executive Summary

Overview

This report presents the results of a project undertaken by a group of Australia and United States based fishery compliance experts to assess and compare methods for measuring fisheries compliance outcomes that can be used to assess and compare the effectiveness of fishery enforcement and compliance assistance activities. This eight month project was requested in 2013 by Australia's National Fisheries Compliance Committee (NFCC) as a way to provide fisheries compliance groups with improved methods for measuring and tracking the effectiveness of their activities and for justifying and managing their budgets. Measures of compliance 'inputs', such as patrol hours, and compliance 'outputs', such as numbers of contacts or inspections, are used routinely by compliance groups to manage their activities. On the other hand, 'outcome' measures that can be used to assess and compare the effectiveness and impacts of these activities, such as changes in observed non-compliance rates, changes in risks to stocks and related changes in fishing conditions, are not widely used. These outcome measures fall into three general categories: immediate outcomes (e.g. numbers of violations detected per patrol hour); intermediate outcomes (e.g. changes in numbers of violations detected per patrol hour); and final or long-term outcomes (e.g., improvements in biological and economic conditions in fisheries that result from compliance activities). Long-term outcomes are by far the most important and reflect how compliance activities contribute to fishery management goals, but they are the most difficult to measure and attribute specifically to compliance activities. Immediate and intermediate compliance outcome measures, therefore, are important not only as management tools, but because they serve as leading indicators of important long-term compliance outcomes that are difficult or impossible to measure directly.

Previous work in Australia and elsewhere to measure compliance outcomes in fisheries have had limited success. This is primarily because the scope of the task was underestimated and because 'output' measures that reflect levels of enforcement and compliance assistance were frequently conflated with 'outcome' measures that reflect the effectiveness of those activities. Changes in some compliance outcome indicators, such as increases in observed rates of noncompliance, are also very easy to misinterpret and misuse. For example, they could reflect less effective enforcement providing less deterrence or more effective targeting of enforcement resulting in higher detection. This difficulty in interpretation makes the development of outcome indicators less popular among some compliance agencies than simple input and output measures. The goal of this project was to identify, assess, and compare methods for measuring and interpreting fishery compliance outcomes

that have been employed or proposed for use; and to make recommendations regarding which methods should be developed and tested to help manage Australian fisheries.

The project was broken into four parts:

- 1) A review of the literature related to the development and use of compliance outcome measures, especially in fisheries. Initial stages of this review revealed that there has been very little research aimed specifically at measuring fishery compliance outcomes, so the scope was broadened to examine more general measures of fisheries compliance and illegal catches (section 4.1.2), how regulators outside of fisheries have undertaken the measurement of compliance outcomes, and of the use of performance-related management indicators in fisheries. Results of the review are described in section 4.1.3;
- 2) A national and international survey of fishery enforcement/compliance experts was undertaken to collect information about types of enforcement and compliance assistance activities being employed and about current and planned uses of input, output, and outcome measures. Responses are documented in section 4.2;
- 3) A workshop of fishery enforcement/compliance experts from multiple fisheries regulation agencies as well as representatives from the Australian Taxation Office (ATO) and Australian Crime Commission (ACC) was convened to review, interpret and draw conclusions from the literature review and survey results, and to assess the pros and cons of methods and best practices for developing fishery compliance outcome measures, as described in section 4.3; and
- 4) Preparation of this final report which we believe provides the most up-to-date and thorough review that is available of methods to develop fishery compliance outcome, and provides defensible and documented recommendations for developing and testing them to improve management of Australian fisheries.

Literature review

The literature review investigated the various theories of compliance that have been developed over the past several decades, and then focused on methodologies that are being used to assess the effectiveness of compliance programs and measure compliance outcomes. The theoretical research section described each of the major methodologies and provided one or more examples of how they have been used.

Peer-reviewed literature provides little guidance on how to implement fisheries compliance outcome measures and only a few descriptions of suitable fisheries compliance outcome measures

themselves. Most relevant work described in this literature describes attempts at quantifying the illegal catch – which is one suitable fisheries compliance outcome measure (section 4.1.2).

Outside the published peer-reviewed literature, we found that some agencies, including Fisheries, have made progress developing compliance outcome measures (section 4.1.3) as part of their risk-based approaches to service delivery.

The conclusion from the review of methodologies is that because noncompliance is so difficult to measure, methods used to measure noncompliance and outcomes of activities aimed at reducing noncompliance produce, at best, indicators rather than measurements. The reliability of these indicators and the ability to extrapolate from them to assess fishery-wide conditions depend in critical ways on the quality of the intelligence and compliance data that are available, and the assumptions behind the research methods used to analyse the data.

Direct observation methods (e.g., those that use enforcement statistics, observed violations or illegal catches confiscated), without additional analysis, can only measure a portion of the quantities of catch that are taken or discarded illegally, and can only provide a partial estimate of tonnages of fish lost to illegal fishing and related impacts and outcomes. Most fisheries compliance programmes can only provide oversight to a limited number of potential fishing violations. As a result enforcement/compliance statistics, by themselves, do not often reflect fishery-wide noncompliance.

Survey-based methods (e.g. stakeholder survey techniques and expert judgement) and those that infer a value or range of values based on analysis (e.g., modelling and subsampling methods such as use of observer data and use of enforcement statistics) are not constrained in the same way as observation based methods. However, these methods rely on opinion and subjective judgement and/or assumptions which means that their accuracy in estimating illegal landings or discarded catches is only as good as the information that is available to respondents and the validity of the assumptions that are used.

The literature review continued by examining the steps or phases that are generally followed in the development of outcome-based compliance indicators (Section 4.1.3). The four phase strategy used by the ATO and other published studies dealing with the development of performance measurement come to some different conclusions about the use of observed data versus the results of surveys and expert opinion. However, the one consistent conclusion presented in these studies is that the development and implementation of outcomes-based indicators within an organisation needs a substantial investment in time and commitment by management.

Survey

The second part of the project was the survey of fisheries enforcement agencies which resulted in useful responses from eight regional and national agencies within Australia and five national fishery agencies outside of Australia. The purpose of the survey was to collect basic information about the sizes of the agencies and the scopes of their management capabilities and responsibilities, and to determine their involvement with, and interest in, enforcement performance indicators. The survey also requested information about input, output and outcome statistics collected and used by the agencies. The surveys went to only one contact person within each of the organisations canvassed – in most cases a senior manager in the enforcement agency with many years of experience. The information provided about agency activities, experiences, and interests by that person was usually a collated response prepared after consulting with other enforcement/compliance experts within the agency.

Survey results, not surprisingly, showed that there are generally high numbers of input and output statistics collected, but substantially fewer attempts to develop outcome measures related to the success of fishery enforcement and compliance enhancement activities. All respondents to the survey indicated a keen overall interest in compliance outcome measurement.

Even where outcome measures were being collected, the underlying methodology for developing them was not always clear. The most commonly collected outcome measures involve estimates of total violations; the percent of detected violations being prosecuted, or resulting in convictions or fines; avoidable acquittals; and estimates of levels of illegal harvest. Most respondents noted the difficulty of developing compliance outcome measures that reflect important long-term impacts on fish stocks and fishing economies, and some noted the high potential for enforcement and compliance measures to be misinterpreted and misused.

Workshop

The third part of the project, the workshop of fishery enforcement/compliance experts to review and interpret results from the literature review and survey, was held on Thursday 13 November 2014. The workshop had several purposes. It provided representatives of the fisheries enforcement community from Australia and New Zealand with an update on the project and ideas on the way forward. Just as importantly, it gave opportunity for discussion and contribution by the attendees to relate useful outcome measures or indicators that they are using, or ones that they believe may have potential for use in the future.

It was acknowledged that there is a need for outcome-based management, and one agency expanded on their formal directive to implement outcomes and risk-based regulation.

The workshop highlighted the disparate views amongst those present about what the primary objectives for fisheries compliance actually are. Although operating under a broad umbrella of ecologically sustainable development, some compliance actions are considered a high priority and yet have very little to do with sustainability (for example illegally pulling someone else's lobster pots). Other high-priority portfolio responsibilities can result in diversion of compliance resources away from fisheries compliance responsibilities (e.g. emergency response). Sustainable fisheries are clearly important, but sustainability is part of a competing mix of business, political, social and ecological priorities which can differ between stakeholders.

These findings tied into presentations at the workshop from representatives of the Australian Taxation Office and the Australian Crime Commission. These organisations have invested heavily in trying to develop compliance outcome measures and the presenters gave participants an insight into the more extensive process that needs to be followed in developing outcome measures in a logical and structured way. From the workshop it was clear that further, highly structured work needed to take place if robust, transparent and meaningful compliance outcome measures are to be developed for Australian fisheries.

Conclusions

At the commencement of this project, it was hoped that it would result in practical fishery compliance outcome indicators being found or a reliable method for estimating them being developed. The literature review and survey failed to identify useful sets of fishery compliance outcome indicators, but did identify and clarify the reasons why previous efforts to develop them have not been successful. The experiences of others who have sought meaningful fishery compliance outcome indicators is that it is a significant endeavour that must rely on a combination of survey and interview results as well as analyses of observed data. The most effective focus of attention and the need for data and stakeholder consultation will not be the same in all fisheries. Providing specific recommendations about how such an endeavour should be undertaken would take more than the eight months of our study and the input of a limited number of compliance experts. It will require engaging stakeholders and upper level fisheries managers and scientists, pretesting survey and interview protocols, and testing out the collection of new types of data before they are used to generate results that are suitable for supporting fishery management decisions. This report recommends a proposed method to begin the process of developing outcome indicators

that will need to be well structured and be supported by fishery managers, but, need not be particularly expensive, burdensome, or intrusive.

The difficulty of measuring compliance outcomes and extrapolating limited observations or survey results to assess fishery-wide conditions was a recurrent theme from the literature review and workshop. Nonetheless, these are activities that need to be undertaken to judge the effectiveness of compliance assistance programs. As long as the error and sources of inaccuracy in various compliance-related outcome measures are understood, these measures can be extremely useful for interpreting differences or changes in ways that can be used to assess past levels of effectiveness and improve future levels of performance. One important application of compliance performance measures is in reducing uncertainty in fishery models which, in turn, affects the fishing regulations that are based on them. For example, deliberate misreporting and falsification of commercial records regarding amount of catch, fishing effort, species composition of catches, or rates of by-catch could lead to inaccurate predictions from stock or quota models that are based only on reported commercial catch data. The degree to which various performance measures may be useful for making direct adjustments in fishery models is yet to be determined. However, without some measure of compliance outcomes, it is not possible to assess potential model prediction errors that are caused by incomplete data regarding illegal harvests, illegal discards, etc.

Summarized below are some of this study's key findings and recommendations:

- Fishery compliance outcome measures cannot be interpreted without an analysis of how other factors that affect conditions and behaviour in the fishery are changing. Assigning causality of compliance outcomes to compliance activities requires examining potential impacts of these other factors on compliance outcomes.
- Outcome measures are unlikely to entirely replace the traditional use of input and output measures in assessing Agency performance. Input and Output measures still have a role to play in giving context to more subtle, and longer term outcome measures and they are also necessary for operational monitoring of processes within the organisation. Rather, the development of outcome measures for fisheries compliance will reduce the reliance on output measures which often do not stand up under close scrutiny to the performance claims that are being made from them.
- We did not find any evidence that compliance outcome measures are widely used to guide fishery compliance management decisions, and given the long time lines likely to be associated with final outcome indicators, they may have limited practicality in some fisheries decision making processes.

- There is a clear understanding among fisheries compliance agencies within Australia and New Zealand about the methods that could be used to develop and use compliance outcome measures. The project also established the types of data that are being collected by fisheries compliance agencies that are suitable for implementing outcome-based management and the extent to which these data are being used (i.e., current best practice) to manage and prioritize compliance activities.
- We find the discipline of fisheries compliance outcome measurement in a fragile state that needs nurturing and encouraging if it is to reach its potential and develop measures that withstand scrutiny from all stakeholders and especially from the spotlight of academic researchers from such disciplines as governance, risk analysis, sociology, criminology and economics. Until such time as robust fisheries outcome measures are developed, we suggest that benchmarking agencies against other Fisheries agencies with similar responsibilities will be necessary, unless the assessors have a detailed understanding of compliance theory. Such benchmarking could involve comparison of capability and efficiency (e.g. officer powers and equipment, organisational structures, planning processes, risk assessment methodologies, specialist capabilities, inspection and detected offence rates) but will almost always be qualitative in the absence of robust outcome measures.
- Since we have found little in the way of robust, mature fisheries compliance outcome indicators, we recommend that suites of indicators be used in a 'weight of evidence' approach when trying to assess compliance performance and attribute outcome changes to compliance activities.
- We suggest national and regional fisheries bodies in Australia should work together in developing fisheries compliance outcome measures that can be used across agencies, standardised where possible, but that are flexible enough to be customised to the subtly different organisational requirements and responsibilities of individual agencies. This process could be facilitated through the use of existing governance structures, like the NFCC.
- Fisheries managers and fishers themselves need to appreciate that different management strategies often come with different compliance options. Some of these will be much easier to enforce and measure compliance with than others
- Finally, we recommend that fisheries agencies prepare for the challenges of measuring compliance outcomes which will almost certainly require structural change within organisations.

KEYWORDS: Australian, fisheries, performance indicators, recreational, commercial, illegal fishing, non-compliance rates, survey, risk-based regulation.

1 Introduction

This eight month project was requested in 2013 by Australia's National Fisheries Compliance Committee (NFCC) as a way to provide fisheries compliance groups with improved methods for measuring and tracking the effectiveness of their activities and for justifying and managing their budgets. While there have been attempts to undertake similar work previously in Australia (Green and McKinlay 2009), the earlier efforts failed to produce a completely satisfactory result. The two main reasons why previous attempts have failed to develop useful compliance outcome measures are that the scope of the task was underestimated, and the need for output measures of performance was conflated with the arguably more important, but more challenging need for robust indicators of compliance outcomes.

Delivering fisheries compliance through enforcement is expensive, especially at sea, rightly making such programmes subject to intense scrutiny. While there is near universal agreement between stakeholders that 'good compliance' is an essential component of achieving management objectives, there are frequent divisions over the strategies for delivery and over how 'good compliance' should be defined. There are, therefore, inherent latent conflicts between fisheries managers, those delivering compliance services, the sectors being regulated and treasury or government.

It is clear that without robust measures of compliance outcomes, it is nearly impossible to evaluate different compliance strategies which can have very different costs. A 'hit-or-miss' approach to compliance can result, with the implicit risk of either excessive costs to industry or society from inappropriate or over-servicing, or adverse stock outcomes from illegal fishing caused by inadequate compliance. Cost is used in a broad sense here to include both monetary and social costs.

As innovative management approaches seek to increase shared responsibility through co-management of aquatic resources, it becomes even more important to find measures of compliance outcomes that are acceptable to all the following groups: those seeking to ensure public accountability (e.g. public sector auditors), third party accreditors of the resource (e.g., Marine Stewardship Council), fisheries managers (including those tasked with enforcement and education), commercial, recreational and customary fishers, and non-fishing special interest groups. They must also be inclusive of, or at least acceptable to, the wider community which may often fund or subsidise compliance activities.

1.1 What are compliance outcomes?

Prior to commencing the project, the experience of the project team indicated that fishery regulatory agencies routinely use input indicators (e.g., budgets, patrol hours) and output measures

(e.g., number of inspections, numbers of violations detected) to characterize fishery compliance activities, but rarely use compliance outcome measures (e.g., changes in compliance rates and resulting impacts in fisheries) for reasons described below in Section 1.3.

Outcome measures are defined as the “determination and evaluation of the results of an activity, plan, process, or program and their comparison with the intended or projected results” (Businessdictionary 2014). They are one of several different indicators used in performance measurement systems (PMSs).

PMSs are described as “evaluating how well organisations are managed and the value they deliver for customers and other stakeholders” (Moullin 2002). Accordingly, having good and relevant outcomes is important in contributing to meaningful PMSs because, as noted by (Moullin 2007), PMSs are in part reflective of how an organisation is managed.

Outside the specialist field of performance measurement systems, there is often a degree of confusion in the differences between an output and an outcome. Westcott (2008) suggests the main differences relate to time and measurability. He suggest that outputs are finalised on completion of the project or activity, whereas outcomes are documented though evaluative actions taken some time after completion of the project or activity. Both outputs and outcomes should be measurable, but outputs are generally tangible and therefore easier to measure than outcomes which may be measured subjectively by approximation (Westcott 2008). Research at the University of Wisconsin suggests that outcomes are what difference was made, while outputs are what was done (Taylor-Powell et al. 2003). Although fisheries compliance will always be an ongoing activity and is not ‘finalised’ in the way that a business project can be, the lag between the completion of ‘output’ work (for instance a compliance inspection) and the eventual outcome of that inspection (a change in behaviour and work practices) should be clear.

There are three types of environmental outcome measures: immediate, intermediate, and final (Mazur 2010). In a fisheries context, immediate compliance outcome measures can be based on extrapolating observed compliance and recidivism rates and quantities of confiscated illegal catches to reflect conditions in the overall fishery. Intermediate outcomes from compliance activity can be measured in terms of changes in behaviour that include reductions in noncompliance and reductions in the quantity of illegally caught and unreported catches. Final compliance outcome measures involve improvements in fisheries, in the fishing industry and in fish market conditions that result due to intermediate compliance outcomes. For example, a final outcome measure is the increase in the biomass of fish that results from reductions in illegal catches. This increase in biomass will grow

and spawn and improve conditions in fisheries and industries and communities that depend on them.

1.2 What are the functional units that generally make up a fisheries compliance force?

In the process of developing compliance outcomes, it is necessary to consider the variety of operational activities covered by fisheries enforcement staff. Some of these activities are undertaken by specialist staff, often siloed within functional units. While functional units and activities will differ nationally and internationally for different fisheries departments, compliance outcomes, if they are to be relevant, need to cover the full array of enforcement responsibilities.

A variety of tasks covered by fisheries enforcement organisations is provided in Table 1.1 (adapted from (Sarti 2006)). There are probably many activities that are not covered, but the object of the list is to illustrate the range of responsibilities to be considered.

Table 1.1: Operational activities commonly covered by fisheries enforcement staff. The list is incomplete, given that enforcement staff will have varying responsibilities in different organisations some of which will not have been considered here (adapted from (Sarti 2006))

Operational Activities

- Patrolling , monitoring and surveillance (overt and covert)
 - Patrol vessel operations to carry out at-sea inspections
 - In-port inspections of vessels, catch and equipment
 - Land inspections and audits of catch and fish processing factories, aquaculture facilities, retail outlets etc.
 - Specialised operations conducting investigations into serious fisheries offences
 - Manning of telephone hotline for public reporting of illegal activity
 - Preparing for and attending court cases to do with prosecuting for illegal fishing practices
 - Educational initiatives aimed at promoting stakeholder awareness of different fisheries legislation and reporting prosecution outcomes
 - Collection, processing and analysis of electronic data including: vessel monitoring system (VMS) catch disposal and receiver consignment forms and closed-circuit TV data
-

As an example of how these activities can form specialist compliance units, the Department of Fisheries, Western Australia have staff units for vessel monitoring, compliance statistics, fisheries intelligence, prosecutions, serious offences, biosecurity, recreational mobile patrols and more.

1.3 What makes developing compliance outcome measures difficult?

Compliance activity in each state in Australia is principally governed by Acts of Parliament (Act) that have adopted the concept of Ecologically Sustainable Development (ESD) as their objective.

Ecologically Sustainable Development is defined in Australia as: 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased' (National Strategy for Ecologically Sustainable Development 1992). Each law, regulation and condition is typically prepared with the object of the Act in mind.

But further to this, each state Act contains a variety of additional objectives which frame the context of compliance, rules, regulations and activities. Some common elements include:

- Promotion of viable commercial and aquaculture industries
- Maximizing net economic returns to the Australian community from the management of Australian fisheries
- Equitable access to aquatic resources that achieves optimum utilisation
- Protection and Conservation of fisheries resources, habitats and ecosystems
- Conducting aquatic resource management in an efficient and cost effective manner, setting targets for the recovery of management costs

This breadth of operating scope provides significant complexity for defining compliance outcomes, especially when stakeholders' views can be diametrically opposed. Further to this complexity, the notion of successful compliance outcomes is entwined with timely and accurate resource management decisions which include scientific assessments, regulation, licence conditions and policy. Successful compliance outcomes are often viewed in the expected light of ESD, and as such, are only as good as the resource management framework provided to govern the utilisation of fully exploited aquatic resources.

The object of each Act, stakeholder diversity and complex operating scope, are significant factors that challenge the definitions of compliance outcomes that will withstand stakeholder scrutiny.

As has been shown, fisheries compliance responsibilities cover a wide range of activities and deliver service to an array of different stakeholder groups. The starting point when measuring the performance of fisheries compliance against these activities is, as in most other professions, to use output measures. The benefit of output measures is that they are easy to collect and display, but their downside is that they are extremely unlikely to allow rigorous analysis of the extent to which a program has achieved its goals in the way that should be possible from outcome measures.

Typical output measures for fisheries enforcement include: field contacts by fisheries officers, number of vessels checked, proportion of the total catch inspected. In the case of the Western Australian Fisheries Department, as with many other fisheries departments, these figures are regularly collected (Green and McKinlay 2009) and subsets are published annually (see Department of Fisheries 2010; 2011). As a measure of performance for accountability purposes, these statistics have their place; however, because of their focus on illegal fishing, they fail to adequately pick up on other aspects of fisheries enforcement activity, such as the prevention of criminal offences occurring in the first place. Measuring outputs can also result in unforeseen consequences, such as an organisation's activities focussing on 'easy' performance targets which give a false sense of efficiency without being effective in achieving their goal. The fundamental problem with measures such as these is that they say nothing about whether the activities were the right ones to undertake to achieve the organisations strategic goals.

There are four reasons why developing good measures of these outcomes for compliance activities is complicated.

- (1) Compliance outcomes in fisheries (e.g., reductions in illegal fishing and resulting improvements in fisheries) can reflect changes in conditions at sea or changes in illegal fish being landed, which are both difficult to measure.
- (2) These outcomes, even when they can be measured, are difficult to causally attribute to compliance activities without assessing them within the context of other changes in the fishery (Sparrow, 2008).
- (3) Compliance outcomes are often "counterfactual"; they involve behaviour that did not take place (e.g., reduction in illegal fishing) that would have taken place in the absence of compliance activity.
- (4) Compliance outcomes are confounded by detection and effort bias issues which are often not accounted for when reporting or evaluating data.

Increases in observed compliance rates, for example, may reflect more effective enforcement detecting more violations, less effective enforcement deterring fewer violations, the result of poor fishing conditions, or more effective enforcement in other fishing areas resulting in more illegal fishing relocating to the area. Changes in fishery and seafood market conditions that could also be viewed as compliance outcome measures are also influenced by many factors other than enforcement/compliance activities, including changes in weather, ocean, market, and political conditions.

Finally, all compliance problems may involve 'invisible' harms and/or active opponents. Invisible harms are those which are difficult to quantify to those who have an interest in them because they have low reporting or detection rates. Active opponents monitor regulatory intent and consciously alter their behaviour to subvert it. These sorts of problems are inherently difficult to measure or understand (Sparrow, 2008).

2 Objectives

1. A desktop study of methodologies and/or assessment and reporting frameworks, both nationally and internationally, that assess the effectiveness of compliance programmes and measure compliance outcomes.
2. A workshop to review the findings of the desktop study and seek further expert input on measuring fisheries compliance effectiveness.
3. Write up of results of the desktop study and workshop with a view to documenting current best-practice, determining the way forward and possible future work.

3 Methods

3.1 Literature review: methodologies to assess effectiveness of compliance programs and measure compliance outcomes

The literature review examined research dealing with the development and use of performance and outcome measures related to environmental enforcement and assisted compliance, with a focus on fisheries. Particular emphasis was placed on identifying what has been published in peer-reviewed literature on the development and use of outcome indicators. The review also covered published and publicly available documents and, to the extent possible, unpublished documents and internal reviews that were available from fishery and environmental enforcement offices outside of Australia.

The literature review quickly showed that measures of fisheries conditions and outcomes are affected by many factors besides compliance and that there are many confounding factors that can drive indicator measures in either direction, making attribution of a good outcome to the efforts of compliance very difficult. There was also a significant lack of published literature relating to the development and use of compliance outcome measures. Consequently, the literature review was broadened beyond studies of compliance outcomes to examine the development and use of

indicators that combine measures of changing compliance inputs and outputs and other factors to determine the relative influence of compliance activities on particular outcomes.

The literature review is divided into four parts. Each addressed separate areas of research that contribute to an understanding of how fishery compliance outcomes should be measured and interpreted in different types of fisheries based on what is known about how noncompliant behaviour is likely to be affected by compliance activities aimed at detecting and prosecuting violators and compliance activities aimed at encouraging compliance.

The first part of the literature review (Section 4.1.1) included an examination of four general theories of compliance that tend to be reflected in the types of compliance activities employed in various fisheries. The types of target outcomes and related outcome measures will differ from fishery to fishery depending on which compliance theory seems to form the basis of compliance strategies and activities which, in turn, tend to reflect differences in the factors that are thought to influence noncompliance and regulatory decisions that are aimed at affecting them.

The second part of the review (Section 4.1.2) focused on specific methods that have been used to collect data, perform shore-based and at-sea inspections, monitor fishing activity, and conduct surveys in order to provide a quantitative basis for developing and interpreting fishery compliance outcome measures. This part of the review provides a basis for determining which combinations of tools and sources of data can be used to measure compliance, confirm or support the accuracy and validity of those measurements, and help attribute changes in these measurements to compliance activities.

Part three of the review (Section 4.1.3) dealt with specific examples and case studies of attempts to develop and use fishery compliance outcome measures. The reason for this focus was that good information on non-compliance and illegal catch would make ideal outcome indicators (indeed as will be seen later into this document, many agencies claim to use this information for that purpose). It was therefore considered worthwhile to examine what methods are available and whether their level of accuracy makes them suitable as indicators. This included a review of specific applications within Australia and elsewhere, and a review of related studies undertaken recently by others.

The final part of the review (Section 4.1.4) focused on the development of indicators in general, guidance that has been developed to develop regulatory performance indicators, and studies that have focused specifically on the special problems associated with developing and justifying the accuracy of compliance outcome measures in fisheries.

3.2 Survey on aspects relating to output and outcome indicators collected by a limited sample of fisheries compliance agencies

The object of this survey was to get basic information on the size of the agencies and the scope of their management capabilities and responsibilities and to explore their interest/involvement in fisheries compliance outcome indicators.

An electronic survey was dispatched to a selected group of fisheries compliance agencies, both national and international. Within Australia, all fisheries compliance agencies were canvassed. In the case of the international agencies that we selected to survey, our targets were developed countries, comparable with Australian enforcement agencies. A list of contact persons was provided by the secretariat of the IMCS network (<http://www.imcsnet.org>), an International Monitoring, Control and Surveillance (MCS) Network for Fisheries-related Activities. In some cases, the initial contact point led to referrals to other people within the agency.

Once a list of contact names and e-mail addresses had been compiled, those organisations/people were sent a “warm-up” letter explaining the reason for the survey, what it hoped to achieve and to generally prime them for receipt of the survey.

The survey went to only one person in each organisation canvassed – in most cases a senior manager in the enforcement agency with many years of experience. In some cases the opinions of other areas of an agency were provided through the single respondent, but the information provided by that person on their organisation is a personal opinion. Their responses have been collated together with other recipients. A copy of the survey form is shown in Appendix E.

3.3 Workshop to review findings of the desktop study and add expert input

This workshop was held on Thursday 13 November 2014 at the Metropole Hotel, Melbourne, Victoria. On the following day, a post-workshop wrap-up was held with a small subset of participants.

The workshop provided an opportunity for the project team to explain the findings of the survey and literature review to a broad audience of compliance experts and get their insights about how they should be interpreted. Each attending agency presented a short summary of their experiences with outcome measures within their agency while experts from outside of fisheries compliance identified through the literature phase of the project were invited to speak on their experiences with outcome measures.

Finally, the workshop provided an opportunity for a broad audience of compliance experts to highlight differing viewpoints, debate the challenges and opportunities, and discuss possible next steps.

4 Results/Discussion

4.1 Literature review: methodologies to assess effectiveness of compliance programs and measure compliance outcomes

The development of outcome indicators in the public sector has been a focus of activity for well over two decades. This form of business planning has been particularly active in government departments such as treasury, health, education and police, and a large amount of literature is available documenting developments in those areas both locally and internationally (Dadds and Scheide 2000; United Nations Development Program 2009; Alach and Crous 2012). The same is not true for fisheries and in particular for fisheries compliance.

The need for indicators of performance measurement to be developed for environmental compliance practitioners has not been unnoticed. The International Network for Environmental Compliance and Enforcement (INECE) first proposed a compliance and enforcement indicator project at the 6th International Conference of that organisation in 2002. Since then, papers dealing with this subject have been presented at periodic international conferences held by INECE (e.g., the presentations available at <http://inece.org/resource/inece-conference-proceedings-directory/>), and the organisation has produced a guide on the subject (INECE 2008) specifically for compliance and enforcement practitioners.

While the INECE (2008) guide is a useful and relevant document, it is aimed at the broadest sense of environmental compliance (typically water, air and soil pollution) rather than specifically fisheries compliance and enforcement. Some of the criminal elements are similar, in that both fisheries and environmental pollution involve the offenders either undertaking illegal activities or failing to adequately report them. The difference is that illegal fishing, like the illegal exploitation of forest and wildlife resources, can involve a product that gets on-sold. This makes the law enforcement of fisheries and other fauna and flora products to be more akin to theft and drug trafficking, in that there are generally accomplices involved in obtaining and distributing the product, as well as informed or unwitting purchasers of the merchandise. Fisheries crime differs again from many other forms of crime, in that the product's value is in consumption, which usually destroys all traces of the product's existence – unlike say a stolen motor vehicle or a 'trophy' species of wildlife. This

difference is relevant when reviewing indicators of performance and the development of outcomes across different professions. The INECE (2008) guide also addresses performance-based management in its broadest context, covering both input and output indicators and while it is to be lauded for addressing outcome indicators, it does not provide a definitive reference source for them.

In fact, after failing to find any published literature devoted solely to the challenge of measuring fisheries compliance outcomes we were forced to broaden our focus to consider similar efforts outside of fisheries.

Since the principal function of a law enforcement branch of any fisheries agency is the observance of laws surrounding the harvesting of aquatic fauna and sometimes flora, some method of measuring the levels of compliance with those laws is needed. Such measurements would ideally be based on data gathered independently of those undertaking the law enforcement role and involve an appropriate sampling regime. That could be achieved directly, (for example, by surveying stakeholders about their perception of the rate of success achieved by enforcement staff in apprehending illegal fishing activity), or it could be achieved indirectly (such as by estimating the quantity or value of seafood harvested illegally using stock assessment methods).

This review summarises the literature relating to methods used to establish and measure fishing non-compliance and assess the scale of illegal activities. The documentation of the literature search is by no means exhaustive. The object has been to consider a range of methods and to provide just a few published studies documenting their application of the techniques. In the discussion of each and the Table that follows (Table 4.1), we have attempted to document some of the main advantages and disadvantages of the different methods in terms of their simplicity and accuracy.

It needs to be made clear at the outset, that assessing the scale of illegal fisheries activity with any accuracy is made difficult by a number of factors:

- There is a confounding of prevalence and detection (discovery rate) – that is, it is generally unknown whether observed increases in crime (prevalence) are due to a real increase or an increase in ‘discovering’ the crime (detection probability), or vice versa (Sparrow 2000; 2008);
- So-called invisible ‘harms’ and active opponents (Sparrow, 2008). The effect of illegal fishing, unless it is at very high levels, is not usually obvious or measurable from biological measurements or intermittent surveillance. Most serious illegal fishers employ counter-surveillance to ensure they are compliant when, or if, inspected;
- Many of the procedures used to estimate illegal fishing have significant assumptions behind the methods;

- The opportunities for offending are far greater than the likelihood of being detected; and
- The need to tease apart environmental and biological influences from human influences.

4.1.1 Compliance Theory

Public policy literature includes four general theories of compliance:

1. The Conventional Theory of Compliance – a purely economic theory under which a fisher’s decision to comply or not is based purely on short-term self-interest (Becker 1968).
2. The Enriched Theory of Compliance – based primarily on sociology and assumes that normative factors, such as respect for the law and peer pressure, also affect compliance decisions (Kuperan and Sutinen 1998 and Nøstbakken 2008).
3. The Cumulative Prospect Theory – based on psychology and individual perceptions of risk and has been used to challenge conventional theories of compliance that are based on economic and sociological considerations (Tversky and Kahneman 1992).
4. The Socio-ecological Theory of Compliance – based on research stemming from observations that in some situations, acceptable compliance outcomes can be achieved by encouraging and supporting a sense of community and individual involvement in collective management for the overall good of a social group (Ostrom 1990 and Ostrom 2009).

Each theory was developed by Nobel Prize winning economists and social science researchers, and each could form the conceptual basis for developing fishery compliance outcome measures in some fisheries. Choosing which theory or mix of theories and related outcome measures to use depends in critical ways on research to determine if and when decisions to comply or not with fishing regulations are influenced purely by economic considerations, by economic and normative influences, by fear of penalties, or by a sense of what is in the best interest of some particular social group. Each theory and its potential influence on the development of fishery compliance outcome measures is summarized below.

4.1.1.1 *Conventional Theory of Compliance*

This theory focuses on economic incentives and how potential violators compare the relative costs and benefits of violating the law (Becker 1968). In fisheries, this implies that fishers will compare expected increases in earnings (commercial) or enjoyment (recreational) from fishing illegally with the potential costs, where potential costs are based on their assessment of the probability of their illegal fishing being detected and prosecuted and the size of the expected penalty. This is the basis of the classic “deterrence model” developed by Becker (who won the Nobel Prize in economics in 1992). The theory has been the basis for developing fishery enforcement and compliance indicators in many fisheries (Sutinen and Kuperan 1999, King and Sutinen 2010). Intermediate compliance

outcomes under this theory would be based strictly on measures of deterrence (e.g., the probability of detection and prosecution, levels of fines, etc.).

We were provided with anecdotal evidence of minor offending being actively enjoyed in the past by licenced commercial lobster fishers in WA as a 'game' played against Fisheries inspectors.

Commercial fishers are in a position to test the probability of detection by consigning very small numbers of sub-legal sized lobsters in their catch, knowing that the offence if these animals are detected carries a simple, small monetary penalty if the fishers opt not to contest it. The fishers, on receiving the infringement notice after having this practice detected, have been known to contact the issuing officer and jovially allude to other occasions they have consigned illegal animals without being caught. With typical inspection coverage of 3% to 7% of the total number of consignments, the cost of non-compliance can be rationally offset against the so-called 'bait money' that can be gained from the practice (T. Green, personal communication).

4.1.1.2 *Enriched Theory of Compliance*

The "enriched" theory of compliance includes the economic incentives specified in the conventional theory of compliance plus "normative" factors that are associated with moral convictions, peer pressure, attitudes regarding the legitimacy and fairness of regulations, and other factors that result in most individuals complying with regulations even though there are economic gains from not complying.

It was developed and applied in fisheries by Kuperan and Sutinen (1998) and Nostbakken (2008) to explain why many fishers act "irrationally" in purely economic terms by complying with fishing regulations even though it is not in their self-interest. This theory can be used as a basis for comparing measures of compliance outcomes based on "harder" deterrent-based approaches to compliance with those of "softer" approaches that are based on measures of improved relationships between fishers, regulators, and enforcement staff, and community or industry contacts by regulators to explain regulations and promote compliance.

4.1.1.3 *Cumulative Prospect Theory*

Prospect theory was developed in the late 1970s by Tversky and Kahneman (1992) to explain seemingly illogical outcomes that are observed because individuals make decisions based on perceived risks, not strict comparisons of potential gains and losses, and prefer avoiding risks of loss *more* than they prefer taking a chance on achieving gain. This theory is based on observations of a very strong and widespread "cognitive tendency to over-weight extreme possibilities." In fisheries, this theory is likely to support compliance activities and outcome measures that involve increasing perceptions of significant risks associated with noncompliance (i.e., increasing risk of loss). However,

the theory is also likely to become more relevant in fisheries where declines in fish abundance and associated reductions in the legal allowable harvest impose extreme risks of economic hardship on fishers and their families and communities if they decide to comply with fishing regulations. The risk of experiencing economic losses by complying with increasingly stringent fishing regulations may be perceived as being far more significant than the perceived risk of being detected to be out of compliance.

4.1.1.4 *Socio-Ecological Compliance Theory*

This modern theory of compliance extends the “enriched” theory of compliance to consider how individuals in some situations can be motivated by public policies to work together, even outside of a regulatory context, to take action that maximizes the welfare of social groups. It was developed specifically to address perceived inadequacies in how conventional compliance theories have been used to guide collective management of common property resources, such as fisheries, and won Elinor Ostrom the Nobel Prize in Economics in 2009 (Ostrom 1990, 2009). This theory is based on observations in fisheries and other natural resource systems that individuals “have a more complex motivational structure and more capacity to solve social dilemmas than posited in earlier rational-choice theory.”

Based on this theory, individuals (e.g., fishers) may make decisions to comply or not based on their assessment of how it will affect the welfare of social groups (e.g., fishing communities) and their sustained acceptance and reputations within these groups. According to this theory, positive compliance outcomes in fisheries would include the results of institutional activities that promote “innovativeness, learning, adapting, trustworthiness, levels of cooperation of participants and the achievement of more effective, equitable, and sustainable outcomes at multiple scales.”

Additionally, this theory suggests that there are situations where traditional fishery management approaches (i.e., having regulators and a regulated community) may be counter-productive regardless of what compliance strategy is employed because they inhibit communities from establishing relationships that allow self-regulation of fisheries (Ostrom 2007). This theory is highly relevant to situations where co-management is being contemplated.

4.1.1.5 *Criminology and Social Science*

It is important to acknowledge the decades of academic study that have gone into the field of Criminology and social science more generally and it is impossible to do them justice in a preliminary study such as this. Our observation is that there seems to have been little influence from modern criminological theories on mainstream fisheries management. There is certainly some published literature directly relevant to fisheries, e.g.: Tailby and Gant (2002), Gezelius (2003), Putt and

Anderson (2007), Hauck (2008), Gezelius and Hauck (2011) but even in the wider field of environmental crime, Bricknell (2010) points out that environmental crime has for the most part been somewhat overlooked in Australia, receiving, at best, episodic attention in the published literature. There is clear evidence for very serious crimes being committed in a fisheries context, both in the multitude of more serious crimes prosecuted by fisheries compliance agencies and, at the more extreme end of the scale, highlighted in reports such as Transnational Organized Crime in the Fishing Industry (United Nations Office on Drugs and Crime 2011). The attractiveness of fishing to organised crime has also been regularly identified by fisheries compliance groups.

Perhaps one reason for the relative scarcity of work in this area is that there is often a desire to react to illegal activity without understanding the behaviour that drives it. Criminologists and other social scientists are interested in questions such as: What is driving behaviour, are current laws legitimate and effective, what regulatory measures are having an impact on fishers' decision-making? And importantly, ask 'what governance measures need to be put in place to enhance compliance?' – as opposed to – 'how do we enforce laws better?'. This kind of different perspective on the needed research may not be seen favourably when there is a perceived urgent need to 'do something about illegal fishing' and a desire to use traditional enforcement metrics (arrests, prosecutions and infringements) as a means of measuring compliance.

In general, ecological crime has only received increased attention in the criminological field over the past two decades, with areas of study that have been termed 'green criminology' and 'conservation criminology' to name a few. It would be beneficial to provide opportunities to conduct fisheries specific research in partnership between government institutions and criminologists. Many criminologists and sociologists clearly have the research skills and methodology, as well as theoretical perspectives, to make a positive contribution.

It is the opinion of the project team that the field of Criminology could contribute to fisheries compliance in the areas of crime reporting, measuring non-compliance, understanding motivations for fisher behaviour and identifying strategies to enhance compliance and opportunities for collaboration should be actively pursued.

4.1.1.6 *Theory put into Practice*

As a practical matter, the theories described above are used in various fishery management situations to support arguments for and against shifting public resources from efforts to achieve acceptable levels of compliance in three ways:

1. By encouraging compliance – through education, outreach, and establishing scientifically credible and understandable fishing regulations that are administered fairly and equitably.
2. By monitoring and responding to non-compliance – through regular, random and targeted inspections of landings and related logbooks and receipts, conducting shore-based and at-sea patrols, and information and intelligence gathering and by dealing with detected violations, imposing penalties that are certain and meaningful.
3. By deterring noncompliance – through publicising compliance capability, significant detected offences and the penalties for noncompliance.

In fisheries or communities where it can be assumed that compliance decisions are based purely on economic self-interest, it is reasonable to focus on intermediate compliance outcomes related only to (2) and (3). In fisheries where it is reasonable to assume that normative factors are also important, it is reasonable to also focus on compliance outcomes related to (1).

The review of the theoretical compliance literature suggests that compliance outcome measures may differ from fishery to fishery based on the management framework employed, the availability of data and intelligence, the extent of noncompliance problems, and the causes of noncompliance.

4.1.1.7 Development of Outcome Indicators

The development of outcome indicators to illustrate, trace, and measure the payoffs from the use of tax dollars by the public sector has been a focus of dedicated research for well over two decades. A professor at the Harvard School of Public policy organized the results of this research in a popular public policy text titled “Creating Public Value” (Moore 1995). That book helped focus attention on ways that government agencies can use performance-based management tools similar to those being developed and used by businesses even though conventional measures of returns on investment (ROI) and benefit cost analysis (BCA) would not be possible. In 2013, Moore published a companion textbook titled “Recognizing Public Value” which focused directly on methods of measuring and tracing the value of public investments. This text included a set of case studies showing how outcome measures related to public sector investment decisions can be used internally by government agencies to improve and help prioritize public investments, and externally by reviewers and auditors to assess and compare agency decisions (Moore 2013). Moore advances the idea of a public value scorecard, balanced and representative of an agency’s work across its entire range of responsibilities. Case studies are used to show that bad outcomes result from agencies focussing narrowly on one or two ‘high priority’ areas and so fail to spread their performance reporting across their entire range of responsibilities.

A chapter of Moore's 2013 book deals specifically with "bottom line" and "public value account" information related to the outcomes of policing and identifies seven "dimensions of public value in policing." These include: reduce crime; call offenders to account; reduce fear; ensure civility; fair, effective and efficient use of force and authority; fair, effective, and efficient use of financial resources; and customer satisfaction. Priority investments in policing information were identified that draw on three sources of data: administrative records, surveys, and programmatic initiatives. These included measures of reported crime rates, arrest rates, response times, repeat offenders, expenditures per capita, numbers of sworn officers, civilian complaints, civilian casualties, number of calls, and people cited or arrested. Investments in policing information that can be used to show changes in measures of these factors were recommended as a way to measure the "public value" of policing.

These broad concepts are ones that could potentially be applied to fisheries compliance outcomes, something that will be discussed in more detail in section 4.1.3.

4.1.2 Methods to measure fishing non-compliance and illegal activity

The above-mentioned literature related to measuring outcomes from "policing" recommend that investments be made in maintaining and using data from both administrative records and surveys. These same two sources of data can be used to measure outcomes of enforcement and compliance support activities in fisheries. However, there are many reasons why collecting and interpreting these types of data are more difficult in the case of fisheries. For example, violations of fishing regulations often take place offshore where there are no witnesses or victims to report violations, and few opportunities for enforcement agents to detect them. Additionally, the public value from improving compliance in fisheries is associated with improvements in fisheries that are more difficult to directly measure or attribute to compliance activities than the outcomes of more traditional "policing" which include reductions in reports of robberies, violence, and street crime. This section describes methods that are being used to collect fishery-related data that may be used directly or indirectly to measure and trace the outcomes of fishery compliance activities. The information has been drawn from peer-reviewed literature wherever possible.

4.1.2.1 Stakeholder surveys

Many empirical studies (Sutinen et al. 1990; Furlong 1991; Akpalu 2008) have utilised stakeholder surveys for at least one of the data streams used in estimating illegal fishing activity to reduce reliance on official statistics as a measure of illegal fishing activity (i.e. numbers of apprehensions, warnings, convictions etc.), which are so fundamentally driven by the amount of enforcement effort and its capability and expertise. There are several different stakeholder groups that can be surveyed,

and since in many cases the questions asked in the survey are for an opinion (e.g. “what is the extent of illegal activity in the fleet?” or “what do you consider the probability of being caught and prosecuted for a particular crime?”), the answers are likely to vary according to whether the group being surveyed are fishermen, managers, compliance staff, or from some other background. While not being an accurate measure, it is generally accepted that surveys of one or more stakeholder groups could at least provide an indication of the extent of noncompliance. If repeated at intervals, surveys could provide trends in noncompliance which could be benchmarked against other independent measures.

For instance, King and Sutinen (2010) used National Oceanic and Atmospheric Administration (NOAA) official statistics for the North Eastern Groundfish Fishery over a five year period to estimate the percentage of detected violations that result in a penalty, and survey estimates from fishermen and enforcement staff to estimate the likelihood of a violation being detected.

Surveys that ask stakeholders to estimate fishery characteristics such as the extent of noncompliance, or the percentage of fishers who occasionally violate laws compared with those that routinely do so are prone to considerable uncertainty. For example in King and Sutinen’s (2010) survey, fishermen estimated noncompliance rates to be approximately half of those estimated by enforcement officers (12.5% compared with 24.4%). Even within a stakeholder group there is a wide range of opinion, for example, in the survey of Sutinen et al. (1990), commercial fishermen estimated that 10-24%, 25-49% and 10-24% of fishermen in the Southern New England, Georges Bank and Gulf of Maine fisheries, respectively, were frequently violating conservation regulations. It is clear, therefore, that while these types of surveys may provide useful indices that can be tracked over time, their use for anything more rigorous is probably limited.

In another study, of the United States Coast Guard (USCG), (Palin et al. 2012), the authors acknowledge that “Metrics such as probability of detection, levels of penalties, and anticipated gains may be easier to quantify than legitimacy, morality, justice, social pressure, equity, and behaviour of others...Thus defining and quantifying observed metrics (or indicators) remains a challenge.” The study includes a list of fifteen survey questions that can be used to assess and compare changes in stakeholder perceptions of compliance factors that cannot be observed directly, such as legitimacy and behaviour of others. Changes in answers to these questions can be treated as intermediate outcome measures that may be linked to specific compliance activities.

Surveys of opinion seeking to establish the extent of a practice, or the frequency of its occurrence, will miss illegal activity if the response group is unaware of its occurrence, or if the activity is deliberately hidden from them, as will be the case for most serious fisheries crimes.

(Blank and Gavin 2009) have attempted to minimise the biases associated with methodologies that measure noncompliance rates by using a randomised response technique (RRT) to estimate noncompliance in the Northern Californian recreational fishery for red abalone (*Haliotis rufescens*). RRTs are considered to be a more reliable estimator of sensitive behaviour than conventional survey and interview methods because the technique minimises evasive answer (i.e. incorrect or no answer at all) bias (Warner 1965; Horvitz et al. 1976). There are disadvantages with RRTs. It is acknowledged by Blank and Gavin (2009) that there are always likely to be survey participants that give evasive responses regardless of the survey method used and that therefore RRTs are likely to still be underestimates of noncompliant behaviour, albeit better than conventional surveys.

Creel surveys as well as dock-side and roadblock interviews of fishermen have been used in numerous studies for measuring noncompliance rates (Martin 1995; Wilberg 2009). Water-side surveys (or inspections) can only provide estimates of certain types of illegal activity revealed by the inspection at the time, such as licence, bag and size limit offences. On-water offences such as fishing in closed waters, gear-related offences etc. cannot be estimated using land-based surveys.

However, as has already been discussed, fishermen do not generally cooperate well with surveys if they are involved in illegal activity, and results are therefore prone to varying degrees of bias. Any data on noncompliance gathered by creel-surveys will be an underestimate for anything other than ignorance of the law unless you grant statutory powers to search fishers to those undertaking the surveys. The Occupational Health and Safety risks, costs, training implications and reputational risks of doing this may be significant, but it would be possible to undertake such surveys using staff with the necessary powers if getting a measure of illegal catch was deemed to have a high enough priority.

In WA, the possibility of using formal inspections to complement creel surveys in order to determine the quantity of illegally caught recreational lobster catch was discussed as long ago as 1978 (Department of Fisheries and Wildlife, WA, 1978).

One method that is commonly used to increase the numbers of interviewees from populations that are difficult to sample, such as criminal elements, is through the use of snowball sampling. The method relies on subjects nominating other potential participants to be surveyed. The main advantage of the method is that it can quickly build up a group of potential survey respondents

through this process of referral. However, one obvious disadvantage of this approach is the potential for introducing biases because of the non-random process of selecting survey participants. It is most useful when the potential for harm is very great, but from a small number of hard to identify people. The technique will give useful information about the problem, but is unlikely to give reliable indications of the scale of the problem.

4.1.2.2 Expert judgement

A different approach (Pitcher et al. 2002; Agnew et al. 2009) has been to adjust reported catches over different time periods according to management changes that might have influenced incentives or disincentives to misreport catches in the fishery. Values (termed influence values or influence incentives) are assigned to indicate the incentive to misreport catch in each time period. Estimates of the level of illegal fishing in the different fisheries under consideration are then established from surveillance data, trade data, fishery independent survey data and expert opinion, and these estimates are used as 'anchor points' for each incentive rating. These figures are then used to estimate the total catch over time for the fishery in question. Monte Carlo simulation techniques are applied to address uncertainty and provide upper and lower estimates of total misreporting over the different time periods being assessed.

The method is acknowledged in Pitcher et al. (2002) to be subjective, particularly in assigning values to the influence factors. In the fisheries they examined, there were periods when the influence factors did not agree with the anchor points. That required a decision to be made as to the reliability of the anchor points and depending on that, to select whether or not to modify the influence factors over the time period under consideration.

Ainsworth and Pitcher (2005) used a modified version of the above method to provide estimates of IUU catches made by the salmon and groundfish fleets in British Columbia between 1950 and 2003. Instead of using a single quantity that represents IUU catch, their modified method has considered the illegal, unreported and unregulated components of IUU separately, before combining them later in the analysis to provide an estimated sum of IUU. These authors have also introduced a more precise method of assigning influence factors. The overall result is considered by Ainsworth and Pitcher (2005) to produce a more accurate estimate of the rate of misreporting.

4.1.2.3 Mark-recapture sampling

The use of tags holds several possibilities for detecting illegal activity. Tags, whether they be commercially manufactured items or simply some physical alteration made to an appendage on the animal, provide a very commonly used method for detecting offences such as the illegal hauling of lobster pots belonging to one fisherman by another. In cases, where someone is suspected of this

activity, the pots of other fishers are seeded with tagged lobsters that are readily recognisable by enforcement officials. The catch of the fisherman suspected of stealing from others is monitored for the tagged animals, and if found, follow up of the offence is a relatively simple matter.

Obviously when there is a possibility that tagged fish may be cooked or eaten without the tag being removed first, the tag must satisfy stringent consumer safety standards which impact on the materials and technologies suitable for tag use.

Tags have also been used in an indirect way for determining noncompliance rates of size regulations (minimum, maximum, slot length) by fishermen (Pierce and Tomcko 1998; Henderson and Fabrizio 2013). These authors used the predicted sizes at recapture of previously tagged fish, to gain insight into the compliance levels of anglers and how that related to management measures in the fishery which changed over the duration (Henderson and Fabrizio 2013) or a few years prior (Pierce and Tomcko 1998) to their studies.

As with other methods, conclusions about noncompliance rates based on the predicted sizes of tagged fish at recapture can be prone to numerous biases. Anglers who were consciously violating the law would most likely not be returning their tags, biasing compliance rates upwards. Conversely, a far greater proportion of the fish tagged in the Henderson and Fabrizio (2013) study were under-size than legal sized, which has led them to believe that compliance estimates of the sublegal proportion of fish harvested in their study was negatively biased.

Radio Frequency Identification (RFID) systems have potential for use in fisheries compliance work, but at the moment, most interest seems to be focussed on their potential for reducing the mislabelling of seafood products. In the food industry, the misnaming of fish products is generally designed to confuse, and misnaming can do this from the point at which the fish is captured, all the way through to the point that it lands up on the plate of consumers in a restaurant. From an enforcement perspective, this is of concern because illegal product can be passed off as legitimate. The extent of mislabelling is widespread; for example, the United States imports 80% of all fish consumed in the country and of those imports, one third are believed to be mislabelled (Jacquet and Pauly 2008).

The need to address mislabelling is receiving increasing attention at the government and industry level, but also at the retailer and consumer level as Eco labelling becomes more widespread. The Marine Stewardship Council is one of the forerunners in this space. They have implemented a Chain of Custody Certification standard that is aimed at ensuring that the origin of seafood can be traced through the supply chain.

Food Innovation Partners and Allan Bremner & Associates (2007) have reviewed traceability systems from paper-based through to Radio Frequency Identification (RFID) systems and specialist markers other than RFIDs. Their view is that electronic technology, particularly RFID systems, are likely to become increasingly important in the development of product traceability methods into the future, At the time of writing, Food Innovation Partners and Allan Bremner & Associates (2007) did state that the high cost of RFID tags made them unsuitable for low cost food products. However, Ringsberg and Mirzabeiki (2013) noted that over the last decade, RFID technology and price have decreased and that they are now half the price that they were five years ago.

In what may be a glimpse of where the seafood industry might head in the future, part of the Australian southern rock lobster catch is marketed with full traceability. The animals are tagged with a barcode at point of capture that allows end-users – restaurants and customers – to establish via the Southern Rocklobster Limited website, where the lobster was caught and by whom (Southern Rocklobster Limited 2014).

4.1.2.4 *Modelling*

Stock assessment models usually assume that catch-at-age, catch per unit effort (CPUE) and other information is precise. Where this assumption is not made, authors have used statistical methods to correct or standardise data before using it in an assessment model (e.g. Bousquet et al. 2010). Few studies have used the models to quantify the extent of under-reporting catch or taking it illegally.

Plagányi et al. (2010) used an age-structured production model developed for the South African abalone fishery to, amongst other things, estimate the impact of illegal fishing on the resource. The model is fitted to commercial CPUE, fishery independent survey and catch-at-age data. Within the model, the illegal and unreported part of the catch has been quantified using an index developed from records of the quantities of abalone confiscated from poachers by law enforcement officials. Model outputs were cross checked against international trade data compiled by TRAFFIC East/Southern Africa.

An interesting aspect of the model, and one that could be considered for other aspects of compliance monitoring (not only for modelling purposes), has been the use of an unusual fisheries index termed confiscations per unit of policing effort (CPUPE). This index (Plagányi et al. 2010) tracks the number of confiscated abalone per fishing zone, but also recognises that policing effort has not remained constant over time. To adjust for different levels of policing, a policing index was established based on the level of resourcing provided to the enforcement officials each year. The CPUPE index allows the confiscation amounts to be adjusted by the policing effort. After standardisation, the result allows estimation across years of the level of poaching.

The illegal and unreported catch is estimated using the model to compute the “additional” catch (i.e. in excess of the recorded commercial and recreational catches) that would be required to account for the decrease in stock as indicated by CPUE and fishery independent survey trends (Plagányi and Butterworth 2011). The model has been subjected to extensive sensitivity testing and as a part of those tests the authors have examined alternative poaching trends. These were not found to make much difference to the result (Plagányi and Butterworth 2011).

Modelling has some scope to assist with developing the final outcomes of compliance activities that are most directly associated with the achievement of public benefits. Reductions in illegal catches increase the biomass of fish that remains in the ocean to grow and spawn and improve conditions in fisheries and industries and communities that depend on them.

Measuring, or at least illustrating, these long-term beneficial outcomes of compliance activities requires a few simple research tasks that involve using estimates of reductions in illegal harvests that result from compliance activities as increases in measures of fish abundance in conventional and widely available fishery models. Intermediate compliance outcomes associated with reductions in illegal catches, when treated in conventional bio-economic fishery models as increases in the biomass of fish left in the ocean to grow and spawn, can be shown to generate measurable long-term beneficial outcomes in terms of improved conditions in fisheries, fishing communities, and seafood markets.

In one case study of the U.S. Northeast groundfish fishery, for example, researchers estimated the size of the annual illegal harvest at 5,200 metric tons (\$13 million) and used estimates of typical annual biomass growth rates (2% to 5%) to determine that eliminating this illegal harvest each year would result in increases in fish abundance that over ten years would increase available fish stocks by 60,000-70,000 metric tons (King and Sutinen 2010).

Such modelling has the attraction that it can produce estimates of values that could be considered outcome measures and directly compared with equivalent empirical information from the fishery over time. These estimates of values include:

- Increases in the expected allowable harvests;
- Less need for stringent fishing restrictions;
- Improvements in reliability of catch statistics used in fishery science;
- Higher catch rates and earnings for law-abiding fishermen;
- Higher legal harvest resulting in lower seafood prices for consumers; and
- Reduced economic incentives for illegal fishing.

4.1.2.5 *Use of observer data*

Comparisons of data obtained with an observer present compared to without one can be a very useful and cost efficient method of getting insight into possible occurrences of illegal activity. Data collected in this way may provide indicators of criminal activity in a way not dissimilar to what might be obtained from covert surveillance operations. Burns and Kerr (2008) report evidence illustrating that misreporting of bycatch is common in the New Zealand ling bottom longlining fishery. Such misreporting has serious implications in a multi species fishery where the accuracy of total catch estimation is important for ensuring fishery sustainability.

Observer catch rates were compared to reported catch rates from Japanese tuna boats operating in the AFZ off WA in the 1970s and this data was valuable in apprehending vessels that were misreporting. The vessels were required by statute to carry observers, the main purpose being research, but with a secondary compliance benefit (John Looby, DoFWA, personal communication).

Bremner et al. (2009) have used observer comparisons to draw conclusions about the level of compliance of by-catch discarding in one of the New Zealand hoki fishery management zones. The completion of logbooks is a compulsory requirement in that fishery. Their analysis showed differences between observed and non-observed catches that were highly suggestive of misreporting in the fishery. Indications for estimates compared to reported catches on unobserved vessels, were that there was an underreporting of both quota and non-quota managed species.

As with most methods, there are potential biases that can be introduced in the sampling process. Comparisons of observer-collected and unobserved data sources assume that the observed activities directly or conditionally approximate a random sample of all activities (Benoit and Allard 2009). This is not always the case. Benoit and Allard (2009) point to two potential sources of bias. The first is what is termed *deployment effect*, resulting from the non-random assignment of observers among sampling units. In the at-sea example provided above, this might be where certain vessels in the fleet are used either more, or less frequently by the observers and therefore contribute disproportionately to the observer dataset. The second is termed an *observer effect* and is where the behaviour of the operation is modified by the presence of an observer. Once again using the above example, if skippers were to fish at unusual fishing locations when there is an observer on board, this could potentially influence comparisons between observer collected and unobserved data sets.

The worst case of bias would be for observers to collude with an illegal fishing operation to give an illusion of compliance, as was hypothesised in the case of the official observer on board the Patagonian Toothfish vessel, *Viarsa*, apprehended fishing in Australian waters in August 2003 (Knecht 2006).

Human observer programmes, especially in smaller fishing vessels and fleets, are increasingly becoming likely candidates for replacement by Remote Electronic Monitoring (REM) techniques (see 4.1.2.7 Video monitoring techniques).

4.1.2.6 *Independent data sources*

Trade and export figures have the potential to provide estimates of landings independent of catch records supplied by the fishery which in turn may provide an indication of illegal or unreported, shipments of catch. Examples where these methods have been used are in the estimation of worldwide bêche-de mer-catches (Conand and Byrne 1993), shark catches (Clarke et al. 2006) and South African lobster catches (Melville-Smith and van Sittert 2005).

Conand and Byrne used a combination of Fisheries and Agricultural Organisation (FAO) and import and export statistics to estimate regional and world catches of bêche-de mer (Conand and Byrne 1993). Their export figures should in theory be reasonably reliable because countries that export bêche-de mer (e.g. the South Pacific Islands) are not big consumers of the product, and, therefore, non-reported product sold locally is expected to be limited. In terms of imports, most of the product flows through just a few countries, principally Singapore, Hong Kong and Taiwan which simplifies the compilation of these figures.

In the case of estimating illegal shark catches, (Clarke et al. 2006) used quantities of shark fins traded through the major markets of Hong Kong, Mainland China, Singapore, Taiwan and Japan. However, both in the case of bêche-de mer and shark fins, the end product is dried and needs to be converted to a wet weight, which introduces potential errors. Further potential for inaccuracy in the estimated biomass of bêche-de mer and sharks is that one is dealing with a multitude of species and in the case of sharks, conversions need to take into account the variation in sizes and weights of fins for different species and for different sizes of the same species. Clarke et al. (2006) adjusted their data for under-reporting and double-counting in order to derive a global catch estimate. However, even with those corrections, there is still potential unknown error resulting from the inability to account for domestic production and consumption in the biomass estimates.

It is simpler to estimate catches from data where only a single species is involved. Melville-Smith and van Sittert (2005) used published export figures from South African Customs Departments combined with actual catch figures as reported by Industry to the Division of Sea Fisheries and its successors, to estimate landings of West Coast rock lobster in South Africa from 1891 to recent times. Once again, there was a need to apply conversion factors to the various ways that the product was exported because early catches were canned. Later production changed to frozen whole and tailed lobsters, which is a packaging method still in use today.

Even though the estimates made by (Melville-Smith and van Sittert 2005) were for only a single species and used what might be considered to be reasonably reliable export figures, they had many sources of potential inaccuracy – most of which would have led to the catches being underestimated. For example, in the earlier years the canning process was unsatisfactory and many cans were rejected. There were also domestic sales and illegal activities that were unaccounted for.

While methods relying on trade figures may be useful broad-scale indicators of trends in landings, they lack the accuracy necessary for establishing fine-scale levels of compliance in a fishery.

There are other possibilities that could be considered as a way of validating landings for compliance purposes using freighting data. Some fisheries (e.g., lobster and blue fin tuna) have only small domestic markets and are highly reliant on airline companies to reach their export markets. In these cases it may be possible to use airline waybills, a method used by the New Zealand authorities. All goods exported from New Zealand for commercial purposes need to be cleared by Customs and the relevant forms for declarations provide useful information on total exported weight of product which can then be compared to total landings (John Slaughter, Ministry for Primary Industries, New Zealand, personal communication).

4.1.2.7 Remote Electronic Monitoring techniques

Remote Electronic Monitoring (REM) offers great potential to independently monitor fishing activity. REM utilises the increasing capability and reliability of digital still and video cameras, coupled to GPS or VMS and fishing gear sensors and using secure data storage and wireless transmission. Although much work is underway in various fisheries agencies, fishing companies and specialist marine technology companies, the techniques have yet to evolve to the extent of providing reliable estimates of non-compliance that could be considered to be robust compliance outcome measures. By deploying REM using statistical sampling processes, costs of equipment and data analysis would be minimised and some common biases associated with observer coverage could be eliminated.

In the Alaskan groundfish fishery, video monitoring has been used to improve the ability of observers to monitor the catch on factory trawlers (McElderry et al. 2008).

Kindt-Larsen et al. (2011) have reported on the use of closed-circuit television camera images of trawling operations on board six vessels in a quota-controlled cod fishery. The objective in this instance was to monitor discard estimates made by the skipper compared to video records. The same method has far reaching opportunities for monitoring in a fisheries surveillance and enforcement capacity although it should be noted that implicit in requiring video technology is a lack of trust between those doing the monitoring and those being monitored. There are frequent

complaints from Fishers that regulators do not trust them and the introduction of video surveillance into fishing operations could easily strain this relationship further. Researchers have shown that the relationship between regulator and fisher is important in maximising voluntary compliance (see Gezelius 2003 and references therein).

4.1.2.8 *Genetic and chemical techniques*

Genetic techniques have been used for well over two decades to identify species for law enforcement purposes (see reviews in Ward and Grewe (1994) and Sweijd et al. (2000)) and this work has now become routine. As techniques have become more powerful, the potential has become greater to use genetic methods at the stock level. This, together with an array of chemical techniques (microchemistry, fatty acid and isotope analyses), provides more application for these methods to be used as a tool in fighting fisheries crime. An excellent review of these methods and their application in supporting fisheries law enforcement is available in Martinsohn (2011), including international examples of where this technology has been applied in practice.

From a fisheries enforcement perspective, the key questions that chemical methods and molecular and population techniques need to address are: what species are we dealing with and where was it caught? Genetic techniques can answer the first question accurately, but the second question is more accurately answered by using naturally occurring chemical markers identified through isotope analyses (or similar), since genetic techniques point to its population origin at spawning rather than where it was caught.

The future of genetic tools in fisheries traceability will entail the continued development of global DNA databases containing authenticated reference sequences, to ultimately provide the tools to enable almost all fish products to be identified down to taxa (Ogden 2008). As an example, the European Union established fish the FishPopTrace project to undertake this sort of work together with complementary technologies such as otolith microchemistry and fatty acid analysis for several commercially important European species (Martinsohn and Ogden 2009). There are now numerous similar projects in other parts of the world (see: <https://fishpoptrace.jrc.ec.europa.eu/tools/projects>).

A database of shark mitochondrial DNA has been established in Western Australia and the Northern Territory which permits compliance staff to match seized tissue samples, such as fins, against a suite of reference species, McAuley et al. (2005).

4.1.2.9 *Vessel Monitoring Systems (VMS)*

Vessel monitoring systems are a key component of monitoring control and surveillance programs in many countries. The most basic use of the equipment is for monitoring the movement of vessels and depending on polling rates, this can provide details on movements to and from fishing grounds, days spent at sea and potential transgressions into restricted areas such as sanctuary zones. By coupling position recording data with additional hardware such as winch sensors, quite detailed records of fishing effort can be obtained with no real reporting impost on the crew. With additional hardware and software, there is the potential to record and transmit catch reports at sea.

The use of VMS for monitoring fishing vessels for compliance with spatial and temporal fishing regulations is widespread in Australia and elsewhere and needs little clarification. Less common is its use for developing indices of fishing effort that are independent of human error, and using those estimates of fishing effort to validate logbook indices (Mullowney and Dawe 2009). Such use does not only have a function for research purposes; it could be used for compliance management as a way of flagging irregular catch disposal, fishing location and intention to fish/offload records. The isolation of unusual records is a commonly used method of identifying suspicious behaviour that is worthy of further investigation (see Transactional Data Analysis in 4.1.2.12).

4.1.2.10 *Statistically designed compliance operations*

The use of covert powers to counter illegal activity is widespread amongst enforcement agencies in countries where these operations are permitted. Traditionally these are intelligence-led operations that focus on known problems and are designed to maximise the chance of catching offenders ‘in the act’, removing key illegal operatives, and, by deterring others, reducing total offending.

Covert investigation powers are typically granted with equally strong accountability responsibilities, but reporting processes are rarely open to full public scrutiny. Covert operations are usually run on the basis of prior intelligence and so, in a statistical sense, are biased and non-random and very unlikely to be representative of illegal fishing activities in the wider community. However, if a statistically designed sampling frame is used as a basis for mounting these operations, results do have the potential to provide robust data about a significant component of illegal activity. Although we received anecdotal information on this type of deployment of compliance resources, we were not able to find any instances documenting this practice in the peer-reviewed literature.

4.1.2.11 *Use of enforcement statistics*

The interpretation of official compliance statistics, where they have been used as measures of noncompliance (Sutinen et al. 1990), can be ambiguous as the probability of illegal activity being detected may also vary with changing levels of fishing and surveillance effort (i.e. detection may

change with respect to compliance effort, location, etc.). In addition, the ability of non-compliant fishers to avoid detection, or the enforcement capabilities of the regulator, may change through time and space. The probability of detection is an important, usually unknown, factor that contributes to uncertainty and confounding in interpreting compliance data. If these uncertainties can be adequately addressed, official statistics can provide a quantitative indication of trends over time and through space.

A number of studies have used the quantity of illegal products that have been seized during the course of operations as one of the parameters used to calculate the scale of illegal fishing (e.g. Gorfine et al. (2002)). Figures from these sources need to be used with caution (a fact acknowledged by these studies) because often a seizure is the result of months and even years of undercover surveillance. This means that the amount of illegal product seized at the time of apprehending of offenders is likely to only be a fraction of what was illegally taken and therefore any upscaling of these quantities would be likely to result in serious underestimation of actual quantities.

The report by Gorfine et al. (2002) concluded that the quantified amounts of illegal abalone in the intelligence and compliance databases for different fisheries agencies across Australia over a five-year period in the late 1990s to early 2000, ranged from only 0.06 -1.31% of the legal commercial catch for the same period. However the data included in that report was for 'known' or detected amounts only, and sampling/extrapolation issues were not considered as it was unknown what proportion of the total true illegal catch the documented illegal quantities represented.

A simpler approach that is applied to evaluating the effectiveness of compliance measures using enforcement statistics is through the use of comprehensive records relating to breaches of fisheries rules combined with detailed records of levels of enforcement activity levels (i.e., hours spent patrolling; number of fishers interviewed; quantity of catch examined etc.). This topic has been investigated in research undertaken by (McKinlay 2002; Green and McKinlay 2009).

McKinlay's (2002) work on the western rock lobster fishery showed that increasing levels of inspection produce decreasing levels of benefit – i.e., non-compliance rates are inversely proportional to levels of inspection effort. This and later work on other western Australian fisheries (Green and McKinlay 2009) has given the systems and means for improved management of available resources, directing them in the best possible way so as to optimise the trade-off between inspections and varying levels of non-compliance. When linking offences to inspections, it must be recognised that not all inspections are able to detect certain modes of offending, and this may result in a biased estimate of non-compliance.

In a fisheries context, it is important to distinguish between observed, or 'crude' non-compliance rates (detected offences as a fraction of inspections) and a 'true' overall non-compliance rate which is (an estimate of) the overall rate of offending. This important distinction is widely understood with regard to police crime statistics as seen in the difference between reported crime and true crime rates as estimated from victim studies (Catalano 2006). When a regulator does not have the ability to undertake inspections across a statistically valid sample of total opportunities for an offence, it is most unlikely that the overall non-compliance rate will be known. Given the typically targeted nature of fisheries compliance work and low rates of inspection coverage, the biases in an observed non-compliance rate could be significant (see King et al. 2009). This is borne out by DoFWA's experience that observed non-compliance rates can exhibit considerable variation. Making inferences about overall non-compliance rates from measures of observed non-compliance rates is impossible without comprehensive data sets that record such variables as: compliance effort that does not result in any inspections or offences being undertaken, whether inspections and any offences resulting were targeted, and whether significant management changes took place over the comparison period. There is a need for related fishery data to determine what fraction of total opportunities for offending were covered by an inspection, these data may be readily available for a commercial fishery where effort is well known, but may be unavailable, or poorly estimated for many recreational fisheries. DoFWA has been able to estimate an overall non-compliance rate for a few fisheries and in them, the expected patterns of declining overall non-compliance as a result of increasing compliance effort are observed and publications are planned.

One of the issues that need to be considered when using non-compliance rates as a measure of performance is whether the data relating to enforcement duties are targeted or random. Compliance inspections often focus on fishing activities (and times) where it is expected that non-compliance rates may be high, which has the potential to artificially inflate observed non-compliance indices. One of the unique features of the data collection system described in Green and McKinlay (2009) is that it keeps track of whether inspections are random or targeted, so that it is possible to generate indices of non-compliance that are unbiased, at least by that issue.

Rates of compliance with fishing regulations are generally understood to be associated with factors such as – the potential economic gain from violating them, the probability of violations being detected, the penalty for the offence, and also social and community norms that result in most fishermen complying regardless of potential economic gains and losses (Kuperan and Sutinen (1998), and references therein). In considering the Northeast Groundfish Fishery (NEGF), King and Sutinen (2010) point out that within their models for that fishery, fishers considering violating a regulation

decide on that course by weighing up the probability of being detected and the probability of facing a penalty if they are detected. They used National Oceanic and Atmospheric Administration (NOAA) official statistics for the NEGF fishery over a five year period to estimate the percentage of detected violations that result in a penalty, and survey estimates from fishermen and enforcement staff to estimate the likelihood of a violation being detected. Multiplication of the two percentages has been used by King and Sutinen (2010) as an estimate of the likelihood of a violation resulting in a penalty.

King et al. (2009) believe that there are three reasons why there are so few studies that report on illegal and unreported fishing in the United States:

- (i) difficulties for researchers to obtain data on violations of fishing regulations because of the offshore nature of the operations
- (ii) the quality of data on fisheries violations that are available is questionable because of the way that it is collected by the different fisheries law enforcement agencies and
- (iii) data published by the U.S. Coast Guard indicates that fisheries compliance in the United States is generally high which does not provide incentive to research illegal fishing in that country.

In addition to those, it is probably also true that compared to many other crimes, the level of societal harm from illegal fishing is low, making reporting on this topic less worthy than on many other forms of crime.

(King 2010) used official statistics regarding the enforcement and prosecution of fishing violations and resulting penalties along with results from surveys of fishers, enforcement staff, and others to examine the performance of fisheries compliance bodies in the United States. The study presented evidence that rates of noncompliance were relatively high in some fisheries, in the range of 12% to 24%, and showed that the low probability of fishing violations being detected and the low probability of detected violations being successfully prosecuted and resulting in meaningful fines resulted in expected costs of noncompliance being relatively low, and significantly less than expected economic gains. In the fisheries studied, in other words, the study concluded that levels of enforcement were not adequate to deter relatively high rates of noncompliance. Although similar studies have not been conducted outside the U.S. it is reasonable to expect that they would reach similar conclusions. This is especially true in places where social norms that promote compliance regardless of economic gain and fishery enforcement budgets are lower than they are in the U.S..

When considering non-compliance rates it is important to realise that 100% compliance with fisheries rules is practically unattainable without either incurring excessive compliance costs or

creating ineffectual legislative frameworks. Indeed, perfect compliance has been shown to be undesirable from an economic perspective (Arnason 2010).

The out of sight, out of mind nature of fisheries enforcement on the high seas means that unless inshore resources are affected, the general public can be completely unaware of the extent of any problem. This is likely to change in the future as third party certification of fish products becomes more commonplace, because at least for those fisheries being assessed, the accreditation process probes how well laws in a fishery are enforced.

Finally it should be mentioned that the risk in making official statistics part of a performance measurement system is well documented (Campbell 1976). This risk has been highlighted in more recent times by both a review of the New York CompStat program (Kelly and McCarthy 2013) and by the UK House of Commons Public Administration Select Committee (House of Commons Public Administration Select Committee 2014). The UK review found amongst other things that:

- Numerical targets drive perverse incentives to mis-record crime.
- This presents officers with “a conflict between achievement of targets and core policing values.”

As a result of the Committee’s inquiry and the evidence it found, the UK Statistics Authority decided in January 2014 to strip Police Recorded Crime data of its designation as National Statistics.

Both reviews reveal classic examples of data corruption as expounded by Donald Campbell (Campbell, 1976) and reinforce the need for independent audits of work practices and statistical reporting when there are financial and political ramifications to the use (and misuse) of official data.

4.1.2.12 Transactional data analysis

The use of transactional data for detecting fraudulent activity is standard practice in many areas of commerce (e.g., the insurance, banking and gaming industries). The potential exists to use transactional data for this purpose in fisheries enforcement, but indications from what is available in the published literature is that the opportunity is yet to be fully appreciated.

Generally, one of the minimal requirements for commercial fishing licence holders is submission of log book information recording where the gear was set, what equipment was used, the length of time that was fished, how much was caught, etc. In addition to this, many fisheries departments in Australia and elsewhere are now moving to systems that record, often in real time, a wealth of additional data. For example, it is now commonplace for fishers to be required to report when and where they are going to sea, when and where they return, when they offload the catch and the

weight of the catch at offloading. It is equally commonplace for processors to be reporting on when they receive the catch, the weight of the consignment and more.

All these data sources, if properly utilised, provide enormous possibilities for identifying illegal fishing in commercial fisheries. Identifying falsified fisheries transactional data is no different than identifying fraudulent transactional data in other industries. The first task is to profile participants – in a fisheries context this would be boats in the fleet or companies in the fishery. These analyses are then used to identify inconsistencies. It is these areas of inconsistency which become the focus of further investigation because they may be indicators of illegal activity.

While no doubt this sort of data exploration does occur to varying degrees in fisheries compliance groups all over the world, our belief is that in a fisheries context, forensic data analytics capability is an area that is seriously neglected. Published examples of the use of this type of analysis are rare, perhaps because there is a belief that publically disclosing any detail could compromise the benefits of such work in the future.

One published case of illegal fishing reported by Groeneveld (2003) outlined the under-reporting of catches in a South African lobster fishery. The case involved a large quota holder in the fishery exporting very significant quantities of undeclared catch together with their legally declared landings. The illegal activity had been taking place for several years and was uncovered through a tip-off, not through catch and effort data analysis. However, of relevance to this discussion is the analysis of catch and effort data after the event (Groeneveld 2003), which showed that the company operating illegally had very different catch rates than the rest of the fleet. Had this data been used for enforcement purposes, it is highly likely that the case would have been flagged and investigated much earlier.

McKinlay (2002) has described a variation of a transactional experiment which instead of using logbook information, utilised the size composition of the catch. Lobsters grow in steps, each time they moult and are of fixed size between moults. At the time of the experiment, the western rock lobster fishery in Western Australia had an annual change in the legal minimum size (LMS) mid-way through the commercial fishing season and outside of the moulting period of the lobsters. At the start of the fishing season, the LMS was 77 mm carapace length (CL), but mid-way through the LMS decreased to 76 mm. There were suspicions that some fishermen were illegally stockpiling lobsters in the 76-77 mm LMS range in days and weeks prior to the mid-season change in minimum size. The suspicion was that they were being held at sea in holding containers and then being landed with the rest of their catch on the day that the smaller LMS became legal.

McKinlay's (2002) experiment involved at-sea sampling of lobsters above the LMS as well as collecting information on the proportion of catch in the 76-77 mm LMS range. Sampling was conducted at sea on several boats fishing in one area of the fishery over a number of days prior to the change in LMS. Landings of boats that had been fishing in the same area that had been sampled at sea, were then sampled for two days after the change in LMS.

Results showed that on the first day of the changed legal size, the proportion of 76:77+ lobsters was approximately equal, but on the second day the ratio was similar to what had been recorded during the at-sea sampling, i.e., around 0.7. McKinlay (2002) was able to use the ratios to show that around 27% of the lobsters consigned by sampled fishers on the first day after the change in LMS, had been held over from prior to the date of the LMS change. One boat in particular, landed a catch on the date that the LMS changed in which almost 80% of the total catch comprised lobsters in the 76-77 mm LMS range. One basket in the catch had a 100% consignment of 76-77 mm LMS lobsters!

As with any kind of data used for any kind of analytics, the quality of the information being used is paramount. Obviously this means that appropriate resources need to be directed at optimising the quality of the data. This may not be appreciated in agencies where compliance has traditionally focused on intelligence gathering, rather than analysing large amounts of data. These methods do not lend themselves to use in data-poor fisheries such as most recreational fisheries where information relating to fishing activity is more likely to have to be sourced from the fisher using survey or creel techniques, rather than provided by the fisher as part of a licence condition.

Table 4.1: Methods used to establish and measure fishing non-compliance and assess the scale of illegal activity

Heading in the report	Method	Reference examples	Main data requirements	Advantages	Disadvantages
4.1.2.1	Stakeholder surveys	Sutinen et al. (1990); Blank and Gavin (2009);	Survey results – mail, phone or one-to one.	Simple and targeted.	Can be prone to opinions rather than fact and these can differ according to which stakeholder groups are surveyed.
4.1.2.2	Expert judgement	Pitcher et al. (2002); Agnew et al. (2009); Ainsworth and Pitcher (2005)	Requires access to reported catches over time. Expert opinion on influence factors.	Generally simple to undertake.	Method is subjective, particularly in assigning values to influence factors.
4.1.2.3	Mark-recapture sampling	Pierce and Tomcko (1998); Henderson and Fabrizio (2013)	Ability to tag the animals. Suitable tags.	Generally simple to undertake.	Consumer welfare – some types of tags may need to be approved as food-safe. Assumptions in predicting sizes at recapture of previously tagged fish. Relatively high cost of RFID tags. Expense of undertaking large tagging exercises
4.1.2.4	Modelling	Plagányi et al. (2010); Plagányi and Butterworth (2011) (King and Sutinen 2010).	Large amount of stock assessment data and a robust and reliable stock assessment model.	The model is multipurpose. There is the ability for it to be updated as more data become available.	Requires a large amount of data. Given the data requirements, there is considerable uncertainty with many of the inputs and therefore correspondingly, with the outputs.
4.1.2.5	Use of observer data	Bremner et al. (2009)	Observer and fishing vessel log book data.	Generally simple to undertake. Observer bias expected and controlled for can be an efficient tool to detect illegal activity.	Costs Deployment bias – non-random assignment of observers among sampling units and Observer bias – where behaviour of fishery operations is modified by presence of an observer.
4.1.2.6	Independent data sources	Conand and Byrne (1993); Clarke et al. (2006); Melville-Smith and van Sittert (2005)	Estimates of landings independent of catch records supplied by the fishery – e.g. Trade figures, freight records.	Independent data. Generally simple to undertake.	Trade and export figures often lump species in a generic category. Figures usually require reworking from processed product to whole mass. Domestic marketed catch is usually unknown.
4.1.2.7	Video monitoring techniques	Kindt-Larsen et al. (2011)	Access to ship, factory or other closed circuit video surveillance equipment.	Potentially very conclusive evidence of any transgressions.	Requires an appropriate legislative framework. May create trust issues that could be detrimental to voluntary compliance. Currently not automated and thus costs are high to review video data; alternatively sub sampling results in uncertainty.
4.1.2.8	Genetics and chemical techniques	Ogden (2008) ; Martinsohn and Ogden (2009); Martinsohn (2011);	Specialised laboratory equipment and research skills.	Sometimes this is the only avenue to solving particular issues to do with identifying species and taxa.	The methods need specialised equipment and skills. Can be expensive. The time lag between sample and result could be problematic in some circumstances.

4.1.2.9	Vessel monitoring systems (VMS)	Mullowney and Dawe (2009)	VMS installed on vessels and shore based technology to receive and process data.	Ease of monitoring vessel activities and validating log book records.	Costly to maintain and operate. Can create trust issues. May not be sufficient to meet evidentiary standards.
4.1.2.10	Statistically designed compliance operations	None	Statistically designed sampling frame.	Generally simple to undertake.	Generally only suitable for one-off targeted operations. Requires skilled staff and suitable legislation. Resource intensive to undertake. Occupational Safety risks for staff.
4.1.2.11	Use of enforcement statistics	Gorfine et al. (2002); McKinlay (2002); Green and McKinlay (2009)	Results of day-to-day inspection activities.	Data readily available.	Can lead to perverse compliance outcomes as staff mis-report in order to inflate their performance. There is also a need to be wary of setting targets as that can result in 'easy' inspections to get the numbers up. Can risk turning compliance officers into form-fillers. To get least biased data requires dedicated reporting systems.
4.1.2.12	Transactional data analysis	McKinlay (2002); Groeneveld (2003)	Availability of suitable log-book data or electronic data logs.	If log books or data logs are in place, should require no additional reporting requirements.	Despite standardising the data, there is still likely to be considerable variability. Any results produced will have a high degree of uncertainty. Analysis of data logs requires forensic IT skills. Not useful in data-poor fisheries such as recreational.

4.1.2.13 *Summary of the literature survey dealing with methods to measure levels of compliance*

A number of methods have been described that have been used to measure how compliant various fishers are within the sectors in which they are operating. Measuring levels of non-compliance is, at best, difficult and all the methods that have been outlined provide indicators that are highly dependent on the quality of the intelligence, compliance data, or research methods used. However, it is the degree to which the uncertainty affects decision making that is the important factor in determining the suitability of an indicator.

Methods relying on intelligence and compliance data without additional analysis will only ever describe a proportion of the quantities of catch that are discarded illegally or that are taken through illegal harvesting (e.g., Table 4.1, methods 6, 7, 8) and likely only provide a minimum figure of tonnages of stock lost to illegal fishing activities. However, they could indicate the shape of the distribution of illegal catch and provide indications of changes over time. Most fisheries compliance programmes can only give comprehensive oversight to a very limited number of opportunities for offending.

Opinion-based methods (e.g. stakeholder survey techniques and expert judgement, Table 4.1 methods 1 and 2) and those that infer a value or range of values based on analysis (e.g. modelling, and subsampling methods such as use of observer data and use of enforcement statistics, Table 4.1 methods 4, 5, 11) are not constrained in the same way. These methods do however rely on subjective judgment and a number of assumptions. This means that their accuracy in estimating illegal landings or discarding of catch is only as good as the assumptions that are used, although this may be adequate for decision making purposes in a well-designed risk management framework.

In spite of their inadequacies, estimates of levels of compliance are likely to remain the cornerstone when judging the effectiveness of many compliance programs. Inexactitude alone will not prevent them being used to monitor past levels of effectiveness or to improve future levels of performance, at least until clearly better, more exact measures can be developed. The challenge is how much reliance to place on indicators of unknown accuracy when seeking to produce sensible outcomes.

While some studies have used estimates of the amount of catch that is landed or discarded illegally in a fishery, it is not necessarily assessing the effectiveness of a compliance program. They could be considered useful immediate outcome indicators and monitoring them over time may give useful intermediate outcome indicators. The errors and uncertainties inherent in these methods make them unsuitable as accurate final outcome indicators when those uncertainties and inaccuracies are

poorly quantified but it must be pointed out that they are the best and most practical outcome indicators we have found in this study.

4.1.3 Measuring compliance outcomes

To fundamentally assess the effectiveness of a compliance program, it is necessary to understand the drivers and motivators behind an individual's decision as to whether they will become involved in one or more of the different facets of illegal fishing. We have referred to *different facets* of illegal fishing because an individual who discards a few fish illegally or keeps a few undersize abalone in his or her catch has different drivers and motivators to an individual that is illegally exporting high volumes (e.g. container loads) of fish. Knowledge of these motivations allows effective strategies to be put in place to prevent unacceptable risks to the sustainability of the fishery.

The primary reasons for measuring compliance outcomes are so that they can:

1. be used to inform the service provider of the effectiveness of the service that they are delivering so that it can be monitored and if necessary, improved over time;
2. be used to give stakeholders the means to gauge what has been achieved by the service provider;
3. in the public sector, allow governments to be able to determine the costs and benefits of the service; and
4. demonstrate good stewardship in a co-managed environment.

To get to the point of being able to use outcomes for this purpose, there are a number of steps or phases that are generally followed, but there is no prescriptive process. The Australian Taxation Office (2007) has outlined eleven different frameworks and models used either in whole or in part to gauge the effectiveness of a program: The OECD risk model, Australian Taxation Office (ATO) compliance model, ATO business model, standard cost model, program logic model, public sector value model, balanced scorecard, performance indicators for government framework, National Association of Councils for Voluntary Service's self-evaluation process, Canada Revenue Agency's compliance measurement framework and a program assessment rating tool developed by the US Office of Management and Budget.

4.1.3.1 Australia Taxation Office Framework

The ATO has developed their own framework (the ATO compliance model) (Australian Taxation Office 2012a) which works through four phases: Phase 1 articulates the risk and aligns it with their business intent; Phase 2 defines outcomes and develops strategies; Phase 3 designs indicators; and Phase 4 validates the indicators and determines the extent of their effectiveness. Other published

studies dealing with the development of performance measurement identify more (Willis et al. 2010) or fewer phases (INECE 2008) in their models. The one constant that all authors are agreed on is that the development and implementation of outcomes-based indicators in an organisation needs a substantial investment in time and commitment by management.

In this preliminary study into the measurement of fisheries compliance outcomes, we have attempted to draw on the steps that have been followed by other authors in developing outcome indicators. Because of the lack of published studies dealing with this topic in fisheries compliance, we have concentrated on methods used to develop outcome indicators for other law enforcement and compliance organisations, in particular the ATO compliance model. In the proceeding headings, we have documented a generalised process of how outcome indicators might be developed in fisheries compliance.

The steps or phases that we will be discussing broadly follow those outlined in Australian Taxation Office documents (2008; 2012b; 2012a). Details would be expected to vary for different fisheries agencies because while all fisheries compliance organisations have similar overall goals and responsibilities, they are not necessarily responding to the same risk profiles. Obviously this would impact their choice of outcome indicators.

4.1.3.1.1 Phase 1: Articulating risk or goals and aligning these with fisheries business intent

As pointed out in section 1.3, Australian fisheries regulators share a common goal of ESD. Many fisheries compliance groups share a similar mission statement or business intent to at least the first part of the one outlined for the Australian Taxation Office (2008) (i.e., “to optimise voluntary compliance”). The mission statement that has been adopted by the Australian National Fisheries Compliance Committee in their compliance strategy for 2010-2015, is that the optimal level of compliance “... is that which holds the level of non-compliance at an acceptable level, which can be maintained at a reasonable cost while not compromising the integrity and sustainability of the resource” (National Fisheries Compliance Committee undated).

The wording in the statement in the previous paragraph is important in forming the reason for developing the indicators. As noted in Willis et al. (2010), staff should never have to be in the position of asking “why are we doing this?”. The reason for developing the indicators can be couched as addressing one or more compliance risks emanating from the statement, or as addressing specific goals drawn from the statement. If it is risks, the Australian Taxation Office (2008) note that these should be expressed as a threat posed to achieving what is in the statement, not in terms of risks associated with observed behaviours. Willis et al. (2010) consider it to be critical

for staff to be involved at this juncture of the process to ensure validity in approach and a degree of ownership by all.

The Australian Taxation Office (2008), in common with the socio-ecological theory of compliance, consider it important to identify the behaviours and drivers of the risk. They use the BISEP (business, industry, sociological, economic and psychological) factors to establish what is driving client behaviour. In the case of fisheries compliance, these behaviours and drivers would at least in part, be similar to the motivators and drivers of compliance behaviour outlined in section 4.1.1.4 Socio-Ecological Compliance Theory. The purpose of this is to identify leverage points so that the drivers of risks are treated rather than the behaviours (Australian Taxation Office 2008).

There is a wide field of literature covering factors that drive fishers to either be compliant or non-compliant. These studies show that in general the majority of individuals are law-abiding and conform to regulations, but that there is usually a small component of what Kuperan and Sutinen (1998) term “flagrant violators.” This group, they suggest, behave in a way devoid of moral obligation or social influence and are driven only by the direct tangible consequences of their actions.

The attitude towards compliance by the majority of fishers tends to be swayed by circumstances in a dynamic and evolving way. King et al. (2009) suggest that deteriorating economic conditions combined with the imposition of highly restrictive, sometimes controversial and often ineffective fisheries regulations, have negatively impacted attitudes to compliance by U.S. fishers. In their view, these circumstances have on one hand strengthened economic incentives for non-compliance and on the other have weakened normative factors favouring compliance. These are examples of the type of drivers of risk that need to be addressed by actions resulting from this phase in the development of compliance outcomes.

4.1.3.1.2 Phase 2: Defining outcomes and developing strategies

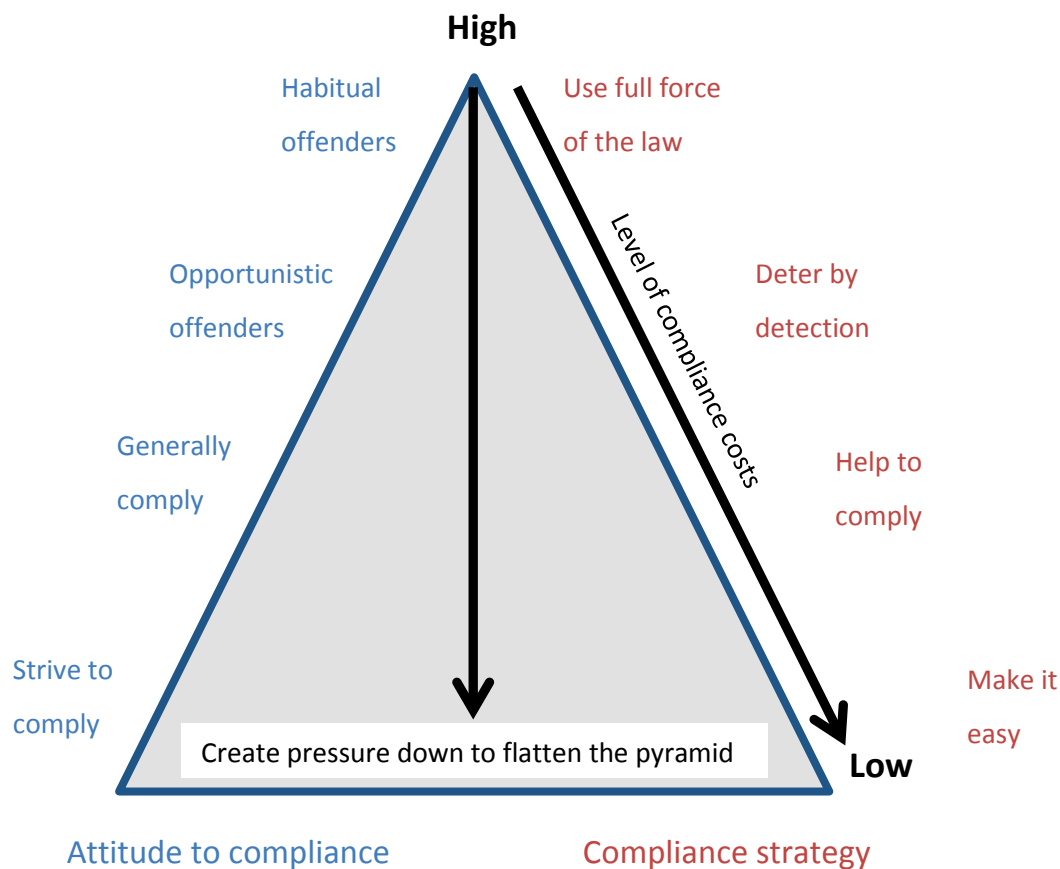
The object of this phase is to clearly express the broad, aspirational desired outcomes and explain what would be different if the organisation is being successful. Defining outcomes is a critical step, because the outcomes determine all the actions that will be directed towards achieving them. In the previous phase, motivators and drivers of non-compliant behaviour were identified. In this phase, the right mix of treatment strategies will also be identified to treat the drivers of noncompliance, not just the observed behaviours. As part of this process the ATO recommends defining success in terms of specific goals (intermediate outcomes to use the terminology of this project) that are linked to positive, sustainable changes in behaviour and or community confidence and hence also to the desired final outcomes. This phase is also about identifying target groups who will be subject to

specific compliance strategies; however, this phase is *not* the point at which performance measures and indicators are developed – that is covered in phase 3.

Logic models explicitly recognise that not all outcomes can occur at the same time (Innovation Network Inc. anon.) which is why they are referred to as a “chain of outcomes”. As we have identified in section 1.1, outcomes need to be considered across different timeframes. INECE (2008) considers intermediate outcome measures to be those measuring progress toward a final outcome, for example a change in behaviour. By comparison, final outcome measures should allow measurement of the final end product that the program was designed to achieve.

The Australian Taxation Office (2008) have used a variation of the pyramidal responsive compliance model concept described by (Ayres and Braithwaite 1992) (Figure 4.1). That model diagrammatically compares public attitude to compliance against the strategy they employ to change behaviour. The model assumes that the vast majority of the public, taxpayers in their case, are law abiding and so require little in the way of compliance costs. These law-abiding individuals form the base of the pyramid in their model. Moving up the pyramid, there are decreasing numbers of increasingly non-compliant individuals who consume increasing amounts of compliance resources through detection, investigation and sanctions. At the top of the pyramid are a small group of habitual violators. Compliance costs are highest at the top of the pyramid, because that is where they focus their law enforcement efforts. Implicit in this simple model is the idea that the shape of the pyramid is dynamic, a result of many contributing factors. At least some of these factors can be influenced by the regulator whose strategy is to flatten the pyramid by increasing the number of those who regularly comply voluntarily and decreasing the number of people who require more extensive efforts from the regulator to get them to comply. This obviously decreases compliance costs and increases the amount of compliance.

Figure 4.1: Pyramid diagram, originally adapted from Ayres and Braithwaite (1992), showing how compliance authorities respond to different stakeholder attitudes towards their compliance obligations.



We argue that viewing the attitude and behaviour of society to compliance in this way is useful because it is difficult and as noted by Weatherburn (2000), often not cost-effective to achieve full compliance where there is something to be gained by individuals who undertake illegal activity. Policy goals should therefore be realistic about what is possible to accomplish (Weatherburn 2000) and sensible outcome statements may need to be qualified with terms such as 'reduce', 'limit' and 'deter'.

To apply the pyramid to fisheries compliance, some consideration of overall risk is necessary to sensibly deploy resources to address the modes of noncompliance that pose the greatest risk to a fishery or area. This is because the cumulative effect of large amounts of low level noncompliance may conceivably cause more damage than a small amount of serious noncompliance.

King et al. (2009) suggest that habitual offenders of fisheries regulations (chronic violators to use their term) comprise 5-15% of the population and that a similar proportion of the population never intentionally violate regulations because of their moral convictions. They consider that the balance

of the population (70-90%) occasionally violate regulations. Presumably within this group of 'occasional violators,' there are varying degrees of violation in keeping with the pyramidal representation of attitudes to compliance in Figure 4.1.

Offenders represented by the top end of the pyramid are unlikely to ever adopt a normalised behaviour towards compliance. For them incarceration or removal from the fishery, reducing the illegal gain or increasing the expected penalty is the only mechanism for controlling their non-compliant behaviour (Kuperan and Sutinen 1998). These habitual violators can account for a disproportionately high percentage of the illegal harvest, and their behaviour, if unchecked, can result in alteration of social norms to favour noncompliance (Nielsen and Mathiesen 2003). It is therefore crucial that those potential offenders should be kept in check.

There is additional motivation for this sub-group to be restrained; Kuperan and Sutinen (1998) note that if those that occasionally violate regulations see habitual, flagrant violators getting away with their crimes, they will come to regard regulatory procedures as unfair and the regulatory practices as failing to protect the fishery and the fishermen. This will erode the moral obligation and social influence within this group, leading ultimately to a breakdown in compliance behaviour in the fishery.

The end goal should be for compliant behaviour to be normalised and voluntary, or for stocks to be managed such that noncompliance is not a risk to the fishery. The Australian Taxation Office (2008) consider that changing behaviour generally requires a mix of strategies: help and education to assist their clients in complying, combined with verification and enforcement to deter, detect and deal with non-compliance.

This is similar to a fisheries enforcement context. Any compliance strategy has to target both the top and base of the pyramid that reflects fishers' attitudes to compliance (Figure 4.1) using intensities of law enforcement appropriate to the level of risk posed. Strategies also need continual review - fisheries enforcement resources that were once adequate can cease to be adequate and when combined with limited prosecution of infringements and inadequate penalties, can fail to deter fishing violations (King et al. 2009).

One factor that also needs to be considered during this part of the planning process is that the strategies to change non-compliant behaviour sometimes have unintended consequences. For example changing non-compliant behaviour in one aspect of policing might result in a shift in risk to a different policing task (Australian Taxation Office 2008).

A particular problem in policing situations is the difficulty of identifying outcome measures for specialist units within the police. Alach and Crous (2012) state that even simple outcome measures such as crime rates, are usually irrelevant for technical units and difficult to allocate to specialist units. This is in part because these groups tend to be very dependent on other agencies or parts of the organisation (Mackenzie and Hamilton-Smith 2011), but also because some of these units (e.g. counter-terrorist units) only record a few incidents a year. Such difficulties in identifying outcome measures could equally be applied in some fisheries enforcement activities (e.g., special investigations branches). Alach and Crous (2012) believe that a way around this is for specialist policing performance measurements to focus primarily (but not solely) on outputs rather than outcomes. For example: an Intelligence Unit may simply count the number of intelligence reports by type produced during a reporting period; or the number of investigative operations that provided organic intelligence support, where an intelligence analyst brings their specific skillset into the investigation team.

4.1.3.1.3 Phase 3: Designing indicators

Indicators are characteristics that can be used to measure the progress a program is making towards achieving a specific outcome and are therefore linked to the intermediate outcomes that were developed in Phase 2. It was noted at the start that one of the key reasons for measuring compliance outcomes is to give stakeholders the means to assess the performance of a service provider in terms of achieving meaningful end goals. In this phase, therefore, there is a need for interaction with operational staff and stakeholders, to discuss and, if necessary, to modify the goals and associated indicators. Issues to be dealt with are suggested by Willis et al. (2010) as determining:

- Relevance of selected measures and indicators to goals
- How well defined selected measures and indicators are
- The reliability of indicator data
- Comparability of indicator data
- Understanding the limitations of indicator data

In developing indicators, it is important to focus on just a few key measures, but the breadth and complexity of fisheries may hamper this aspiration. A distinction needs to be made between measures and indicators. As their name implies, one measures something and is therefore usually a single quantitative value; the other indicates something and is therefore a qualitative value that compares one value with another or indicates trends in data. Australian Taxation Office (2008) state that indicators are generally quantitative but that they can be based on both quantitative and qualitative sources.

There is consensus as to the need for multiple indicators to provide enough information to give a comprehensive picture of performance (Australian Taxation Office 2007; INECE 2008). However there is a balance that needs to be struck, because generating too many indicators can result in the production of too much detail to make the outcomes useful for implementation and improvement (Hughes et al. 2011).

Indicators of performance need to be relevant and meaningful. While this should go without saying, it is human nature to focus on collecting information on items that are easy to measure and to neglect those for which it is difficult to collect data (Australian Taxation Office 2007). Obviously, if some measurements of performance are ignored, the risk is that it could negatively impact conclusions that are drawn as to whether a programme is achieving its goals. One way of helping to ensure the relevance of the indicators is to align them with the intermediate outcomes (or goals) identified in Phase 1 (see 4.1.3.1).

Information from indicators should reflect trends in performance against the intermediate outcomes (or goals) in the short, medium and long-term. A fisheries compliance example is provided in Table 4.2, showing how success can be defined against a planned result and performance indicators that could contribute to revealing the level of success in achieving the planned result.

Table 4.2: Example of how success might be gauged in a fisheries compliance context, against a planned result and performance indicators

Planned result	Defining success/Intermediate outcomes	Performance indicators
<ul style="list-style-type: none"> • High level of compliance with regulations in commercial fishery 	<ul style="list-style-type: none"> • Low rate of illegal catch landed • Fishers perceive a high probability of detection • Reliable recording of bycatch and discards • Sustainable stocks 	<ul style="list-style-type: none"> • Rate of illegal catch per 1,000 animals measured at off-loadings • Number of Licenced Fishing Boats (LFB) fined or prosecuted as a proportion of all LFBs • Qualitative evaluation of community perceptions using focus groups • Low rates of catch return errors

Diamond (2005) points to the importance of not neglecting process indicators of workload, throughput and work rate, which together measure technical efficiency of an agency's operations. He views workload as an input that can be used to produce quality of service output data (e.g., the amount of work not completed as a proxy for delays in service to customers). Quality of service, which includes services such as adequacy of dissemination to potential users, timeliness in service provision and so forth, is a difficult output to measure. However, if properly tracked it can provide an indicator of efficiency (Diamond 2005).

4.1.3.1.4 Phase 4: Validating indicators and determining the extent of effectiveness

This phase involves the analysis of data that have been collected so that the effectiveness of the compliance strategies can be assessed. The questions that Australian Taxation Office (2012b) consider need to be addressed when evaluating compliance effectiveness are:

- Is there a change in compliance behaviour and/or community confidence?
- If there is a change, did we cause it?

To be clear about what interventions have led to a change in the indicators, one should ideally compare what would have happened in the absence of the intervention against what happened with intervention (Australian Taxation Office 2007) although the gold-standard evaluation method of a controlled experiment is rarely possible in the public policy sphere in which most regulators operate.

Australian Taxation Office (2008) have summarised a number of different methods that can be used to determine how effective the strategies have been at achieving the desired outcomes. These range from baseline comparisons – a comparison of performance before and after the strategy, to benchmarking against other areas or organisations with similar characteristics and other methods.

One of the complexities in analysing and interpreting performance against outcomes, is that while agencies or programs can influence outcomes, they do not always control them (INECE 2008). Often factors external to the agency play a significant role in determining the success or otherwise of performance against particular outcomes. This requires consideration in the interpretation of the results and in the explanation in the reporting of the conclusions. INECE (2008) advises that because of these external factors, agencies need to be mindful of not always taking too much credit for successful achievement of outcomes; nor necessarily taking too much blame when outcomes are not achieved.

Professor Malcolm Sparrow has very clearly highlighted the difficulties for regulators in trying to prove causality since, scientifically speaking, that can be impossible. His recommendations for

measuring progress against outcomes are broadly in line with those advocated by the ATO whereby the aggregate performance of a regulator is best described by breaking its operations into specific projects, each designed to address specific problems, identified using verifiable information and tracked using indicators chosen at the commencement of the project to show whether change is taking place. By taking such an open and transparent approach, continuously monitoring progress and being prepared to actively seek out new approaches if the first does not have the desired effect, he argues that correlation should be sufficient for a regulator to take credit for an observed change in behaviour (Sparrow 2008). Indeed he goes further to argue that by seeking academic levels of proof of causality, a regulator may actually restrict their ability to try new approaches and so fail to achieve good outcomes (Sparrow 2011).

Further complicating the matter is that where there is more than one program or agency contributing to an outcome, there is the option for them to share responsibility in reporting against that outcome. Indicators measuring the collective performance of several programs or agencies are referred to as cross-cutting indicators (Audit Commission quoted by Australian Taxation Office (2007)).

The end result of this process of validating indicators and determining the extent of their effectiveness in achieving success goals and desired outcomes is to use this information to improve services, allocation of resources and increased accountability. It needs to be possible to answer the question “how are we doing?” in terms of both efficiency and effectiveness in achieving organisational goals and objectives.

Diamond (2005) has outlined several additional complications about measuring performance against outcomes. He points to:

- (i) The danger of overreliance on performance measures and the fact that it usually involves considerable evaluation to determine the reasons behind either the success or failure of a program’s activities and its resulting outcomes. A thorough evaluation of this is an expensive exercise that does not necessarily provide all the information required for resource allocation decisions.
- (ii) The danger of inappropriate measures - with the move from outputs to outcomes the technical problems of measurement have increased and made the task of interpreting performance indicators substantially more difficult. A particular problem he identifies has been already noted in section 4.1.2.11 (Use of enforcement statistics), that the use of performance measures can end up displacing the actual outcomes as an agency’s

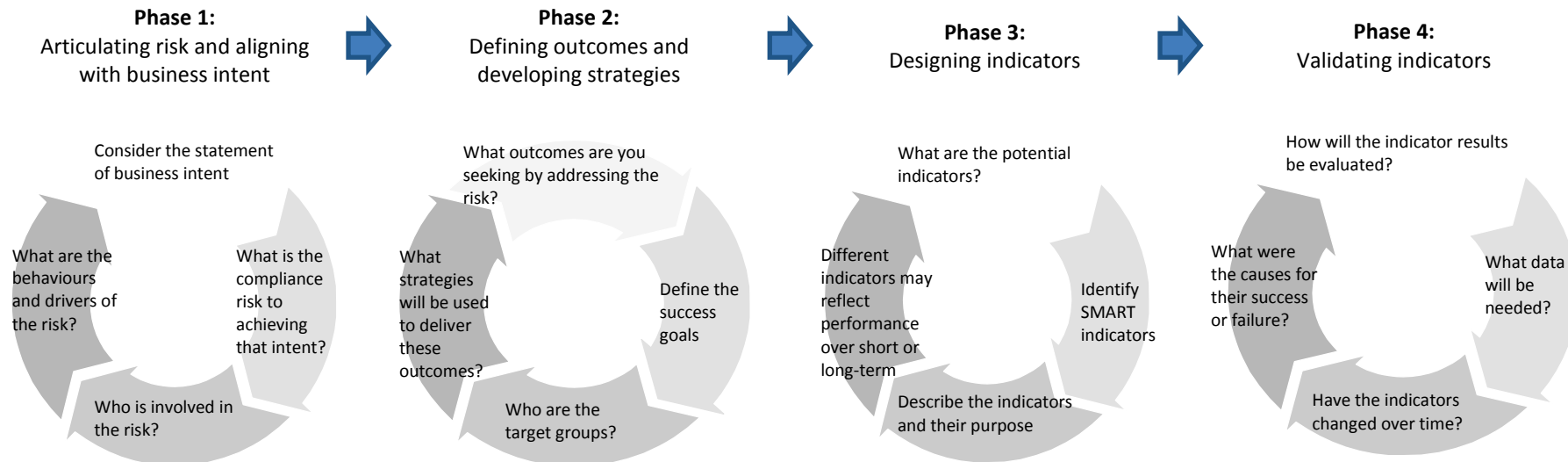
objectives. This could result in an Agency's energies being focussed on improving the performance measure results without necessarily improving actual outcomes.

- (iii) The danger of misuse, because different people interpret performance indicators in different ways. Inevitably, there is a tendency for the interpretations to be used in a way that is most favourable to the Agency that is generating them. This can even filter down through the Agency to the staff, where there may be incentives to identify performance measures that can be used for self-serving purposes resulting in the reporting of misleading performance data and finally,
- (iv) The danger of information overload if too many performance indicators are used, or if they are inappropriate for decision making.

The important part of thoroughly evaluating outcomes is that the process provides the opportunity to examine causes of success or failure and to use these judgements to improve service delivery. Good communication channels are particularly important in the early stages of changing from a framework that measures efficacy to one that measures effectiveness, because as noted by Australian Taxation Office (2007), such a change is a cultural shift in any organisation.

A summary of the four phases is provided in Figure 4.2.

Figure 4.2: Summary of the four phases in the development and validation of outcome indicators (modified from Australian Taxation Office (2012a))



4.1.3.2 *Organization for Economic and Cooperative Development*

The Organization for Economic and Cooperative Development (OECD) published a report that analyses the experiences of ten OECD countries in the design and implementation of indicators used to assess the outcomes of environmental enforcement authorities' efforts to ensure compliance with pollution prevention and control regulations (Mazur 2010). The report notes that regulatory agencies' performance has typically been evaluated through measures of level of activity (i.e., input and output measures) rather than outcomes. The objective of the study is to help environmental enforcement authorities to measure the effectiveness of their efforts.

OECD countries included in the study review reported using one or more measures of compliance rates as intermediate compliance outcome measures, and agencies in England and Wales reported using some weighted compliance indexes. Reported measures of rates of compliance included:

- Percent of noncompliant facilities out of the number of inspected facilities. (USA, various states)
- Percent of violation-free facilities during initial routine inspections out of the number of initial routine inspections. (USA, state of North Carolina)
- Ratio of the number of inspections that did not identify violations and the total number of inspections. (USA, state of Pennsylvania)
- Hundred percent minus the number of facilities in noncompliance divided by the number of performed inspections. (Australia, state of Victoria)
- Hundred percent minus the number of facilities with significant violations divide by the number of inspected facilities.(USA, various states)
- Hundred percent minus the number of facilities with significant violations divided by the number of inspected facilities (USA, state of Maryland)
- Number of facilities with documented noncompliance (inspection-based) divided by the total number of known regulated facilities. (USA, states of Massachusetts and North Dakota)
- Number of violations of core license conditions over a number of institutions inspected. (Netherlands)
- Number of facilities in compliance with requirements of “best available techniques” under specific environmental regulations. (Netherlands)
- Number of breaches of categories 1 and 2 (levels of significance in an index-based compliance classification scheme), based on targeted inspections. (England and Wales)

Given the challenges associated with the design of compliance assurance outcome indicators, the author acknowledges that it is not possible to identify a “best practice” approach or a set of “flawless” indicators. However, several key principles are identified:

- Outcome indicators should only be developed following the identification of a clear management need, and a plan for how, and by whom, they would be used.

- Outcome indicators should be associated with time-specific targets to integrate strategic planning and performance management processes.
- Targeting outcome indicators on specific regulatory priorities (e.g., pollutants) improves analytical rigor, but reduces comparability between enforcement agencies that may have different priorities.
- Trends analysis of outcome indicators, when conducted in conjunction with an agency's input and output indicators, increases their policy relevance.
- Outcome indicators must be regularly reviewed and revised to maintain their objectivity and relevance.

4.1.3.3 *Industrial Economics, Inc. for U.S. Environmental Protection Agency*

In 2010, Industrial Economics, Inc. prepared a compliance indexing project for the U.S. Environmental Protection Agency. This study examined the potential benefits of replacing conventional measures of compliance, such as compliance rates, with compliance indexes, and reviewed case studies where this is being done. The paper states that “compliance rates are not flexible instruments (and) do not provide subtle measures of (compliance) performance...that are possible with compliance indexing.” Binary measures of whether an inspected vessel or facility was found to be in or out of compliance, in other words, are less useful for measuring performance than compliance indices which are expressed in the form of a number (e.g., 7.5 out of 10) representing the extent to which the vessel or facility is complying with “a pre-identified subset of the facility's overall set of compliance obligations”.

The authors examined the use of systems of weights assigned to specific compliance indicators that make up the compliance index to reflect their relative importance. “Such indicator weights can have a profound effect on the results of an index and reflect underlying priorities and value judgments concerning ...performance.” The use of weights in a fishery compliance indexing system can help guide compliance activities (facility and vessel inspections) to address more important types of violations in order to improve index-based measures of success.

Based on the review of case studies, this report identified four major categories of consideration when considering the use of compliance indexes rather than overall or regulation-specific binary measures of compliance rates:

- 1) Use of Indexes
- 2) Selection of Indicators that make up Indexes
- 3) Data collection
- 4) Weighting of indicators

Based on case study results, the report concludes that key factors that affect the success of developing and using a compliance indexing system include:

- Selection of whether indicators that make up the index focus on all or a subset of regulatory requirements
- Keeping indicators up to date
- Selecting facilities to include in data collection
- Streamlining and managing data collection efforts
- Maintaining objectivity in the data collection process
- Importance of transparency in the weighting scheme
- Role of stakeholder outreach in developing the weighting scheme

The use of indices for fisheries compliance measurement is intuitively relevant since implicit in the risk assessment frameworks that underpin most fisheries management regimes is the reality that not all regulations are enforced equally.

4.1.4 Fisheries compliance outcome measurement systems developed or in use

There are large volumes of literature that have been written on the methodologies and assessment and reporting frameworks for evaluating the effectiveness of programmes using outcome measures. Health and finance have been a particular focus of attention. Literature relating to policing is less conspicuous, but not uncommon. The published literature specifically relating to fisheries compliance and enforcement however, is negligible. Of course, this is not to say that fisheries enforcement agencies have not engaged in this process, but if they have, their work in this area is not sufficiently mature to be publically accessible. The following sections describe the efforts of various enforcement agencies and accreditation bodies with respect to developing outcome measures.

4.1.4.1 U.S. Coast Guard

The US Coast Guard (USCG) has a publically available outline of performance measures, metrics and targets for their activities (United States Coast Guard 2004). They have three goals:

Goal 1: To prevent illegal encroachment of the U.S. Exclusive Economic Zone by foreign fishing vessels, with the performance measurement being to reduce detected incursions by foreign fishing vessels illegally fishing inside the U.S. Exclusive Economic Zone (EEZ), to 185 or less by 2014;

Goal 2: To effectively enforce federal regulations that provide stewardship of living marine resources and their environments, with performance measurement being to maintain a 97% or better observed compliance rate in U.S. domestic fisheries; and

Goal 3: To ensure compliance with international agreements for the management of living marine resources, with performance measured only on an as-needed basis when resource commitment is significant enough to track performance.

Each of the performance targets, but particularly those for Goals 1 and 2, have several input, output, outcome and “efficiency” indicators that feed into the performance result (Table 4.3).

Table 4.3: USCG metrics and types of indicators for Goal 2 (97% or better compliance rate) of their Ocean Guardian program. Derived from USCG (2014). Tier I refers to measures reported outside the USCG via the annual performance reporting system. Tier II refers to measures to evaluate Tier I results and better link Tier I results to USCG performance. Tier III are measures designed for monitoring internal program performance and are not normally reported outside of the USCG.

Metric	Type	Tier
Observed domestic fisheries compliance rate (1-significant violations/domestic fishing vessel boardings)	Outcome	I
Total domestic fisheries enforcement resource hours (shore-based boats, cutter and aircraft hours)	Input	II
Number of active commercial fishing vessels by major fishery	Input	II
Number of domestic fishing vessel boardings by major fishery	Output	II
Boarding rate – Boardings/Active Commercial Fishing Vessels by major fishery	Output	II
Number of significant violations by major fishery	Output	II
Return on investment - Number of significant violations/Domestic Resource Hours	Efficiency	II
Status of fish stocks	Outcome	II
Training Performance - Number of USCG staff trained at Fisheries Training Centers	Input	III
Training Return on Investment – Cost per person of training at Fisheries Training Centers	Efficiency	III
Marine Affairs Program Progress – No. of Marine Affairs graduates on active duty	Input	III
Marine Affairs Program Productivity - % of Marine Affairs graduates in Marine Affairs coded billets	Efficiency	III

Another USCG study (Palin et al. 2012) notes that the USCG “has not adopted an explicit data-informed strategy of deterrence,” and as a result, “outcomes of USCG compliance activities are uneven, measurement is not possible, and continual improvement is accordingly difficult.” The study recommends that the USCG develop an “explicit strategy of deterrence...that will identify specific expectations for the relationships between practice and outcomes and will track this relationship to support continual improvement.”

The study identified complementary theories of compliance/deterrence based on economics, psychology, and sociology and associated with the work of Becker, Kahneman, and Ostrom, respectively and recommended a strategy for putting these theories into practice using an indicator system they called DIME (Deterrence Integration Modeling Environment). When implemented as a

computer program, DIME becomes part of a continuous improvement feedback loop whereby USCG actions are performed, influences recorded, deterrence measured, and future actions informed.

The recommended indicators fell into three general categories:

- Instrumental – Probability of Detection, Level of Penalties, Anticipated gain
- Normative – Legitimacy, Procedural Justice, Equity
- Social – Morality, Social Pressure, Behaviour of others

The authors acknowledge that quantitative measures of legitimacy, morality, justice, social pressure, equity, and behaviour of others are difficult to define but included a list of fifteen survey questions that can be used to assess and compare changes in stakeholder perceptions of compliance factors that cannot be observed directly, such as legitimacy and behaviour of others. Changes in answers to these questions can be treated as intermediate outcome measures that may be linked to specific compliance activities.

4.1.4.2 U.S. National Oceanic and Atmospheric Administration

In 2013, the U.S. National Oceanic and Atmospheric Administration (NOAA), Office of Law Enforcement (OLE) undertook a project titled "Establishing Meaningful Metrics" which was designed to help NOAA respond to Executive Branch requests for all federal agencies to illustrate how they planned to undertake "performance based management." Although, that project never resulted in a publicly released final project, it did result in a publicly released list of preliminary measures related to enforcement, primarily fishery enforcement, that project team members identified as being potentially meaningful for purposes of prioritizing and managing enforcement activities. The draft set of measures to help prioritize and track NOAA's fishery enforcement efforts was organized as follows:

- Fishery enforcement "Activities" were grouped into five major categories: Patrol, Monitoring, Inspection, Investigation, and Compliance Assistance.
- The same four categories of Possible Outcomes/Impacts were identified for each activity: Sustainable Fisheries Impacts, Protected Resources Impacts, Economic Impacts, and Compliance Rate Impacts. Specific metrics of Possible Outcomes/Impacts were not identified.
- Sets of possible metrics associated with inputs and outputs were specified for each activity and include such measures as:
 - Total number of air patrols; results of air patrols.
 - Total number of sea patrols; number of vessels inspected.
 - Total number of land patrols; number of vessels and other entities inspected.

- Number of complaints generated from VMS and other monitoring.
- Number of interventions that help industry comply with regulations (e.g., warnings).
- Compliance Assistance, including formal outreach events and education (e.g., avoiding gear conflicts, complying with VMS regulations) and participating in council/industry meetings.
- Numbers and types of inspections related to: Gear, Area, Prohibited species, Undersize, Over limit, Condition of fish, Permits, Recordkeeping, False statement, Observer issues, VMS, Sanctuary/ violations.
- Numbers and types of violations detected and regulations cited.
- Total number of vessel boardings (VB).
- Total number resulting in violation detection (VBV).
- VBV/VB = Observed compliance rate for vessels.
- Total number of dealer inspections (DI).
- Total number resulting in violation detection (DIV).
- DIV/DI = observed compliance rate for dealers.
- Total number of Civil/Administrative and Criminal investigations initiated.
- Total number of investigations forwarded to NOAA OLE for prosecution.
- Total number of investigations closed by OLE.
- Total number of investigations declined by prosecution.
- Total Summary Settlements issued by OLE.
- Total Notices of Violation and Assessment issued by the General Counsel.
- Total indictments.
- Total number of arrests.
- Total number of search or admin warrants executed.

It is noteworthy that although the project identified four categories of potential outcomes/impacts (Sustainable Fisheries Impacts, Protected Resources Impacts, Economic Impacts, Compliance Rate Impacts), all of the specific metrics identified as being meaningful are inputs and outputs, not outcomes/impacts. Discussions with NOAA enforcement staff involved in this project indicate that the project team did not recommend using metrics of enforcement outcomes primarily because they were either not measurable or not clearly attributable to enforcement activities (e.g., protected resource, sustainable fisheries impacts, economic impacts).

4.1.4.3 *DGR Consulting Report*

The firm 'DGR Consulting' was engaged in the development of fisheries compliance performance indicators for all Australian fisheries jurisdictions (DGR Consulting 1996). Their report outlines a number of draft performance indicators that were formulated during the course of a workshop and which were deemed by the participants to be suitable for use nationally. The workshop identified nine goals (termed 'success' in the document), each with their own indicators/evaluators of performance (Table 4.4). Although some elements or close derivatives of these performance indicators have been used in some Australian jurisdictions, many of the indicators placed heavy reliance on focus groups and these have not been taken up by any jurisdiction.

Table 4.4: Performance indicators for Australian fisheries jurisdictions as recommended by participants at a workshop held on 27 and 28 November 1996 (DGR Consulting 1996).

Goals (Success)	Performance indicators
Compliance: High level of compliance with regulations	<ul style="list-style-type: none"> • % and number of target groups who comply with regulations, categorised by a) groups (commercial and recreational) and b) fishery • Qualitative evaluation using focus groups with industry and field staff
Deterrence: Target groups perceive a high probability of detection	<ul style="list-style-type: none"> • % and number of target group members who perceive a high probability of detection, categorised by target group, using surveys • Qualitative evaluation of community perceptions using focus groups
Stakeholder satisfaction: High level of community support for compliance programs	<ul style="list-style-type: none"> • % change and number of 008 reports (report illegal fishing hotline) • Qualitative evaluation using structured interviews and focus groups with stakeholders e.g. volunteers
Prosecutions: High level of success in prosecuting High quality case preparation	<ul style="list-style-type: none"> • % and number of matters found proven • Qualitative evaluation using focus groups with prosecutors, on evidence quality and brief preparation
Inspections/Investigations: Highly successful and focussed inspections	<ul style="list-style-type: none"> • % and number of offences detected per inspection, categorised by group and type of offence
National Co-operation: High level of national coordination of compliance programs and information	<ul style="list-style-type: none"> • % and number of successful operations which involved shared information
Efficiency: Reasonable cost of compliance to the a) agency and b) industry	<ul style="list-style-type: none"> • Ratio of costs to Gross Value of Production (GVP), categorised by fishery
Awareness: High level of awareness among community and target client groups	<ul style="list-style-type: none"> • Qualitative evaluation using focus groups of community and target group members
Appropriateness: Policy and legislative framework is appropriate	<ul style="list-style-type: none"> • Outcome of legislative review • Qualitative evaluation using focus groups with compliance staff

4.1.4.4 *Marine Stewardship Council*

A third source of compliance and enforcement performance indicators are those recognised by the Marine Stewardship Council (MSC) in their assessments of commercial fisheries seeking accreditation (Table 4.5). Their performance indicator PI 3.2.3 is “monitoring, control and surveillance mechanisms ensure the fishery’s management measures are enforced and complied with.” They have a number of scoring issues that fall within the overarching performance indicator,

with detailed performance indicator scoring guidelines attached to each issue (Table 4.5). The MSC performance indicators are neither output nor outcome focussed, but are performance standards against the scoring guidelines. They are, however, worth considering here, because they could contribute to formulating the reasons for developing indicators in Section 4.1.3.1 (i.e., articulating risk or goals and aligning those with business intent).

Table 4.5: The Marine Stewardship Council’s compliance and enforcement performance indicator (3.2.3) and scoring guidelines against different scoring issues that fall within the scope of that indicator.

Compliance and enforcement indicator	Monitoring, control and surveillance mechanisms ensure the fishery’s management measures are enforced and complied with.		
Scoring issues	SG60	SG80	SG100
a. MCS implementation	Monitoring, control and surveillance mechanisms exist, are implemented in the fishery under assessment and there is a reasonable expectation that they are effective.	A monitoring, control and surveillance system has been implemented in the fishery under assessment and has demonstrated an ability to enforce relevant management measures, strategies and/or rules.	A comprehensive monitoring, control and surveillance system has been implemented in the fishery under assessment and has demonstrated a consistent ability to enforce relevant management measures, strategies and/or rules.
b. Sanctions	Sanctions to deal with non-compliance exist and there is some evidence that they are applied.	Sanctions to deal with non-compliance exist, are consistently applied and thought to provide effective deterrence.	Sanctions to deal with non-compliance exist, are consistently applied and demonstrably provide effective deterrence.

Compliance and enforcement indicator	Monitoring, control and surveillance mechanisms ensure the fishery's management measures are enforced and complied with.		
c. Compliance	Fishers are generally thought to comply with the management system for the fishery under assessment, including, when required, providing information of importance to the effective management of the fishery.	Some evidence exists to demonstrate fishers comply with the management system under assessment, including, when required, providing information of importance to the effective management of the fishery.	There is a high degree of confidence that fishers comply with the management system under assessment, including, providing information of importance to the effective management of the fishery.
d. Systematic non-compliance	There is no evidence of systematic non-compliance.		

4.1.4.5 *Australian Fisheries Management Authority*

The Australian Fisheries Management Authority (AFMA) has produced a Policy and Guide for the Development of Performance Indicators for Fisheries Compliance (Spencer 2013). This document represents the most comprehensive attempt we have found to apply best practice for performance indicators to a fisheries compliance context. It draws on advice provided by INECE and Malcom Sparrow and highlights many of the challenges faced by trying to evaluate the performance of fisheries compliance programmes.

The report contains a number of relevant case studies from commercial fisheries around the world and concludes that "Fisheries (and other) regulators are forced then, to seek alternative indicators of the performance of their compliance and enforcement programs. By utilizing combinations of indicators which;

- Are linked directly to objectives,
- Are outcome based wherever possible,
- Are problem specific, and
- Are principally designed to improve effectiveness.

then we can be reasonably assured that we have an effective performance measurement program in place."

The report highlights the importance of seeking final outcome indicators, and AFMA’s own ‘show cause’ program has exemplified the design and use of a robust intermediate outcome indicators; however, the quest for good final outcomes indicators still remains.

4.1.4.6 *Victorian Auditor General*

The Victorian Auditor General reviewed Fisheries Victoria’s performance in a report published in 2012 (Victorian Auditor-General 2012). The audit found “Fisheries Victoria has a comprehensive and transparent process that involves analysing compliance intelligence, data and information... [that] it regularly assesses and evaluates its performance which makes its approach to compliance risks and resourcing responsive and adaptive... [and that] it has an effective, evidence-based approach to planning and targeting its educational and advocacy compliance activities to the issues and community groups where these will be most effective.” (VAG, 2012). The report highlighted that further work was required to develop the risk-based regulation approach further to identify “a core set of compliance outcomes” as well as “relevant, appropriate and representative compliance performance measures of effectiveness against the outcomes and compliance objectives” (VAG, 2012, p.xii).

4.2 Survey on aspects relating to output and outcome indicators collected by a limited sample of fisheries compliance agencies

After receipt of the ‘warm-up’ letter (described in Section 3.2), a few of the international participants declined to complete the survey. They did not specify their reasoning, but it is our assumption that fisheries organisations that were using excellent compliance outcome indicators are likely to recognise their value and would be prepared to share them with other regulators – either through this survey opportunity, by publication in peer-reviewed literature or through the many formal networks that exist between compliance practitioners. The survey itself was emailed to all participants in October 2014; the agencies that completed and returned it are listed in (Table 4.6). There were some agencies (one national and several international) that agreed to complete the survey, but later failed to do so despite follow-up reminders.

Table 4.6: Jurisdictions that responded to the electronic survey aimed at collecting general information on fisheries agencies and their interest/involvement in collecting and applying enforcement performance indicators.

Jurisdiction	Agency Name
New South Wales, Australia	Department of Primary Industries, New South Wales Government
Victoria, Australia	Department of Environment and Primary Industries,

	Victorian Government
Tasmania, Australia	Water and Marine Resources Division, Department of Primary Industries, Parks, Water and Environment, Tasmanian Government
Queensland, Australia	Department of Fisheries and Forestry, Queensland Government
Western Australia	Department of Fisheries, Western Australian Government
South Australia	Primary Industries South Australia, South Australian Government
Commonwealth Fisheries, Australia	Australian Fisheries Management Authority, Australian Government
New Zealand	Ministry of Primary Industries, New Zealand Government
Spain	Ministry of Agriculture, Food and Environment, Spain
Scotland	Marine Scotland
Norway	Directorate of Fisheries, Norway
Canada	Fisheries And Oceans Canada

In the following sections, the survey results are presented according to the seven subsections of the survey. Not all answers to questions are presented below because some questions asked for background information. In some cases, answers to questions have been displayed, but not in full – for example countries/states/organisations have been omitted from the bar charts. This was done wherever we felt that there was potential for organisations that completed the surveys to be identified by the results.

4.2.1 Survey Section 1: Your agency

Question 1 provided background information on the size of the fisheries and the corresponding management bodies: Gross Value of Production (GVP) of the resource, operating budget, numbers of full time equivalent (FTE) staff and number of FTEs dedicated to fisheries compliance. Several agencies asked for these data to not be part of the report, therefore specifics are not presented here.

The intent of Question 2 was to get an overview of the extent and diversity of compliance responsibilities managed by the organisations surveyed. Table 4.7 shows the number of respondents that affirmed their organisations' involvement in the different areas of compliance in international, national and state/regional capacities. The figures are only indicative, because for example, Tasmanian fisheries compliance responsibilities are shared by Marine Resources, Marine Farming

and Tasmania Police, but only the Marine Resources part of the organisation was surveyed. Even acknowledging these deficiencies, the Table gives an indication of the wide spread of responsibilities owned by many fisheries compliance agencies.

Table 4.7: Responsibilities of fisheries compliance agencies surveyed, broken down by whether these are international, national or state/regional obligations. Note that a single agency could be responsible for one or more categories in international, national and state/regional waters.

Responsibility	International	National	State/Regional
Commercial Fishing	6	9	8
Recreational Fishing		6	8
Land and Sea based Aquaculture		4	8
Customary, Indigenous, or Artisanal Fishing	1	7	8
Marine Parks and/or Marine Reserves	1	5	5
Marine Safety		2	2
Emergency Response		2	4
Biosecurity		3	5
Border Security	2	2	
Wildlife/Terrestrial Park Management			1
Policing	1	1	1

4.2.2 Survey Section 2: Your role in your agency

Question 5 had two parts. The first asked respondents about whether they considered their agency to be doing a good job ensuring that fishers abide by the rules. Ten of 12 respondents felt that their agencies were doing a good job with that, while two felt that their agency was partially doing a good job. A number of different externally audited (or similar) statements were cited as evidence (Table 4.8). The responses to question 5 suggest that professionally, most fisheries agencies are probably doing very good work, but that it is difficult to show in an auditable way (Table 4.8).

Table 4.8: Selection of statements from different agencies referring to published or unpublished audit (or similar) reports

Country/ State	Published or Unpublished Audit Report
NSW	Self-assessment using the NSW Department of Premier & Cabinet's Quality Regulatory Services Initiative Diagnostic Tool. (Unpublished). Ref: http://www.dpc.nsw.gov.au/programs_and_services/better_regulation/quality_regulatory_services_initiative
AFMA	http://www.anao.gov.au/~/_media/Uploads/Documents/2008%2009_audit_report_4

	7.pdf http://www.anao.gov.au/~media/Files/Audit%20Reports/2012%202013/Audit%20Report%2020/Audit%20Report%20No%2020.pdf
DoFWA	Office of the Auditor General report 2009
Queensland	Wildlife Trade Operation accreditations under the EPBC Act assessments have a compliance component.
SA	Compliance plans and scorecards are reviewed annually by each commercial fishing sector and the majority accept the direction, effort and outcomes. Over the past 5 years all compliance activity has been directed to ensure everyone knows the rules to maximise voluntary compliance as a first principle
Scotland	We are audited by the European Union and also by internal audit. We have no externally available supporting documents.
Victoria	Victorian Auditor General Office 2012-13 Performance Report. The Fisheries Victoria compliance function was rated well in the audit, "Fisheries Victoria has a comprehensive and transparent process that involves analysing compliance intelligence, data and information... [that] it regularly assesses and evaluates its performance which makes its approach to compliance risks and resourcing responsive and adaptive... [and that] it has an effective, evidence-based approach to planning and targeting its educational and advocacy compliance activities to the issues and community groups where these will be most effective." (VAG, 2012)
Spain	As Member State, Spain is audited by the European Commission in order to verify that our Administration is complying with the fisheries control law in the European Union, and also in relation with the international obligations committed by the European Union.

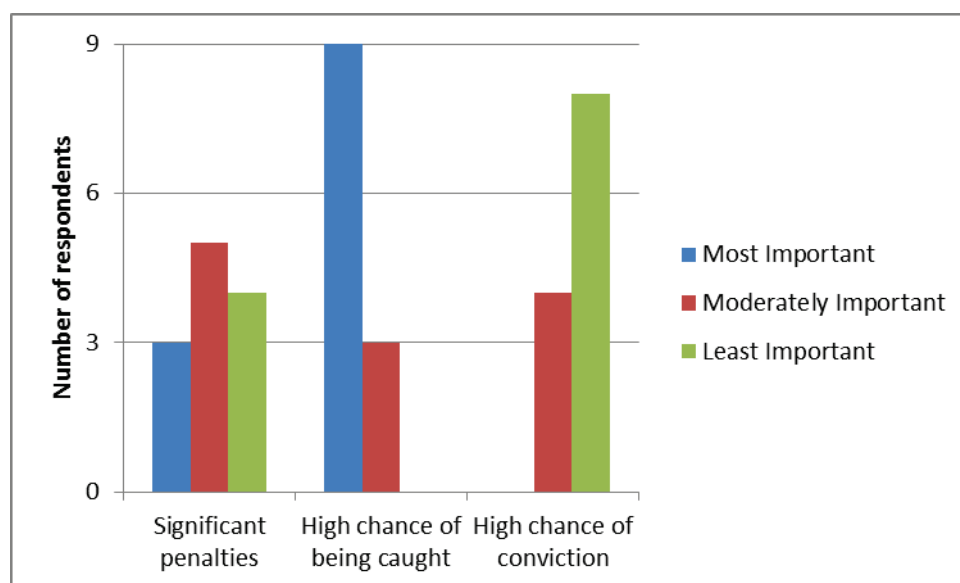
4.2.3 Survey Section 3: Working relationships with your law enforcement/compliance branch or division

Question 9 asked whether the agency responsible for fisheries management changes considers the responding agency's experience before making changes. For the most part, respondents indicated that their compliance groups are consulted by the management/policy branch within their agencies prior to management changes being made. Eight out of twelve reported being fully consulted and four being partially consulted.

Question 12 asked respondents whether their programs had been audited against a risk assessment standard. All but one respondent indicated that they had not. These responses link to questions later in the survey that show that outcome based management is in its infancy in most fisheries compliance agencies and that to date this form of management has been developed in isolation in the different agencies.

Deterrents against illegal fishing activity are important for compliance groups when considering proposed management changes. It is well recognised that there are three pillars in creating an effective deterrent: the size of the penalties, the chance of being apprehended and the probability of being convicted if caught. In question 14, respondents were asked to rank these factors as deterrents for illegal fishing, with 1 being the most important and 3 being the least important. Most respondents felt that a high chance of being caught was the most important deterrent (mean response = 1.3), but significant penalties were also rated highly (mean response = 2.1) (Fig. 4.3). High rates of conviction were mostly rated lowest, occasionally second lowest and never highest as a factor (mean response = 2.7). It is possible that the relatively low rating attributed to a high rate of conviction may be because the Australian and four international fisheries agencies are generally successful in getting convictions. It would be of interest to explore whether this factor might rank higher as a form of deterrent in countries where convictions are less successful.

Figure 4.3: Barchart showing the responses to the question of which factors are the most important in deterring illegal fisheries activity ($n=12$).



Question 15 enquired about the tools directed at the public that each agency uses to seek maximum voluntary compliance. An open free text response option was given to allow agencies to tell us about approaches we had not considered and 3 agencies told us that they use social media tools. Results are presented in Table 4.9. A related question, number 26 (discussed in Section 4.2.5, below), asked about compliance tools each agency uses to engage fishers.

Table 4.9: Tools directed at the public by agencies seeking to maximise voluntary compliance

Tool	Number of agencies using tool
a. School education programs	7
b. Fishing rule guides	11
c. Media bulletins	10
d. Electronic apps	6
e. Other (social media)	3

4.2.4 Survey Section 4: Your agency's enforcement and its enforcement performance measurement

In general, the costs of enforcement and compliance work are not charged back to stakeholders (Question 17). Only two respondents indicated that that is the case, while one indicated that stakeholders are partially assessed, and nine indicated that stakeholders are not assessed. Question 18 asked what percentage of the compliance staff budget in each of the fisheries surveyed was allocated to support analysts. The percentage of compliance staff budget allocated to support analysts varied across 11 different agencies for which we had data, from 0 to 55% (mean=15%).

The data from question 1 regarding staff size and the value of the fisheries managed were used to examine whether there was any relationship between the size (FTEs) of the fisheries agencies or the value of the fishery (GVP) and the percentage of compliance staff budget allocated to support analysts (Question 18). It might have been expected that larger/more valuable fisheries might have had greater capacity to employ analysts, or conversely, that smaller less valuable fisheries might have considered analysts a more cost efficient way of monitoring compliance in their fisheries. Neither of these hypotheses proved correct – there was no obvious trend to the proportion of analysts on staff across the different fisheries surveyed.

Respondents were quizzed on what input, output and outcome measures they collected out of lists provided in questions 19, 20 and 21, and they were asked to describe how data are categorized: in general (i.e., not categorised by sector or fishery), by sector (i.e., categorized by commercial, recreational, etc.), or by fishery (i.e., categorised by stock, gear type, etc.). The numbers of agencies that recorded the particular measures in the lists provided are outlined in Figs 4.4, 4.5 and 4.6.

There were generally high numbers of input statistics collected by the agencies surveyed (Fig. 4.4), which is not surprising given that there has been a long history of recording these statistics in most organisations. Similarly, there were a high number of output measures recorded (Fig. 4.5) by the

different agencies surveyed. The number of agencies recording the list of suggested outcome measures was unsurprisingly, substantially lower than for inputs and outputs (Fig. 4.6).

With the outcome measures that were confirmed as being collected, it was not always clear how the information would have been processed to deliver the measurement. The most commonly collected output measures – changes in stakeholder behaviour as a result of your activity, negative outcomes (e.g., avoidable acquittal, failed prosecution), and total fishery illegal take (e.g. estimated illegal landings in tonnes) are difficult to measure. Illegal take formed the basis of much of the literature review in 4.1 and this section highlights some of the measurement difficulties.

Figure 4.4: Input measures and the number of agencies surveyed that collect data on them

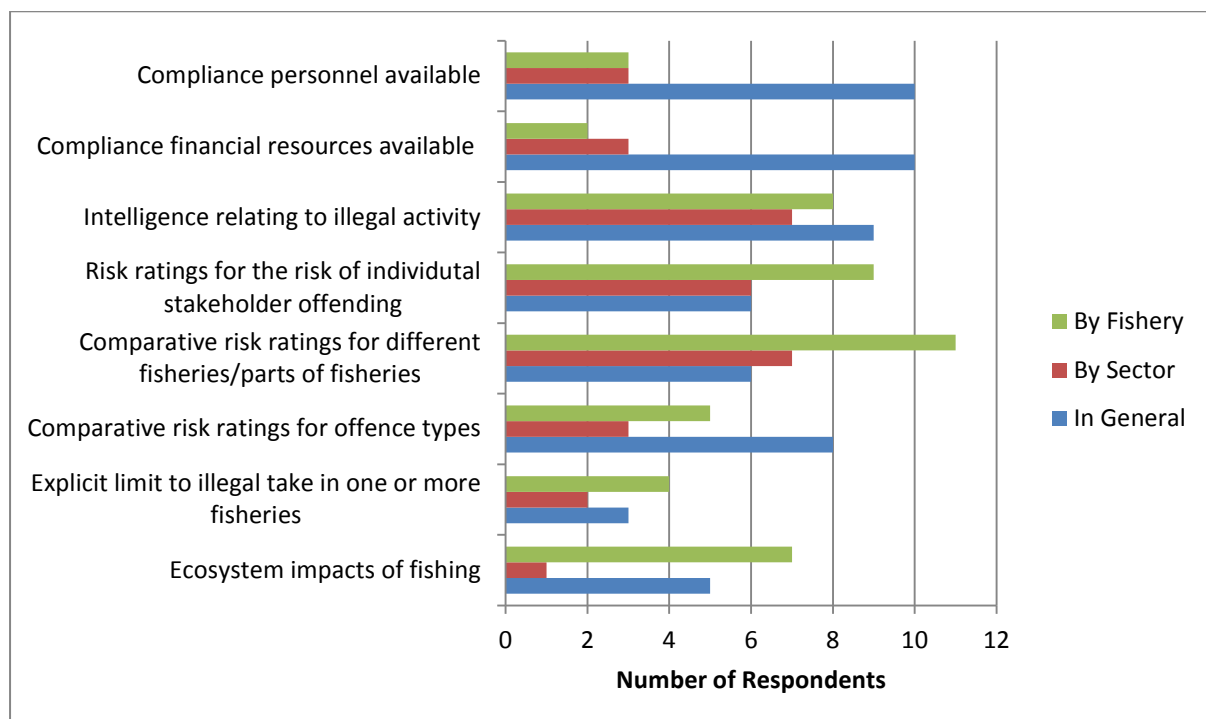


Figure 4.5: Output measures and the number of agencies surveyed that collect data on them

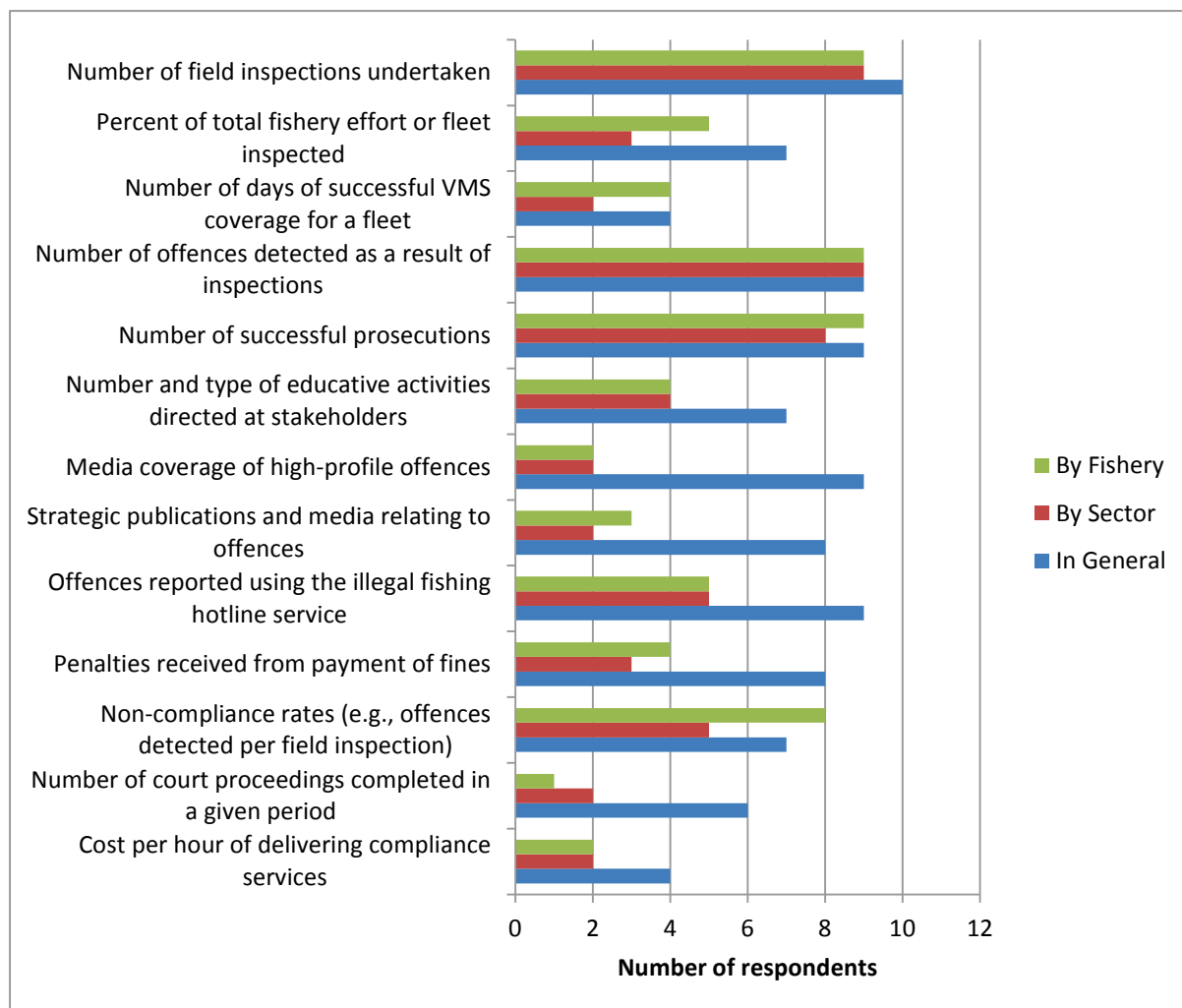
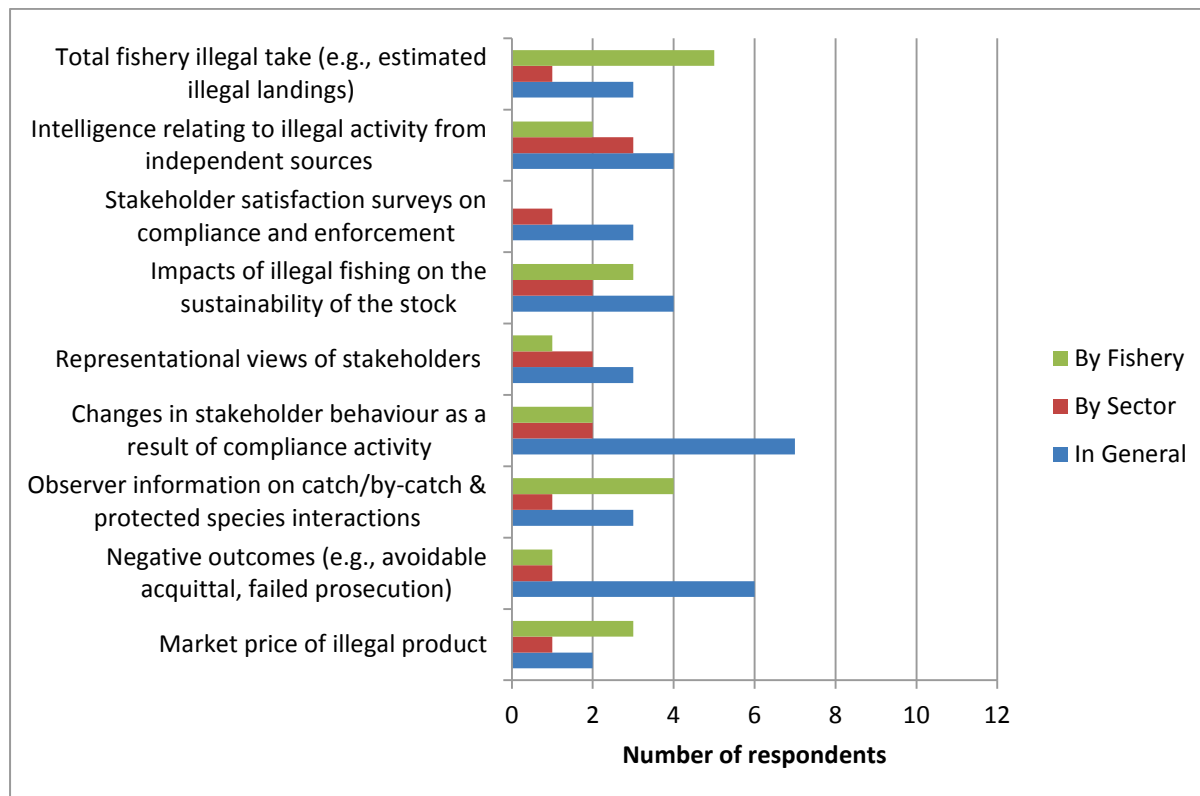


Figure 4.6: Outcome measures and indicators and the number of agencies surveyed that collect data on them (N=12)



Question 22 asked respondents about whether they undertake planned deployments of compliance resources in order to try and quantify the extent to which an identified risk is actually occurring. One form of these deployments could be statistically designed compliance operations. Nine out of 12 respondents indicated that they did so, and in answer to part (b) of the question, eight of the nine respondents that indicated that their agencies undertake these sorts of operations also stated that they repeat these ‘experiments’ to test whether the situation has changed. Repeat ‘experiments’ such as this have the potential to be used as an outcome indicator indicating changed stakeholder behaviour.

Question 24 asked whether agencies are able to reprioritise their compliance assets in response to changing risk. All but one respondent indicated that their agency has that ability. A follow-up question sought examples of how this has been done. Responses were varied, but included such triggers as spikes in intelligence, monthly meetings to discuss emerging issues, high levels of noncompliance reported by the industry and noted by compliance officers, etc. Responses to these triggers included reallocation of assets (e.g., compliance officers, vessels, aircraft), implementation of a risk assessment process and increased presence of observers, undercover operation followed by

increased education, creation of a dedicated task force to assess the issue, rule changes in the affected fishery, etc.

Question 25 asked whether any fisheries within the responsibility of each agency are accredited for sustainability by an external assessor. Nine of the twelve respondents indicated that one or more of their managed fisheries are accredited, primarily by the Marine Stewardship Council.

4.2.5 Survey Section 5: Your agency's enforcement tools and capabilities

The enforcement agencies surveyed use a wide range of tools and capabilities in the course of their work. At least one or more respondents recorded the use of the compliance tools provided as options in question 26. Table 4.10 lists the compliance tools and capabilities included in the survey and the number of agencies using each.

Table 4.10: Agency use of various compliance tools organized according to frequency of response, grouped by number of agencies reporting the use of each tool

Compliance Tools	# of respondents using tool
Strategic communications; Factory & wholesaler inspections; VMS; Strategic risk assessment	11
Tiered penalties; Land patrols; Education & awareness programs; Sea patrols; Illegal fishing reporting hotline; Roadside checks; Dedicated intelligence analyst functions	10
Undercover operations; Illegal fishing telephone hotline; Operational risk assessment; Covert surveillance using compliance staff; Covert surveillance using remote optical devices	9
Fishing licenses (fee for license); Manned aerial surveillance; Inland waterway patrols; Use of fishery observers; Social media communications; Retail outlet inspections	8
Dedicated volunteer programs	7
Informant management programs	6
Demerit point system (for licenses); Covert tracking devices	5
Communication intercepts; Strategic driver analysis	4
Public weigh stations; Covert CCTV monitoring; Mandatory no-fee fishing registers	3
Unmanned aerial surveillance; Reward-for-information programs	2
Stock traceability/DNA species register	1

4.2.6 Survey Section 6: Level of interest in compliance outcomes measurement

In answering question 28, the respondents indicated their level of interest in compliance outcome measurement. There were none that had no interest, although it is unlikely that any with no interest would have taken the time to respond to the survey. Five of 12 were highly or vitally interested, while seven had moderate to low interest (Table 4.11).

Table 4.11: Answers to the level of interest that respondents attached to compliance outcome measurement.

Level of interest	Number of respondents
None	0
Some	3
Moderate	4
High	4
Vital	1

Question 29 explored how far the agencies that were surveyed had progressed with development of compliance outcome measures. Most (nine out of 12) had some measures and have plans to develop more (Table 4.12) but three agencies had not developed outcome measures. In the case of these three, two had plans to develop outcomes in the future and one had no plans to develop any in the future.

Table 4.12: Selection of respondents to four different options as to the state of development of compliance outcomes by the agencies

Statements	Numbers that selected each option
We do not have any measures of compliance outcomes and have no plans to develop any in the future	1
We do not have any measures of compliance outcomes but are developing some to use in the future	2
We have some measures of compliance outcomes and don't plan to develop any more	0
We have some measures of compliance outcomes and are developing more to use in the future	9

4.2.7 Survey Section 7: Measures of successful compliance or enforcement activity

The survey was used to canvas views on outcome measurement and assess data that is collected by different fisheries compliance agencies. The opportunity was also used to ask respondents to provide relevant information on outcome indicators, impediments to their measurement and

guidelines or standards for their measurement (Questions 33, 34, 35). Several respondents provided useful details and relevant ones are reproduced in full below (Table 4.13, Table 4.13 and Table 4.14).

Table 4.13: Comments provided by survey respondents to question 33: Can you think of any possible novel compliance outcome indicators that the project could consider, especially if you are using them, or if you have some experience with using them?

-
- <http://www.search.org/files/pdf/PMTechGuide.pdf>
 - http://inece.org/principles/PrinciplesHandbook_23sept09.pdf
 - <http://www.inece.org/indicators/guidance.pdf>
 - We are currently investigating the potential of Market and Quota Price indicators, including potential impact on GVP of various rates of quota evasion.
 - According to the NSW Treasury document (What you do and Why, An Agency Guide to Defining Results and Services) an outcomes is a measurement of "whether the skills, attitude, behaviour or circumstances of the target group or community in general have changed".
 - Quality Regulatory Services Initiative - NSW Department of Premier and Cabinet. Guidelines for Risk Based Compliance. Note these are compulsory for all NSW regulators from December 2014.
http://www.dpc.nsw.gov.au/announcements/circulars/2014/c2014-06_qu
 - Intelligence led model is good for developing information to assist risk profiling and assist develop better compliance effort models. Over time it will start to show trends from previous years and give an indication of compliance measures but has some flaws as there are a number of variables that can also change patterns (e.g. weather, environmental issues etc.). It is not a comprehensive measure of successful compliance activity.
 - Measures of sustainability of the fishery. Some examples are in:
<http://www.daff.qld.gov.au/fisheries/monitoring-our-fisheries/data-reports/sustainability-reporting/performance-measurement-systems>.
 - Measuring fishers attitudes to compliance.
 - Measuring past levels of compliance without risk of complicity.
 - Use of intelligence and financial indicators. Generally these track trends in compliance rather than give absolute levels. I have found that these are more useful especially when used internally.
 - Using the amount (kg) of illegal fish relating to each offence and the spatial coordinates of each offence location, this information can be used to help authorities understand changes in compliance and that relationship with changes in species, amounts of illegal take and the locations of offences. It is important that these trends be understood in the context of potential effort biases in their detection – e.g. changes of staffing, changes in monitoring equipment etc.
-

Table 4.14: Comments provided by survey respondents to question 34: If you have identified any impediments to measuring successful compliance outcomes, please provide further details

-
- The main impediment is that much of the fishing activity (compliant or otherwise) occurs out of sight.
 - Changing the mindset of the regulators is the biggest barrier. People in regulatory organisations seem to still find it difficult to differentiate between outputs and outcomes. We have been good at recording our 'busyness' but not measures of success.
 - Business systems (IT) that are not easily used/accessed/integrated. Staff who do not buy in or understand the importance of the part they play (especially capturing information). Management likewise and who fail to lead a culture where this can grow, not having enough analytical grunt to develop processes and conflicting operational priorities where analysts are seen as back room 'boffins' and reassigned to front line/operational duties.
 - The majority of traditional compliance performance measures are input and output measures. The outcomes are most often more difficult to measure and are less able to be 'controlled' making managers reluctant to adopt them. Many true outcome performance measures are impacted by more than just the actions of the agency responsible for compliance (e.g. environmental factors) so agency managers are reluctant to have their 'performance' assessed based on these types of measures.
 - Outdated expectations that a low number of people prosecuted is a reflection of low non-compliance.
 - Limited/low public value rating to fishing rules.
 - Cultural attitudes and approach regarding right to take fish.
 - Most measurements can be interpreted in at least two ways. High or increased detection levels can be hailed as successful detection or a symptom of increased non-compliance. In the absence of supporting intelligence or other information either could be true. Some pressure groups deliberately use the published figures to try to promote their own interests which can make Governments wary of publishing too much.
 - Detectability.
 - Unreported victimless crime.
 - Cultural inertia – moving from old models to new models.
 - Traceability.
 - Budgetary – limited resources.
 - Technological – bureaucratic disruptions.
 - Lack of adequate survey programs.
 - Measuring changes in behaviours at a macro-scale.
-

Table 4.15: Comments provided by survey respondents to question 35: Please provide any additional information you think the project team may find relevant

-
- Refer to AFMA internal document, 'A policy and guide for the development and use of performance indicators for fisheries compliance'
 - Often properly researched and coherently collected internal indicator information is much more useful in trend analysis and resource deployment than anything that can be published. Publishing tends to be often a response to a need to justify expenditure and often focuses on "input" compliance measures rather than outcomes. Biological outcomes are the only ones that are absolute. Healthy fleet economics are sometimes proposed as an outcome measure, but they are vulnerable to a host of external factors such as alternative species fisheries, currency rates, technology changes, fuel prices
-

4.3 Workshop to review findings of the desktop study and add expert input

The workshop was held on Thursday, 13 November 2014. The affiliations of those who attended are presented in Appendix D. A copy of the agenda on the day is in Appendix C.

The workshop achieved a number of functions. It provided representatives of the fisheries enforcement community from Australia and New Zealand with an update on the project and ideas on the way forward. Just as importantly, it gave opportunity for discussion and contribution by the attendees to relate useful outcome measures that they are using, or ones that they believe may have potential for use in the future.

It was acknowledged that there is a need for outcome based management and in one instance there is a directive to implement outcomes and risk based regulation. In New South Wales, the Department of Premier and Cabinet has directed regulators to define the outcomes they seek to secure, to review outcome monitoring mechanisms and to commence reporting regularly on outcomes (Department of Premier & Cabinet 2014).

An unexpected finding from the workshop was the level of discussion generated by relating fisheries compliance outcomes to stock sustainability. Fisheries compliance is frequently linked to sustainability of fishing stocks and the legislated Ecologically Sustainable Development frameworks that give rise to fisheries regulation in Australia mean that this will not change. The workshop highlighted many aspects of fisheries compliance that are not about stock sustainability. Equity between sectors, ecosystem impacts, political and reputational imperatives and non-Fisheries responsibilities (such as emergency response) all shape how fisheries compliance is delivered. Further, stock sustainability is strongly impacted by factors outside of the control of organisations tasked with Fisheries compliance. Effort creep and environmental impacts were cited as common

reasons for sustainability pressures, and while excessive illegal fishing would undoubtedly be a bad outcome – both for fish stocks and regulator reputation, it was not immediately obvious how stock sustainability could be used as a robust, transparent measure of fisheries compliance outcomes.

Presentations by representatives of the Australian Taxation Office and the Australian Crime Commission gave participants an insight into more extensive process that needs to be followed in developing outcomes in a logical and structured way. The need for this structured, ordered process was highlighted in group discussions which revealed the diverse views about what good compliance outcomes would look like in practice.

4.4 Documenting best practice

Outcomes from discussions at the workshop (4.3) and from the survey of output and outcome indicators collected by national and some international fisheries compliance agencies (4.2) have provided this project with the status of outcome indicators across a selection of forward thinking compliance agencies. It has also allowed the status of outcome – based management in these organisations to be contrasted against work that has been done in this field in the Australian Taxation Office (ATO) and the Australian Crime Commission (ACC). Those two organisations have been active in the field of development of outcome based management for several years and have achieved a high level of practice that can be used as a benchmark for those newer to this subject.

To summarise previous sections (4.2 and 4.3), there are different levels of development of outcome indicators across compliance agencies within Australia and New Zealand. Several have outcome indicators and are developing more, while others have none but have plans to develop them. None have a comprehensive suite of compliance outcome indicators currently in place.

The experience of the ATO and ACC with the development of outcome indicators is that it is a task that needs to follow a comprehensive progression from conceptualisation through different iterations of refinement, all the way including consultation with staff/co-workers and stakeholders. This depth of representation required is also highlighted by the case studies covered in the work of Moore (2013) to ensure that outcome reporting remains balanced.

The lack of documentation on Departmental websites shows that agencies surveyed by this study that have outcome indicators are using them internally. They have yet to be used for reporting to stakeholders and for benchmarking against other organisations. Documenting best-practice is not possible until a speciality reaches a certain level of maturity and visibility. Only then can the generalisation, comparison and review processes begin that result in the formulation of best-

practice. In our opinion, Fisheries Outcome Measurement has not yet reached that level of maturity.

5 Conclusion

This report reviews work done to date on fisheries compliance outcome measurement. A review of published peer-reviewed academic literature found little guidance on how to implement fisheries compliance outcome measures, nor descriptions of suitable fisheries compliance outcome measures themselves. There has been some considerable work on quantifying illegal catch – which is one fisheries compliance outcome measure (section 4.1.2).

Outside the literature, we found that some compliance agencies, including fisheries, have made varying progress in developing compliance outcome measures, but that fisheries compliance has so far lacked the structure and rigour that has been applied to trying to measure policing outcomes using a public value approach (section 4.1.3).

In order to benchmark current practice with regards to fisheries compliance outcome measurement, a survey of fisheries organisations was conducted and their responses documented in section 4.2.

Finally a workshop was held with multiple fisheries regulation agencies as well as representatives from ATO and ACC in order to discuss development of outcome measures and explore best practice, as described in section 4.3.

Overall we find:

- For purposes of measurement and tracking compliance, outcomes fall into three general categories:
 - immediate (e.g., observed compliance rates),
 - intermediate (e.g., changes in behaviour such as increases in compliance rates), and
 - final (e.g., improvements in fisheries that result from increases in compliance rates).
- Measuring fisheries compliance outcomes is intrinsically difficult because fisheries compliance tackles harms that are invisible, can involve a conscious opponent and many of the harms only manifest themselves slowly.
- The survey conducted on local and international fisheries compliance agencies suggested that outcome-based management is in its infancy in most fisheries compliance agencies, but that most agencies had a high degree of interest in outcome-based compliance

management, and most (but not all) have developed or are attempting to develop compliance outcome measures.

- Compliance input and output measures reflect levels of effort aimed at achieving compliance outcomes, but do not reflect the extent to which those efforts are succeeding. However, they are important for interpreting changes in outcomes that may be influenced by changes in compliance inputs and outputs and many other factors, and for understanding biases in data collected.
- Fishery compliance outcome measures cannot be interpreted without an analysis of how other factors that affect conditions and behaviour in the fishery are changing. Increases in the observed non-compliance rate, for example, could reflect compliance activities being less effective at deterring violations, more effective at detecting violations, or it may reflect changes in other measurable economic, environmental, weather, or political factors that favour noncompliance regardless of compliance activity. Assigning causality of compliance outcomes to compliance activities requires examining potential impacts of these other factors on compliance outcomes.
- The workshop found that a comprehensive fisheries compliance outcome measurement framework needs to encompass more than just stock sustainability. Equity between sectors, ecosystem impacts, political and reputational imperatives and non-Fisheries responsibilities (such as emergency response) are all also important aspects of service delivery for fisheries compliance agencies.
- While the principles for developing useful fishery compliance outcome measures are the same across fisheries, the development and use of specific outcome measures in any particular fishery must depend on the factors that influence noncompliance, the ways compliance activities are attempting to affect them, and the particular regulatory regime for that fishery.
- The literature review, survey results and related discussions with, and presentations, by representatives of the ACC and ATO regarding outcome-based management provided essential insight and perspectives about productive next steps. These are described under the recommendations heading (see 7.0 below).
- Although ongoing work is being undertaken by fisheries compliance agencies both in Australia and internationally, much of it is in relative isolation. There is considerable potential for shared learning in this area, especially in the recruitment of external expertise to assist with developing performance measurement programs that focus on outcome measures.

- The quest for informative outcome measures is unlikely to replace the traditional use of input and output measures in assessing Agency performance. Input and Output measures still have a role to play in giving context to more subtle, and longer term outcome measures. They are also necessary for operational monitoring of processes within the organisation. Rather, the development of outcome measures for fisheries compliance will reduce the reliance on output measures which often do not stand up under close scrutiny to the performance claims that are being made from them.
- We did not find any evidence that compliance outcome measures are widely used to guide fishery compliance management decisions, and given the long timelines likely to be associated with final outcome indicators, they may have limited practicality in some fisheries decision-making processes.
- The project has clarified the methods that could be used to develop compliance outcome measures. The project also established the types of data that are being collected by fisheries compliance agencies that are suitable for implementing outcome-based management and the extent to which these data are being used (i.e., current best practice) to manage and prioritize compliance activities.
- There is common interest among fisheries compliance agencies in working together to improve and standardize the use of outcome measures so they can become a reliable and integral part of fishery compliance management. Results from the literature review and survey that were conducted as part of the project assured project participants from various agencies that “lessons learned” from similar efforts in Australia and elsewhere around the world provide a solid basis for moving ahead.
- Although statistical modelling has been used to estimate illegal catch and uncertainties around the estimates, there is also some promise in using modelling to simulate the long-term beneficial outcomes of compliance activities using estimates of reductions in illegal harvests that result from compliance activities as increases in measures of fish abundance in conventional and widely available fishery models. Intermediate compliance outcomes associated with reductions in illegal catches, when treated in conventional bio-economic fishery models as increases in the biomass of fish left in the ocean to grow and spawn, can be shown to generate measurable long-term beneficial outcomes in terms of improved conditions in fisheries, fishing communities, and seafood markets.

Specifically, improved compliance in fisheries that results in reductions in illegal catches and associated increases in the abundance of fish in future years can be expected to result in the following long-term beneficial and measurable outcomes:

- Increases in the expected allowable harvests;
 - Less need for stringent fishing restrictions;
 - Reductions in the uncertainty of catch statistics used in fishery monitoring and stock assessments;
 - Higher catch rates and earnings for law-abiding fishermen;
 - Higher sustainable legal harvests resulting in lower seafood prices for consumers;
 - Reduced economic incentives for illegal fishing; and
 - Reduced numbers and severity of convictions.
- We find the discipline of fisheries compliance outcome measurement in a fragile state. It needs nurturing and encouraging if it is to reach its potential and develop measures that withstand scrutiny from all stakeholders and especially from the spotlight of academic researchers from such disciplines as governance, risk analysis, sociology, criminology and economics. While it is tempting to interpret non-response to our surveys from some international jurisdictions as evidence of limited interest in developing fisheries outcome measures, we find sufficient evidence from other disciplines to indicate that this is incorrect: fisheries compliance outcome measurement is necessary and possible, although certainly not easy. We hope that those who are indifferent to the way fisheries compliance might be currently delivered by an agency can look to this report to support development of measures of fisheries compliance outcomes that all agree are valid, because then it is in everyone's best interests to see that such measures demonstrate consistently good performance. Until such time as robust fisheries outcome measures are developed, we suggest that benchmarking agencies by comparing reputation, capability and efficiency against other Fisheries agencies with similar responsibilities will be necessary, unless the assessors have a detailed understanding of compliance theory.

6 Implications

It is too early in the development of Fisheries compliance outcome measures to be able to document best practice.

Fisheries compliance agencies cannot currently assure all their stakeholders that they are being effective in their mission because of a lack of established, visible, best-practice in compliance

outcome measurement for fisheries. In lieu of such best-practice, the best that can be done is to benchmark against what other fisheries compliance agencies are doing. Equally, fisheries compliance agencies should not seek to overstate their achievements on the basis of inconclusive data.

Specialised measurement programs and methodologies such as quantitative risk management, stakeholder surveys and program logic models would be helpful in developing useful outcome indicators. Expertise in these areas may not reside within agencies responsible for fisheries compliance so some external assistance could be required.

From the evidence found by this project, Australia does not seem to be lagging in the area of fisheries compliance outcome indicators and could even be seen as leading a developing field.

The cost and complexity of measuring compliance outcomes will almost certainly prove to be barriers to developing useful measures for some fisheries.

The challenge of 'measuring the unmeasurable' is shared by other areas of regulation (especially policing) and future work should seek assistance from the academic community in areas such as public value, uncertainty, quantitative risk assessment and decision theory to ensure that the best tools available are being used when designing and evaluating compliance programs.

Any area of regulation that shares:

- Low inspection rates (compared to total opportunities for offending)
- Remote locations which are hard for regulators to access
- High opportunity benefit from offending
- Lack of ready quantification of illegal activity or harm
- Variable or unknown offence detection rates

will likely benefit from some consideration of the issues covered in this report.

7 Recommendations

1. Weight of Evidence Approach

Since we have found little in the way of robust, mature fisheries compliance outcome indicators, until such indicators exist, we recommend that suites of indicators be used in a 'weight of evidence' approach when trying to assess compliance performance and attribute outcome changes to compliance activities. For example, it may be impossible to calculate the illegal take from a fishery with any degree of certainty, but if fishers are reporting large numbers of illegal

fishing incidents, the observed non-compliance rates and offence types suggest large quantities of fish are being taken illegally, and if compliance officers are not focussing on small pockets of isolated noncompliance, then it should be reasonable to assume that there is a problem with non-compliance in the fishery. By considering these multiple strands of evidence some degree of confidence could be placed on whether or not the situation warrants intervention, especially if viewed in conjunction with biological information such as stock abundance and accessibility. On re-evaluation of the situation after time, a judgement could be made on whether an intervention has improved the situation.

2. Collaboration and Sharing

We believe national and regional fisheries bodies in Australia should work together in developing fisheries compliance outcome measures that can be used across agencies, standardised where possible, but that are flexible enough to be customised to the subtly different organisational requirements and responsibilities of individual agencies. This process could be facilitated through the use of existing governance structures, like the NFCC.

3. Structure and Governance

There are structured ways of developing and interpreting outcome measures and attributing them to specific activities. Examples of the way this has been done by the ATO and ACC were shown to representatives of the compliance agencies who attended the workshop on this project. We believe the next phase of this project should be to use those methods to develop a suitable framework to assess and compare expected and actual outcomes of various fishery compliance activities in some selected fisheries.

The work will require facilitation by a professional skilled in the area of outcome measures and using them with other fisheries data to correctly interpret the impacts of compliance activities. The project would need to have executive support and involvement from the participating agencies and be run over a period long enough to allow time for agencies to be able to involve their staff and stakeholders in the process.

To make this project manageable, we suggest an initial pilot effort that involves just a few fisheries nominated from across the country. It would be useful for these pilot studies to include examples of:

- recreational, commercial and customary fisheries.

- different management objectives (e.g., maximum sustainable yield/maximum economic yield, equitable allocation of fishing rights).
- different management targets (e.g., reduce illegal fishing vs reduce unreported landings vs reduce closed area or closed season violations).
- the use of different fishery management methods (e.g., input vs output controls, sector management and tradable fishing permits).
- the application of different compliance delivery strategies (e.g., focus on enforcement/deterrence vs compliance assistance).

4. Benchmarking

When assessing the performance of a fisheries compliance agency, benchmarking their compliance capabilities and governance framework against those of other Fisheries agencies with similar responsibilities will be necessary, unless an assessor has a detailed understanding of compliance theory and is prepared to apply that to the specific fisheries context of the agency being assessed.

5. Compliance Input to Management Frameworks

Fisheries managers and fishers themselves need to appreciate that different management strategies often come with different compliance options and resourcing (cost) implications. Some of these will be much easier or cheaper (and ideally both) to enforce and measure compliance with than others. If it is vital that fisheries compliance agencies are held accountable to stakeholders through suitable final outcome measures, it makes sense that the advice of fisheries compliance experts is sought and taken into consideration when deciding on suitable management frameworks. It was clear from the survey results that this advice is not universally sought, meaning that there will undoubtedly be inefficiencies intrinsically built into many fisheries management frameworks. The measurement of fisheries compliance outcomes will undoubtedly be easier if measurement of compliance outcomes resulting from any management framework is considered from the start.

6. Modelling

Fisheries compliance agencies should investigate the use of modelling to simulate the long-term beneficial outcomes of compliance activities using estimates of reductions in illegal harvests that result from compliance activities as increases in measures of fish abundance in conventional and widely available fishery models.

7. Beyond Sustainability

A comprehensive fisheries compliance outcome measurement framework needs to encompass more than 'just' stock sustainability. Fisheries compliance agencies give effect to regulation concerned with equity within and between sectors, ecosystem impacts, political and reputational imperatives and non-Fisheries responsibilities (such as emergency response). Since these may all be considered important, they need to be considered in a comprehensive measurement framework. Stock sustainability may also be coincidentally impacted by factors entirely outside of the control of organisations tasked with fisheries compliance such as effort creep and environmental impacts.

8. Preparing for the Future

Finally, we recommend that fisheries agencies prepare for the challenges of measuring compliance outcomes which will almost certainly require structural change within organisations to address the challenges of:

- Identifying suitable outcome measures
- Sourcing existing and novel data sources
- Investing in the data collection and analytical capability to discern patterns of behaviour and underlying issues
- Reacting to emerging trends in a timely fashion
- Designing measurement into their compliance programs from the start
- Being prepared to try new approaches when faced with results that show they are not making a measurable difference, or are making the problem worse.
- Ensuring the inclusiveness of all staff (compliance practitioners, fisheries managers, and monitoring and assessment scientists) and stakeholders in the development and implementation of outcome measures.

8 Extension and Adoption

We know from this project that there is a high degree of interest amongst fisheries agencies in developing outcome measures. Of those that completed the questionnaire distributed by this project (Appendix D), most ranked compliance outcome measurement as high or vital. Furthermore, all those that completed the survey indicated that they would like to receive further information on the progress of the project and so will be sent a copy of this final report.

In the last few years the European Fisheries Control Agency has held annual seminars on the subject of compliance. We have contacted that organisation to get information on compliance outcomes work undertaken by their member states and some exchange of information and sharing of views is underway. That organisation has requested a copy of this final report.

The National Fisheries Compliance Committee has been presented with a copy of this report at the final draft stage. This committee is the peak body for fisheries compliance agencies in Australia and was instrumental in commissioning the work undertaken in this project. Representatives from the project team have briefed the NFCC on the project and its findings. The NFCC is keen to use structured methods to begin the task of translating the findings of this project into useful outcome indicator measures.

An overview of the work done during this project was given at the 5th Global Fisheries Enforcement Training Workshop in Auckland in March 2016 (facilitated by the International Monitoring, Control and Surveillance Network) and that network will be used to advertise the availability of the final report. Over 200 delegates from 60 different countries attended and valuable contacts were made with key jurisdictions which will allow future collaboration on the topic of fisheries compliance outcome measurement. The workshop provided further confirmation of the International Survey findings, that no jurisdiction has yet solved the problem of measuring fisheries compliance outcomes.

Distribution and publication of this report will take place using the contact points established during the project. At this stage at least three peer-reviewed publications are envisaged, having been motivated by the work completed. The first would be a 'primer' paper on the current state of Fisheries Outcomes Measurement outlining the difficulties faced. The second would be based on the use (and misuse) of official compliance statistics and the third would be on the experiences of trying to develop measurement methods from within a changing government policy environment. As the literature review has highlighted, there is little visibility of much of the good work being done

by fisheries compliance agencies across Australia and Internationally. Publishing work in peer-reviewed literature is one route to helping other disciplines appreciate the challenges that fisheries compliance agencies currently face and showcase their successes. Another route is through informal networks such as IMCS and INECE and those groups will be approached to publicise this report and its findings.


Appendix A: Intellectual Property

Ownership of any intellectual property (IP) arising from this project has been waived.

Appendix B: Staff

Timothy Green	Principal Investigator	Department of Fisheries, WA
William Dixon	Co-investigator	Fisheries Victoria, Department of Environment and Primary Industries
Sebastian Lambert	Co-investigator	Primary Industries and Regions, South Australia
Tod Spencer	Co-investigator	Australian Fisheries Management Authority
Roy Melville-Smith	Researcher	Private Consultant
Dennis King	Visiting Professor	University of Maryland Center for Environmental Science, and King and Associates, Inc.
Elizabeth Price	Research Associate	University of Maryland Center for Environmental Science, and King and Associates, Inc.

Appendix C: Workshop Agenda: Measuring Fisheries Compliance Outcomes



FRDC
FISHERIES RESEARCH &
DEVELOPMENT CORPORATION

Workshop: Measuring Fisheries Compliance Outcomes

13 November 2014

Brunswick Room, Metropole Conference Centre, 44 Brunswick Street, Fitzroy

The Chatham House Rule will be used – what is said in the room should not subsequently be attributed to a person or organisation. This rule is invoked to encourage open discussions.

There will be a discussion session immediately following each invited speakers talk. Any issues will be documented as we go.

Morning Session

08:00 Arrival and coffee

08:30 Welcome and Background (Tim Green, 10 mins)

08:40 Project Findings From the Literature Review and Best Practice Survey (Roy Melville-Smith, 50 mins)

9:30 Case Studies from Jurisdictions (5+2 for each jurisdiction – 1:10 hr)

10:40 Morning Tea (15 mins)

10:55 The ATO Experience Implementing Compliance Outcome Measurement (1:15 hr)

12:10 lunch (45 mins)

Afternoon Session

12:55 A New Zealand perspective on Fisheries Compliance Outcome Measurement (, 1:30 hr)

14:25 Developing Effectiveness Indicators for Intelligence (- 1:15 hr)

15:40 Afternoon Tea (15 mins)

15:55 Group Discussion – The next steps (25 + 25 mins)

- Future research we could consider
- Beginning implementation at agency level

16:45 Wrap-up (Tim Green, 15 mins)

17:00 Close

Appendix D: The Affiliations of Attendees at the workshop: Measuring Fisheries Compliance Outcomes

Affiliation

Quadrat Ltd, New Zealand

Department of Primary Industries and Regions, South Australian Government

Department of Environment and Primary Industries Victorian Government

Department of Fisheries, Western Australian Government

Department of Fisheries and Forestry, Queensland Government

Australian Fisheries Management Authority

Ministry of Primary Industries, New Zealand Government

Australian Taxation Office

Department of Primary Industries, New South Wales Government

Australian Crime Commission

Appendix E: Survey form providing insight into compliance outcomes nationally and internationally



Measurement of Fisheries Compliance Outcomes: A Preliminary National Study

Purpose of this survey

This survey is contributing to a project that has the backing of Australia's National Fisheries Compliance Committee (NFCC). It is supported by funding from the Fisheries Research and Development Corporation, on behalf of the Australian Government. The project seeks to develop robust indicators of fisheries compliance outcomes and the questions in this survey seek to gain an insight into best practice in staffing, data collection, enforcement capability and more, in fisheries agencies both within and outside Australia.

Confidentiality

Information that you provide in this survey will only be used for this project and will be treated as confidential. Data emanating from the survey used in the report or presentations to stakeholders, will be in aggregate form and will therefore not identify you or your organisation.

Due date

Please complete and return this form by 24 October or earlier if possible.

Help available

If you have any problems in completing or returning this survey, please contact Dr Tim Green [timothy.green@fish.wa.gov.au or +61 8 9203 0234] or Dr Roy Melville-Smith [roy.smith@curtin.edu.au or +61 48730 0302].

How to complete this survey electronically

This survey is built using Acrobat Fillable Forms. You must at least have Adobe Reader 8 to take full advantage of functions such as the ability to save completed forms. Older versions of Acrobat will continue to work, but with fewer functions. You can click on the icon to download Adobe Reader.



On a Windows device press the F1 key for help while viewing a form.

An easy way to help enter information into a Fillable PDF Form is to click on the Highlight Fields button in the upper right hand corner of the menu bar of the PDF form. Clicking this button will change the highlighting of the Fillable Fields within the form, making them easy to identify. Besides using your pointer device you can use the tab key to move the cursor to the next field, and the space bar to enter a tick for 'yes' into tick boxes. To indicate 'no' leave the box blank.



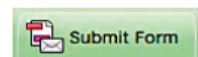
At any time while entering information in the form, click the Save button in the PDF menu bar.



At any time click the Print button in the PDF Menu Bar to print the current state of the document.



To return the completed and checked form click the *Submit Form* button on the upper right hand corner of the PDF Menu Bar or at the end of the survey.



Agency Name:

Your Name:

Preferred Contact Details:

Position Title:

Your Agency

1. Please provide the following information to set the context of your answers in this survey:

- a. Gross Annual Value of Production of fish resources managed by your agency (in your local currency):
- b. Annual operating budget for fisheries compliance activities during 13/14 (in your local currency):
- c. Approximate number of Full Time Equivalent Staff (FTE) employed by your agency during 13/14:
- d. Approximate number of FTE dedicated to fisheries compliance activities during 13/14:

2. Please indicate each of the following that your agency manages by 'clicking' to tick the relevant box. Add any that are not already in the list:

	International	National	State/Regional
Commercial Fishing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Recreational Fishing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sea Based Aquaculture (including Pearling)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Land Based Aquaculture	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Customary, Indigenous, or Artisanal Fishing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Marine Parks and/or Marine Reserves	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Marine Safety	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Emergency Response	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Biosecurity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Border Security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wildlife / Terrestrial Park Management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Policing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (specify) <input type="text"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Your role in your agency

3. Tick the words that best describe your current role:

a. Front line Enforcement	<input type="checkbox"/>
b. Compliance Management	<input type="checkbox"/>
c. Compliance Support	<input type="checkbox"/>
d. Performance Measurement	<input type="checkbox"/>
e. Analyst	<input type="checkbox"/>
f. Other (specify): <input type="text"/>	<input type="checkbox"/>

4. Over the duration of your career, please indicate the length of time you have been involved in the following. (Enter decimal years e.g. 0.0, 0.5, 14.0):

a. Fisheries Compliance	<input type="text"/>
b. Non-Fisheries Compliance and Enforcement	<input type="text"/>
c. Performance measurement	<input type="text"/>
d. Risk assessment (fisheries or decision making science)	<input type="text"/>

5. a. Based on your judgement, would you say that your agency is considered to be doing a good job in ensuring that fishers abide by the rules? Please choose from the list.

b. Have you been externally audited on that statement, or something close to it? If so, please provide further details on the results of the audit, and links to a published report if possible

Working relationships with your law enforcement/compliance branch or division

6. Does your Agency also manage **both** fisheries research **and** fisheries management? Please choose from the list.

7. Do you have a strong working relationship with the Agency, Policy Division or Branch responsible for research into the fish stocks to which you deliver compliance services? Please choose from the list.

8. Do you have a strong working relationship with the Agency, Research Division or Branch responsible for management of the fish stocks to which you deliver compliance services? Please choose from the list.

9. Does the Agency responsible for fisheries management changes consider your compliance experience and advice before making fisheries management changes? Please choose from the list.

10. a To identify common problems of interest does your agency have strong collaborative working relationships with external government agencies? Please choose from the list.

b If yes, with which Departments? (eg: Tax Department, State and Federal Police, Port Authorities etc.)

11. a Do you have strong collaborative working relationships with private organisations in identifying potential offenders or types of offending? Please choose from the list.

b If yes, Which Departments? (eg: Airline Companies, Road Transport Companies, Freight Services etc.)

12. a Has your compliance program recently been audited against a risk assessment standard? (e.g. ISO 31000:2009 and its derivatives.) Please choose from the list.

b If yes, please provide further details on the results of the audit, and links to a published report if possible:

13. If you use voluntary codes of practice as part of your suite of compliance tools to achieve sustainability outcomes, please explain how these are used. If you don't use them, enter N/A.

--

14. Please rank in order of importance the following factors in creating a deterrent for illegal fisheries activity, with 1 being the most important and 3 the least. Choose from each list.

factor	ranking
a. significant penalties	<input type="text"/>
b. a high chance of being caught	<input type="text"/>
c. a high rate of conviction through the courts	<input type="text"/>

15. Which of the following tools, directed at the public, does your agency actively use to seek maximum voluntary compliance? Click to tick all that apply.

a. school education programs	<input type="checkbox"/>
b. fishing rule guides	<input type="checkbox"/>
c. media bulletins	<input type="checkbox"/>
d. electronic 'apps'	<input type="checkbox"/>
e. Other (specify) <input type="text"/>	<input type="checkbox"/>

16. Please click to select the button next to the more appropriate statement:

a. We integrate education of fishers, licence owners, processors etc into our compliance activities	<input type="radio"/>
b. The education role is entirely carried out by a separate branch or organisation	<input type="radio"/>

Your Agency's Enforcement and its Enforcement Performance Measurement

17. Are the costs of your enforcement and compliance work assessed and the actual amounts charged back to your stakeholders? Note that simple payment of licence fees is not considered 'cost-recovery'. Please choose from the list.

18. What percentage of the compliance staff budget is allocated to support analysts? (i.e. staff responsible for the analysis of logbook, vms, observer logs and other data sources.)

 %

19. Does your agency assess and gather data on the following 'input' measures? (click to tick all that apply).

[Note: for the columns below in Q19 to Q21, *In General* means data are not categorised by Sector or Fishery; *By Sector* means data are categorised by commercial, recreational, indigenous or other; *By Fishery* means data are categorised according to stock, or particular gear type.]

	In General	By Sector	By Fishery
a. Compliance personnel available (e.g. no of officers)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Compliance financial resources available (e.g. budgeted field time etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Intelligence relating to illegal activity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Risk ratings for the risk of individual stakeholder offending	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Comparative risk ratings for different fisheries/parts of fisheries	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Comparative risk ratings for offence types	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. An explicit limit to illegal take in one or more fisheries	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. The ecosystem impacts of fishing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Other (specify) <input type="text"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

20. Does your agency assess and gather data on the following 'output' measures? (click to tick all that apply.)

	In General	By Sector	By Fishery
a. Number of field inspections undertaken	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. % of total fishery effort, or fleet, inspected	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Number of days of successful VMS coverage for a fleet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Number of offences detected as a result of inspections	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Number of successful prosecutions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Number and type of educative activities directed at stakeholders	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. Media coverage of high-profile specific cases of offences detected	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Strategic publications and media relating to general offences and types of offending	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Offences reported by stakeholders using the illegal-fishing hotline service	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. Penalties received from the payment of fines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
k. Non-compliance rates (e.g. offences detected per field inspection)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
l. Number of court proceedings completed in a given period	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	In General	By Sector	By Fishery
m. The cost per hour, or similar, of delivering compliance services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
n. Other (specify): <input type="text"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

21. Does your agency assess and gather data on the following 'outcome' measures? (click to tick all that apply.)

	In General	By Sector	By Fishery
a. Total fishery illegal take (e.g. estimated illegal landings in tonnes)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Intelligence relating to illegal activity from sources independent of your agency (e.g. official government statistics, freight transport companies etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Stakeholder satisfaction surveys which include questions relating to compliance and enforcement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. The impacts of illegal fishing on the economic or biological sustainability of the stock	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Representational views of stakeholders (e.g. through consultation, industry bodies etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Changes in stakeholder behaviour as a result of your activity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. Observer information on catch/by catch and protected species interactions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Negative outcomes such as avoidable acquittals and failed prosecutions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. The market price of illegal product	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. Other (specify): <input type="text"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

22. a Do you undertake planned deployments of compliance resources in order to try and quantify the extent to which an identified risk is actually occurring? Please choose from the list.

b If Yes, do you ever repeat these deployments to test whether the situation has changed? Please choose from the list.

23. How do you optimise your compliance resource levels? If you don't, enter N/A

24. a If required, can you reprioritise your agency's compliance assets in response to changing risk? Please choose from the list.

b If yes: Can you give some examples of where you have done this and what the triggers were?

c If No: Is this recognised as a gap in your agency, with active attempts being made to close it?

25. a Are any of the fisheries that fall under your Agency's responsibility accredited for sustainability by an external assessor? (e.g. Marine Stewardship Council.)

b If yes, please provide details of the Assessment Framework (e.g. the fishery and a link to the assessor's website).

Your Agency's Enforcement Tools and Capabilities

26. Please 'click' to tick all of the following compliance tools that your agency uses. Add any that are not represented in the list below

a. Fishing Licences (fee for licence)	<input type="checkbox"/>	b. Manned aerial surveillance	<input type="checkbox"/>
c. Tiered Penalties	<input type="checkbox"/>	d. Unmanned aerial surveillance	<input type="checkbox"/>
e. Demerit Point System (for licences)	<input type="checkbox"/>	f. Undercover Operations	<input type="checkbox"/>
g. Strategic Communications	<input type="checkbox"/>	h. Land Patrols	<input type="checkbox"/>
i. Education and Awareness Programs	<input type="checkbox"/>	j. Sea Patrols	<input type="checkbox"/>
k. Illegal Fishing Telephone Hotline	<input type="checkbox"/>	l. Inland Waterways Patrols	<input type="checkbox"/>
m. Illegal Fishing Reporting Online	<input type="checkbox"/>	n. Roadside Checks	<input type="checkbox"/>
o. Dedicated Volunteer Programs	<input type="checkbox"/>	p. Use of Fishery Observers	<input type="checkbox"/>
q. Dedicated Intelligence Analyst Functions	<input type="checkbox"/>	r. Factory and Wholesaler Inspections	<input type="checkbox"/>
s. Public weigh stations	<input type="checkbox"/>	t. Vessel Monitoring Systems	<input type="checkbox"/>
u. Stock traceability / DNA species register	<input type="checkbox"/>	v. Overt CCTV monitoring	<input type="checkbox"/>
w. Social media communications	<input type="checkbox"/>	x. Mandatory no-fee fishing registers (i.e. name and address of fishers must be supplied, but no payment of a fee is required to register or to fish).	<input type="checkbox"/>
y. Informant Management Programs	<input type="checkbox"/>	z. Reward-For-Information Programs	<input type="checkbox"/>
aa. Strategic Risk assessment	<input type="checkbox"/>	ab. Retail Outlet Inspections	<input type="checkbox"/>
ac. Operational Risk assessment	<input type="checkbox"/>	ad. Communication Intercepts	<input type="checkbox"/>
ae. Strategic Driver analysis	<input type="checkbox"/>	af. Covert Tracking Devices	<input type="checkbox"/>
ag. Covert surveillance using compliance staff	<input type="checkbox"/>	ah. Covert surveillance using remote optical devices	<input type="checkbox"/>
ai. Other (specify)	<input type="text"/>		<input type="checkbox"/>

Level of Interest in Compliance Outcomes Measurement

27. Are you aware of any guidelines or standards for best-practice in compliance outcome measurement in Fisheries? Please give details:

28. In your Agency, what level of importance do you think is attached to Compliance Outcome Measurement? Please choose from the list.

29. Please 'click' to select the button next to the most appropriate statement:

a. We do not have any measures of compliance outcomes and have no plans to develop any in the future.	<input type="radio"/>
b. We do not have any measures of compliance outcomes but are developing some to use in the future.	<input type="radio"/>
c. We have some measures of compliance outcomes and don't plan to develop any more.	<input type="radio"/>
d. We have some measures of compliance outcomes and are developing more to use in the future.	<input type="radio"/>

30. Are you willing to be contacted for follow up by our project team in relation to the information provided in this survey?
31. Would you like to receive further information on the progress of this project?
32. Do you want your contribution to be anonymous in the final report? In that case we will not acknowledge your contribution.

Measures of successful compliance or enforcement activity

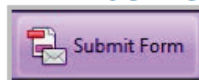
33. Please suggest any possible novel compliance outcome indicators that the project could consider, especially if you are using them, or if you have some experience with using them?

34. If you have identified any impediments to measuring successful compliance outcomes, please provide further details:

35. Please provide any additional information you think the project team may find relevant:

Please now 'save' or 'print' a copy if you wish.

Then click this button:



to return your completed survey to the project team.

Thank you for your time and input.

Appendix F: References

- Agnew DJ, Pearce J, Pramod G, Peatman T, Watson R, Beddington JR, Pitcher T (2009) Estimating the worldwide extent of illegal fishing. PLoS ONE 4(2): e4570 doi:10.1371/journal.pone.0004570
- Ainsworth CH, Pitcher TJ (2005) Estimating illegal, unreported and unregulated catch in British Columbia's marine fisheries. Fisheries Research 75: 40-55
- Akpalu W (2008) Fishing regulations, individual discount rate, and fisherman behaviour in a developing country fishery. Environment and Development Economics 13: 591-606
- Alach Z, Crous C (2012) A tough nut to crack: Performance measurement in specialist policing. AIC Reports Technical and Background Paper 53: 38 pp.
- Arnason R (2010) Optimal dynamic fisheries enforcement. In: Proceedings of the Fifteenth Biennial Conference of the International Institute of Fisheries Economics & Trade, July 13-16, 2010, Montpellier, France: Economics of Fish Resources and Aquatic Ecosystems: Balancing Uses, Balancing Costs. . accessed 17 November 2014, URL: <http://irlibrary.oregonstate.edu/xmlui/bitstream/handle/1957/39243/168pdf?sequence=1>
- Australian Taxation Office (2007) Literature review: Measuring compliance effectiveness. Australian Taxation Office, Canberra, 72 pp
- Australian Taxation Office (2008) Measuring compliance effectiveness: Applying our methodology. Australian Taxation Office, Canberra, 20 pp
- Australian Taxation Office (2012a) Measuring compliance effectiveness - our methodology. Australian Taxation Office, Canberra, 19 pp
- Australian Taxation Office (2012b) Measuring compliance effectiveness: Evaluating effectiveness. Australian Taxation Office, Canberra, 32 pp
- Ayres I, Braithwaite J (1992) Responsive Regulation: Transcending the deregulation debate. New York: Oxford University Press
- Becker GS (1968) Crime and punishment: an economic approach. Journal of Political Economy 76: 169-217
- Benoit HP, Allard J (2009) Can the data from at-sea observer surveys be used to make general inferences about catch composition and discards? Canadian Journal of Fisheries and Aquatic Sciences 66: 2025-2039
- Blank SG, Gavin MC (2009) The randomized response technique as a tool for estimating non-compliance rates in fisheries: a case study of illegal red abalone (*Haliotis rufescens*) fishing in Northern California. Environmental Conservation 36: 112-119
- Bousquet N, Cadegan M, Duchesne T, Roivest L-P (2010) Detecting and correcting underreported catches in fish stock assessment: Trial of a new method. Canadian Journal of Fisheries and Aquatic Sciences 67: 1247-1261
- Bremner G, Johnstone P, Bateson T, Clarke P (2009) Unreported bycatch in the New Zealand West Coast South Island hoki fishery. Marine Policy 33: 504-512
- Bricknell S (2010) Environmental crime in Australia. AIC Research and Public Policy Series 109, 132 pp Accessed 11 August 2014, URL: <http://www.aic.gov.au/documents/2/1/1/%7B211B5EB9-E888-4D26-AED4-1D4E76646E4B%7Drrpp109pdf>
- Burns RJ, Kerr GN (2008) Observer effect on fisher bycatch reports in the New Zealand ling (*Genypterus blacodes*) bottom longline fishery. New Zealand Journal of Marine and Freshwater Research 42: 23-32
- Businessdictionary (2014) Outcomes measurement. Accessed 20 August 2014, URL: <http://www.businessdictionary.com/definition/outcome-measure.html>
- Campbell DT (1976) Assessing the impact of planned social change. The Public Affairs Center, Dartmouth College Occasional Paper 8: : 70 pp.
- Catalano SM (2006) The measurement of crime: victim reporting and police recording. New York: LFB Scholarly Pub ISBN 1-59332-155-4

- Clarke SC, McAllister M, Milner Gulland EJ, Kirkwood GP, Michielsens CGJ, Agnew DJ, Pikitch EK, Nakano H, Shivji MS (2006) Global estimates of shark catches using trade records from commercial markets. *Ecology Letters* 9: 1115-1126
- Conand C, Byrne M (1993) A review of recent developments in the world sea cucumber fisheries. *Marine Fisheries Review* 55: 1-13
- Dadds V, Scheide T (2000) Police performance and activity measurement *Trends & Issues in crime and criminal justice* No 180 Australian Institute of Criminology, Canberra Accessed on line 11 October 2014 URL: http://aicgovau/media_library/publications/tandi_pdf/tandi180pdf
- Department of Fisheries WA (2010) State of the Fisheries and Aquatic Resources Report 2009/10. Fletcher, W.J. and Santoro, K. (Eds). Department of Fisheries, Western Australia
- Department of Fisheries WA (2011) State of the Fisheries and Aquatic Resources Report 2010/11. Fletcher, W.J. and Santoro, K. (eds). Department of Fisheries, Western Australia
- Department of Premier & Cabinet NSW (2014) C2014-06 Quality Regulatory Services initiative – Guidance for NSW regulators to implement outcomes and risk-based regulation. accessed 25 November 2014, URL: nsw_regulators_to_implement_outcomes_and_risk-based_regulation
- DGR Consulting (1996) Performance indicators for fisheries compliance. Unpublished Report, 11 pp
- Diamond J (2005) Establishing a performance management framework for government. International Monetary Fund WP/05/50, 28 pp
- Food Innovation Partners and Allan Bremner & Associates (2007) Review of traceability and product sensor technologies relevant to the seafood industry. Australian Seafood Cooperative Research Centre Accessed online on 8 September 2014 URL: http://www.yooyahcloud.com/SEAFOODCOOPERATIVERESEARHCENTRE/EpjQdc/Traceability_and_Product_Technologies_Reportpdf 48 pp
- Furlong WJ (1991) The deterrent effect of regulatory enforcement in the fishery. *Land Economics* 67: 116-129
- Gezelius SS (2003). Regulation and compliance in the Atlantic Fisheries: state/society relations in the management of natural resources Dordrecht: Kluwer Academic Publishers
- Gezelius SS, Hauck M (2011) A comparative study of compliance motivations in developed and developing world fisheries. *Law & Society Review* 45: 435-470
- Gorfine H, Tailby R, Gant F, Bruce I, Donaldson M (2002) Assessment of illegal catches of Australian abalone: Development of desk-based survey methods. Fisheries Research and Development Corporation Final Report, Project 2000/112: : 25 pp.
- Green TJ, McKinlay JP (2009) Compliance program evaluation and optimisation in commercial and recreational Western Australian fisheries. Fisheries Research and Development Corporation Final Report, Project 2001/069: : 77 pp.
- Groeneveld JC (2003) Under-reporting of catches of south coast rock lobster *Palinurus gilchristi*, with implications for the assessment and management of the fishery. *African Journal of Marine Science* 25: 407-411 doi 10.2989/18142320309504030
- Hauck M (2008) Rethinking small-scale fisheries compliance. *Marine Policy* 32: 635-642
- Henderson MJ, Fabrizio MC (2013) Detecting noncompliance in the summer flounder recreational fishery using a mark–recapture growth model. *North American Journal of Fisheries Management* 33: 1039-1048
- Horvitz DG, Greenberg BG, Abernathy JR (1976) Randomized response: a data-gathering device for sensitive questions. *International Statistical Review* 44: 181-196
- House of Commons Public Administration Select Committee (2014) Caught red-handed: why we can't count on police recorded crime statistics. accessed 25 March 2015, URL: <http://www.publications.parliament.uk/pa/cm201314/cmselect/cmpublicadm/760/760pdf>

- Hughes BP, Newstead S, D'Elia A (2011) Outcomes-based national road safety performance measures. in Proceedings of the Australasian College of Road Safety Conference: A Safe System: Making it Happen!, Melbourne, Australia
- INECE (2008) Performance measurement guidance for compliance and enforcement practitioners. Guidance Document, Accessed on line 11 August 2014, URL: <http://ineceorg/indicators/guidancepdf>
- Innovation Network Inc. (anon.) Logic model workbook. Accessed on line 1 October 2014, URL: http://www.innovationet.org/client_docs/File/logic_model_workbookpdf
- Jacquet JL, Pauly D (2008) Trade secrets: renaming and mislabeling of seafood. *Marine Policy* 32: 309-318
- Kelly DN, McCarthy SL (2013) The report of the Crime Reporting Committee to Commissioner Raymond W. Kelly concerning CompStat Auditing. Accessed on line 27 June 2016, URL: http://www.nyc.gov/html/nypd/downloads/pdf/public_information/crime_reporting_review_committee_final_report_2013pdf
- Kindt-Larsen L, Kirkegaard E, Dalskov J (2011) Fully documented fishery: a tool to support a catch quota management system. *ICES J Mar Sci* 68: 1606-1610
- King DM (2010) Enforcement and compliance in U.S. commercial fisheries: results from two recent studies. *Lenfest Ocean Program Report*, 15 pp Accessed 11 August 2014, URL: http://www.lenfestocean.org/~media/legacy/Lenfest/PDFs/king_enforcement_comparison_paper_2010pdf?la=en
- King DM, Porter RD, Price EW (2009) Reassessing the value of U.S. coast guard at-sea fishery enforcement. *Ocean Development & International Law* 40: 350-372
- King DM, Sutinen JG (2010) Rational noncompliance and the liquidation of Northeast groundfish resources. *Marine Policy* 34: 7-21
- Knecht GB (2006) *Hooked: pirates, poaching, and the perfect fish*. Allen and Unwin, NSW, Australia
- Kuperan K, Sutinen JG (1998) Deterrence, legitimacy, and compliance in fisheries. *Law & Society Review*: 309-337
- Mackenzie S, Hamilton-Smith N (2011) Measuring police impact on organised crime: Performance management and harm reduction. *Policing: An international Journal of Police Strategies and Management* 34: 7-30
- Martin CC (1995) Evaluation of slot length limits for largemouth bass in two Delaware ponds. *North American Journal of Fisheries Management*, 15: 713-719
- Martinsohn JT (2011) *Deterring illegal activities in the fisheries sector*. JCR Reference Reports Publications Office of the European Union, Luxembourg, Belgium 72 pp
- Martinsohn JT, Ogden R (2009) FishPopTrace - Developing SNP-based population genetic assignment methods to investigate illegal fishing. *Forensic Science International Genetics Supplement Series 2*: 294-296
- Mazur E (2010) Outcome performance measures of environmental compliance assurance: current practices, constraints and ways forward, OECD Environment Working Papers, No. 18, OECD Publishing. Accessed 25 March 2015, URL: <http://www.oecd-ilibrary.org/docserver/download/5kmd9j75cf44.pdf?expires=1427351670&id=id&accname=guest&checksum=78353C7D329EE92DDD1C40943ABB1DF1>. OECD Publishing
- McAuley R, Ho K, Thomas R (2005) Development of a DNA database for compliance and management of Western Australian sharks. Fisheries Research and Development Corporation Final Report, Project 2003/067: Fisheries Research Report No 152, Department of Fisheries, Western Australia, 24 p
- McElderry HI, Reidy RD, Pahti DF (2008) A pilot study to evaluate the use of electronic monitoring on a Bering Sea groundfish factory trawler. *International Pacific Halibut Commission Technical Report* 51: 32 pp.

- McKinlay JP (2002) Optimising the efficiency and effectiveness of enforcement to achieve compliance in the western rock lobster fishery. Fisheries Research and Development Corporation Final Report, Project 1998/156:
- Melville-Smith R, van Sittert L (2005) Historical commercial West Coast rock lobster *Jasus lalandii* landings in South African waters. African Journal of Marine Science 27: 33-44
- Moore MH (1995) Creating public value: strategic management in government. Harvard University Press, Cambridge, MA, U.S.A
- Moore MH (2013) Recognizing public value. Harvard University Press, Cambridge, MA, U.S.A
- Moullin M (2002) Delivering excellence in health and social care. Open University Press, Buckingham, UK
- Moullin M (2007) Performance measurement definitions: linking performance measurement and organisational excellence. International Journal of Health Care Quality Assurance 20: 181-183
- Mullowney DR, Dawe EG (2009) Development of performance indices for the Newfoundland and Labrador snow crab (*Chionoecetes opilio*) fishery using data from a vessel monitoring system. Fisheries Research 100: 248-254
- National Fisheries Compliance Committee (undated) Australian fisheries national compliance strategy 2010-2015. accessed 22 October 2014, URL: <http://www.afmagov.au/wp-content/uploads/2010/06/Australian-Fisheries-National-Compliance-Strategy-2010-2015pdf>
- National Strategy for Ecologically Sustainable Development (1992) Ecologically Sustainable Development Steering Committee, Endorsed by the Council of Australian Governments, December 1992.
- Nielsen JR, Mathiesen C (2003) Important factors influencing rule compliance in fisheries - lessons from Denmark. Marine Policy 27: 409-416
- Nøstbakken L (2008) Fisheries law enforcement—A survey of the economic literature. Marine Policy 32: 293-300
- Ogden R (2008) Fisheries forensics: the use of DNA tools for improving compliance, traceability and enforcement in the fishing industry. Fish and Fisheries 9: 262-272
- Ostrom E (1990) Governing the commons: the evolution of institutions for collective action. Cambridge University Press, Cambridge, UK
- Ostrom E (2007) Sustainable social-ecological systems: an impossibility? Proceedings of the National Academy of Science, Washington D.C., U.S.A
- Ostrom E (2009) A general framework for analyzing sustainability of social-ecological systems. Science 325: 419-422
- Palin P, Hall S, Lewis T, Baldwin C (2012) Deterrence and the United States Coast Guard: enhancing current practices with performance measures. Center for Homeland Defense and Security, Naval Postgraduate School, Monterey, CA
- Pierce RB, Tomcko CM (1998) Angler noncompliance with slot Length limits for northern pike in five small Minnesota lakes. North American Journal of Fisheries Management 18: 720-724
- Pitcher TJ, Watson R, Forrest R, Valtysson H, Guenette S (2002) Estimating illegal and unreported catches from marine ecosystems: a basis for change. Fish and Fisheries 3: 317-339
- Plagányi É, Butterworth D (2011) A spatial-and-age-structured assessment model to estimate the impact of illegal fishing and ecosystem change on the South African abalone *Haliotis midae* resource. African Journal of Marine Science 32: 207-236
- Plagányi É, Butterworth D, Burgener M (2010) Illegal and unreported fishing on abalone - Quantifying the extent using a fully integrated assessment model. Fisheries Research 107: 221-232
- Putt J, Anderson K (2007) A national study of crime in the Australian fishing industry. Australian Institute of Criminology Research and Public Policy Series 76: 120 pp.

- Ringsberg HA, Mirzabeiki V (2013) Effects on logistic operations from RFID-and EPCIS-enabled traceability. *British Food Journal* 116: 104-124
- Sarti NL (2006) Development of risk assessment procedures in national fisheries compliance programs. Fisheries Research and Development Corporation Final Report, Project 2002/085: : 33 pp.
- Southern Rocklobster Limited (2014) The finest in the world. accessed on 8 September 2014 URL: <http://www.southernrocklobster.com/lib/pdf/mf1093pdf>
- Sparrow MK (2000) *The regulatory craft: controlling risks, solving problems and managing compliance*. Brookings Institution Press, Washington DC, USA
- Sparrow MK (2008) *The character of harms: operational challenges in control*. Cambridge University Press, Cambridge, UK
- Sparrow MK (2011) *New perspectives in policing: governing science*. accessed 25 March 2015, URL: <https://www.ncjrs.gov/pdffiles1/nij/232179.pdf>
- Spencer T (2013) *Performance indicators: a policy and guide for the development and use of performance indicators for fisheries compliance*. Australian Fisheries Management Authority, Canberra, Australia, 15 pp
- Sutinen JG, Kuperan K (1999) A socio-economic theory of regulatory compliance. *International Journal of Social Economics* 26: 174-193
- Sutinen JG, Rieser A, Gauvin JR (1990) Measuring and explaining noncompliance in federally managed fisheries. *Ocean Development & International Law* 21: 335-372
- Sweijd NA, Bowie RCK, Evans BS, Lopata AL (2000) Molecular genetics and the management and conservation of marine organisms. *Hydrobiologia* 420: 153-164
- Tailby R, Gant F (2002) The illegal market in Australian abalone. *Trends and Issues in Crime and Criminal Justice* 225: 1-6
- Taylor-Powell E, Jones L, Henert E (2003) *Enhancing Program Performance with Logic Models*. Accessed on line 25 March 2014, URL: <http://www.uwex.edu/ces/lmcourse/>
- Tversky A, Kahneman D (1992) Advances in prospect theory: cumulative representation of uncertainty. *Journal of Risk and Uncertainty* 5: 297-323
- United Nations Development Program (2009) *Handbook on planning, monitoring and evaluating for development results*. UNDP, Accessed on line 1 October 2014, URL: <http://www.undp.org/eo/handbook>
- United Nations Office on Drugs and Crime (2011) *Transnational organised crime in the fishing industry. Focus on: trafficking in persons smuggling of migrants illicit drugs trafficking*. accessed 25 March 2015, URL: [http://www.unodc.org/documents/human-trafficking/Issue Paper - TOC in the Fishing Industry.pdf](http://www.unodc.org/documents/human-trafficking/Issue_Paper_-_TOC_in_the_Fishing_Industry.pdf)
- United States Coast Guard (2004) Appendix D - performance measures and targets. Accessed on line 18 August 2014 URL: http://www.uscg.mil/hq/cg5/cg531/LMR/OceanG/OG_AppD.pdf
- Victorian Auditor-General (2012) *Victorian Auditor-General's Report. Effectiveness of compliance activities: Departments of Primary Industries and Sustainability and Environment*. Victorian Government Printer, Melbourne, Victoria, Australia
- Ward RD, Grewe PM (1994) Appraisal of molecular genetic techniques in fisheries. *Reviews in Fish Biology and Fisheries* 4: 300-325
- Warner SL (1965) Randomized response: A survey technique for eliminating evasive answer bias. *Journal of the American Statistical Association* 60: 63-39
- Weatherburn D (2000) Performance indicators for drug law enforcement. *Crime and Justice Bulletin* 48: 1-10
- Westcott R (2008) *Outputs and Outcomes: defining distinguishing and differentiating deliverables*. *Quality Progress* 41: 72
- Wilberg MJ (2009) Estimation of recreational bag limit noncompliance using contact creel survey data. *Fisheries Research* 99: 239-243

Willis K, Homel P, Anderson J (2010) Developing the capacity and skills for national implementation of a drug law enforcement performance measurement framework. Report funded by the National Drug Law Enforcement Research Fund, Monograph Series 34, Accessed on line 11 August 2014, URL: <http://www.ndlerfgov.au/sites/default/files/publication-documents/monographs/monograph34.pdf>