NATIONAL PLAN FOR THE PREVENTION OF POLLUTION OF THE SEA BY OIL AND OTHER NOXIOUS AND HAZARDOUS SUBSTANCES

RESEARCH, DEVELOPMENT AND TECHNOLOGY

PROJECT SUMMARY

June 2008

Australian Government

Australian Maritime Safety Authority

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INTRODUCTION

This paper summarises projects completed or in progress under the Research, Development and Technology (RD&T) Strategy of the National Plan for the Prevention of Pollution of the Sea by Oil and Other Noxious and Hazardous Substances (the National Plan). Up to 2.5% of the National Plan's annual budget is allocated to RD&T. This paper describes how each project came about and the results and their application.

Requests for further information on these projects should be directed to the Environment Protection Standards Group of the Australian Maritime Safety Authority (AMSA) eps@amsa.gov.au

CURRENT PROJECTS

Vegetable Oil Based Biodiesels as Cleansing Agents for Heavy Oil Spills (2007-2011)

Project Conducted by:

Centre for Marine Studies (as a member of the Marine Pollution Research and Response Unit), University of Queensland.

Background:

Recent experience in heavy bunker fuel oil spills in the Philippines (MV Solar I), Australia (Global Peace) and Spain (Prestige) has highlighted the need to find a cheap, effective and biodegradable agent to clean residual oil from mangroves, roots and surfaces, marshlands and other shoreline vegetation without adversely impacting the intertidal and marine environment. Inherent to the cleaning of heavy oil from dense coastal mangroves in remote tropical regions of Australia are the challenges of fragility of intertidal areas, accessibility, responder safety and selection of appropriate cleaning agent to minimise impacts on fringing seagrasses, coral reefs and intertidal aquatic organisms.

Oil spills in port areas often result in both natural and man-made surfaces being contaminated. Cleaning of oil from marina structures, wharf piles, boat surfaces, concrete, rock walls and oil containment and recovery equipment is time-consuming and expensive, for example, MSQ advise that $93,256 was spent on cleaning equipment after the recent Global Peace spill.

Present surfactant and solvent based cleaning agents such as Corexit 9580, Corexit 7664, CRUDEX, DE-SOLV-IT, JANSOLV and OMNI_CLEAN are expensive, not universally accepted as shoreline cleaning agents and currently not stocked by the National Plan.

A naturally occurring solvent such as biodiesel may provide an environmentally acceptable cleaning agent for natural and man-made oiled surfaces. Also, the residues of the cleaning process could be easily collected, pumped, stored and disposed of.

Previous studies overseas have showed promising results using biodiesels to remove persistent coal-tar residues in soil remediation and to clean crude oil-contaminated sediments.

In this context, the ESC Workshop 2006 identified a need to evaluate natural plant-derived oil products for effectiveness as shoreline and surface cleaning agent for bunker spills. On this recommendation, the Environment Working Group (EWG) developed a proposal to undertake a new project to analyse the effectiveness and net environmental benefit of using vegetable-oil based biodiesels as biodegradable cleaning agents for heavy oil spills.

NPOG 13 (November 2006) agreed to the proposal and instructed AMSA to commence the project.

The proposed project will be conducted as follows:

- Stage 1. Identify and characterise particular biodiesels for further study (literature review).
- Stage 2. Theoretical effectiveness as a cleaning agent (laboratory trials).
- Stage 3. Costs and Net Environmental Benefit Analysis.
- Stage 4. Field Trials.

Stages 1 and 2 were carried out in 2007-08. The literature review revealed that while research into biodiesels as oil cleaning agents commenced more than a decade ago, few definitive conclusions have been reached about its relative merits as a cleaning agent. Of the range of potential biodiesels, those derived from palm oil and coconut oil were judged to posess favourable physical and chemical properties and to be readily available in Australia.

Results of the laboratory trials supported previous findings that biodiesel is an effective cleaner of spilled oil. When applied to a range of hard natural and synthetic substrates covered in bunker oil, biodiesel-based agents were at least as effective as other reference cleaners. Oil was removed efficiently from aluminium, fibreglass, granit, coral and concrete in excess of the rates achieved by the application of seawater (control) alone. However, removal rates tended to be lower and more variable for soft substrates such as mud and sand. This may indicate that the oil-biodiesel mixture becomes bound to the substrate reducing its uptake into the water fraction and subsequent recovery by hexane extraction. In-situ field studies may improve results with soft sediments, as field conditions such as the presence of biofilms and the nature of fine sediment saturation may reduce the tendency of oil-biodiesel mixtures to migrate into or bind with a sediment.

Overall, the laboratory trials revealed little to distinguish between the performances of the two biodiesels, and further tests are recommended, noting that the choice will also involve issues such as price, shelf life and toxicity.

The next stages of the project will assess the net environmental benefit of biodiesel application in the event of an oil spill in the Australian marine environment. Issues such as the ecotoxicity to critical habitats and associated organisms (e.g. mangroves, coral reefs, seagrass), appropriate application techniques for oil spill response, and how application method, toxicity and the resultant oil-biodiesel mixture might imapct the marine environment.

Application of Results (intended):

The outcome of this project will be a series of reports which will enable the National Plan to consider the potential and practicalities of the use of biodiesel in a heavy oil spill response.

Web address:

http://www.amsa.gov.au/Marine_Environment_Protection/National_Plan/Contingency_Plans_and_Management/Research_Development_and_Technology/Biodiesels.asp

Oil and Dispersed Oil Impacts on Temperate Seagrasses (2004-08)

Project Conducted by:

University of Technology Sydney

Background:

This project was first proposed to NPOG in 2002 by Victoria following that State's completion of a literature review of oil spill dispersants in temperate marine environments to support the development of new dispersant use protocols for Victoria. The project was developed by EWG and endorsed by NPOG for commencement in June 2004.

Seagrasses are a vital component of many near-shore areas of coastal Australia, providing habitat and food for a variety of marine, estuarine and beach-dwelling animal species, as well as being important in the nutrient cycle of near-shore and foreshore areas.

Oil spills may affect seagrasses either by direct smothering or by toxic effects of the water-soluble fraction of oil.

Although National Plan approved oil spill dispersants are rated predominantly as "slightly toxic" to "practically non-toxic" by the International Maritime Organization Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP)'s classification system, there is limited knowledge on the specific effects on seagrasses exposed to dispersants. The use of dispersants may also increase the exposure of submerged seagrasses to oil as dispersed oil enters the water column.

To address the knowledge gap on the impact on seagrasses exposed to oil spills, AMSA has entered into a funding agreement on behalf of the National Plan with the University of Technology Sydney (UTS). The National Plan is also providing in-kind support and technical advice to the research team. UTS have contributed additional funding and have also been successful in securing an Australian Research Council Industry Linkage grant to expand the project.

The UTS researchers are using a combination of laboratory and field experiments to compare the toxicity of several oils and dispersant/oil mixtures on seagrasses, and to provide advice on the best approach to the use of dispersants on oil spills in the vicinity of seagrasses.

Results (to date):

The project outcomes to date have been a literature review completed in late 2004, and a report on the proof-of-concept experimental work completed in June 2005. In this work, the toxic impact of oil and dispersants on the seagrass *Zostera capricorni* was measured at field sites (Pittwater, NSW) and in the laboratory using seagrass leaf sections, thylakoid membranes and migroalgal cells.

Whole plants, leaf sections, thylakoids (the parts of plant cells where photosynthesis occurs) and microalgae were exposed to the water soluble fraction of Gippsland Crude oil produced with and without the addition of Slickgone NS dispersant.

The main findings so far are that seagrasses are mostly unaffected by Gippsland Crude oil and mixtures of this oil and Slickgone NS dispersant. Furthermore, microalgae bioassays may provide a time- and cost-efficient way to test for concentrations of toxic petrochemicals in the field that might affect seagrasses.

Over the next three years, UTS will carry out further experiments with several more oil and oil/dispersant mixtures. The National Plan Environment Working Group will provide advice and assistance to UTS for the duration of the project.

UTS presented a paper at the 2008 International Oil Spill Conference (IOSC) describing the results of Sydney field experiments with Tapis crude. The findings presented in this paper include that, overall, dispersed Tapis crude oil has less of an impact on *Zostera capricorni* than Tapis crude alone. An impact was measurable at a concentration of 0.4% water soluble petrochemicals. The impact of the Tapis crude alone was short-lived, and the seagrass recovered the same day (Wilson, K.G. & Ralph, P.J., 2008 *A comparison of the effects of Tapis crude oil and dispersed crude oil on subtidal Zostera capricorni.* International Oil Spill Conference, Savannah, 4-8 May 2008.

Application of results (intended):

The results of this project will be used to assess the net environmental benefit of using dispersant in the vicinity of submerged seagrass beds – if dispersed oil is more toxic to seagrasses than oil alone then dispersant would preferably not be used (depending on what resources other than seagrass required protection). If, however, oil is more toxic to seagrasses than dispersed oil then the use of dispersant over submerged seagrass beds should be considered (in light of other resources present and extent of weathering of oil).

Web Address:

http://www.amsa.gov.au/Marine_Environment_Protection/National_Plan/Contingency_Plans_and_Management/Research_Development_and_Technology/Effects_Oil_Seagrass.asp

COMPLETED PROJECTS

Investigation Into the Feasibility of Using Magnetic Particle Technology for Oiled Wildlife Cleaning in the Field (2006-07)

Project Conducted by:

Victoria University

Background:

The application of magnetic particle technology to environmental remediation in general, and to wildlife rehabilitation in particular, has been under investigation at Victoria University for a number of years, in collaboration with the Phillip Island Nature Park Research Department, and has been the subject of a number of peer-reviewed journal articles.

Participants at the 2nd National Plan Oiled Wildlife Workshop in 2004 and at the Environmental & Scientific Coordinators Workshop in 2005 recommended that the National Plan develop a research project to build upon the previous work of Victoria University and consider the feasibility of application in the field

A proposal was considere by NPOG 11, and finally endorsed by NPOG 12 (May 2006).

Phillip Island Nature contributed additional financial assistance and in-kind support for this project. AMSA contracted VU to undertake the project and manage the contribution of PINP, and research was carried out between July 2006 and March 2008.

Application of results:

The outcome of this project is a basic evaluation of magnetic cleansing compared to conventional detergent-based methods, including benefits to oiled wildlife, particularly with regard to handling time (and therefore stress); cost of materials and deployment; logistics; and waste disposal. It recommends the future direction of research into the field application of this technique.

Web address:

http://www.amsa.gov.au/Marine_Environment_Protection/National_Plan/Contingency_Plans_and_Management/Research_Development_and_Technology/Magnetic_Cleansing.asp

Bunker Fuel Weathering and Fingerprinting (2004-05)

Project Conducted by:

Leeder Consulting

Background:

Intentional and illegal discharge of bunker fuel oil and waste oils at sea from vessels is the most common type of oil spill investigated by Australian regulatory agencies. Oil spill statistics compiled by AMSA highlight an increasing proportion of "mystery fuel oil spills" where the source of the spill is unknown. This not only creates a problem in meeting the obligations to properly enforce the International Convention for the Prevention of Pollution from Ships 1973/78 (MARPOL 73/78), it also makes recovery of any response costs difficult.

When investigating and prosecuting mystery spills, authorities need to be able to determine how long the spilt oil has been at sea. Recent court cases in Australia have raised concerns regarding a lack of fundamental data on the rate and timing of bunker fuel oil weathering at sea. Because weathering of the oil changes its chemical properties, chromatographic profiles for weathered oils can look very different to profiles for fresh oil samples from ships.

To address the identified lack of data, funding was allocated from the National Plan and a consultant engaged (Leeder Consulting – Melbourne) to carry out a research project on the effects of weathering at sea of various grades of bunker oils. Oil weathering studies can provide physical and chemical data on how bunker oils change over time and can provide an estimate as to how long they have been on the water. This data can be used as an input to improve modelling capabilities and is useful for prosecution purposes as well as determining the window of opportunity for combat techniques.

Results:

A series of marine bunker fuel oils of different viscosities (180, 280 and 380 cSt) were artificially weathered in a laboratory under moderate and extreme wind and sea temperatures. The weathering process was videoed and the physical properties (viscosity and pour point) and mass balance of the remaining oil was determined after 9, 24, 48 and 96 hours of simulated summer and winter conditions. Samples were taken of the oil residues for chemical (biomarker) fingerprinting analysis by gas chromatography and mass spectrometry (GC/MS).

The results of the GC/MS chemical analysis technique undertaken on the weathered bunker fuel oil residues demonstrated that even after extreme weathering at summer conditions over 96 hours the biomarkers were still intact. This highlights that the specific biomarker used and the ratios calculated are highly resistant to weathering and an excellent marine oil spill source identification tool. This provides the National Plan with demonstrated proof of the effectiveness of the oil spill fingerprinting techniques used in our investigations of oil pollution incidents.

The weathering, mass balances and oil properties tested provided some interesting results:

- bunker fuels that were rated with equivalent oil specifications on viscosity have quite different weathering rates and residual oil properties;
- as would be expected, both the pour point and kinematic viscosity of the bunker fuel oils were found to increase with time as the oil weathered;
- the viscosities of the weathered bunker fuels after 96 hours increased on average by two orders of magnitude;

- all bunker fuels tested were found to have lost an average of 30% by volume after 96 hours weathering under all test conditions; and even after the most extreme weathering approximately 70% of the bunker fuels remained as a solid residue on the water surface;
- once the pour point of oil exceeds the seawater temperature, mainly between 9-12 hours of weathering, the oil can be regarded as solid non-spreading oil, and dispersant effectiveness will be very low;
- after only 9 hours weathering of all the oils tested, even under moderate winter conditions, the pour point of the remaining oil was higher than the sea temperature, that is, it would be a solid residue on the water surface.

The main conclusion reached by the consultant is that even where the initial grade and specification of the bunker fuel and weathering conditions experienced at sea is known it is not possible to predict the physical properties of weathered bunker oil residues. The weathering characteristics of unknown bunker fuels cannot be predicted with any accuracy as bunker fuels are made from a blend of heavy residual oils and lighter viscosity "cutting" oils from around the world that vary in physical properties and chemistry.

To determine the weathering rate of marine bunker fuel and the physical properties and behaviour of any residues it would therefore be necessary to carry out laboratory weathering of the oil in question under controlled conditions.

Caution should also be taken with any oil weathering models in spills involving marine bunker fuel oils that are not fully characterised.

In summary, the results of this successful project have contributed to an improved understanding of marine bunker fuel properties, behaviour, variability and weathering. Also the study has demonstrated the effectiveness of the oil spill fingerprinting techniques employed by local analytical testing laboratories for National Plan oil spill investigations.

Application of Results:

This report has been distributed to National Plan State/NT Committee Chairs who were asked for forward it to relevant personnel in their jurisdictions responsible for oil spill investigations.

Web Address:

http://www.amsa.gov.au/Marine_Environment_Protection/National_Plan/Contingency_Plans_and_Management/Research_Development_and_Technology/Fingerprinting_Database.asp

Rescue and Rehabilitation of Oiled Birds Field Manual (2004)

Project Conducted by:

Erna Walraven from Sydney's Taronga Zoo with components prepared by relevant wildlife specialists.

Background:

Erna Walraven first published this document in 1992 with the support of Taronga Zoo. Dr Walraven, as her own initiative, updated the text and in 2003 approached the National Plan for funds to facilitate its republication, including specialist input from six additional authors, peer review and printing.

Results:

A 192 page field manual providing information to assist in the development of contingency plans for oiled wildlife, and guidelines for field staff on handling, treatment and rehabilitation of oil-affected birds.

Application of Results:

At the time of publication, 500 copies of the field manual were widely distributed to National Plan oiled wildlife responders, State Committees and Maritime Agencies

A copy of the manual is included in the National Plan Oiled Wildlife Response Kits.

The copyright is held by Taronga Zoo and is available through the Zoo.

A Review of Recent Innovations and Current Research in Oil and Chemical Spill Technology (2002-03)

Project Conducted by:

Asia-Pacific Applied Science Associates (APASA) and The Ecology Lab

Background:

The Environment Working Group identified this project as a priority to address one of the objectives of the National Plan RD&T Strategy, namely: "to monitor relevant worldwide oil and chemical pollution RD&T activities, identifying those applicable to Australia". NPOG 3 (November 2001) endorsed the undertaking of this project.

The review aims to summarise recent innovations and current worldwide research in the areas of oil and chemical spill response technology. It does not attempt to synthesise information on the extensive commercially available technologies except where research addresses the limitations to such equipment and technologies. The scope of the review is limited to spills affecting marine and estuarine water relevant to Australian conditions.

Data were collected from a wide range of sources with focus on post 1998 international conference proceedings, trade notes and publications as well as information published on the World Wide Web, particularly by primary research organisations.

Results:

A 77-page report including references and www-links covering the following areas: spill preparation, testing and training; spill detection, surveillance, tracking and measuring; detection of submerged oil slicks; oil spill trajectory and fates models; data assimilation to improve trajectory and fates modelling; electronic spill management software; containment technology; performance testing of oil recovery devices; fast water oil recovery; oil recovery in high wave conditions; skimmer performance for problem oil types; pumping and handling of high viscosity oils; emulsion handling; oily waste treatment, handling and recycling; in-situ burning of oil spills; research on chemical dispersants; decision support for dispersant application; surface washing agents; shoreline cleanup and bioremediation; wildlife management and minimisation; developments in chemical spill response; and funded research efforts by international agencies.

Application of Results:

The report is available as a reference for the National Plan Operations Group working groups. The most recent (2006) proposal by the Environment Working Group for an RD&T project is consistent with an area identified by this work – the use of magnetic particle technology for cleaning oiled wildlife.

The report is identified on the National Plan RD&T page the AMSA website with an email address to contact for a copy.

ESCs were asked to examine the executive summary of the report in advance of the 2005 ESC Workshop in preparation for the RD&T session. The entire report was placed on the ESC network website in May 2005, and is currently available from AMSA's website.

Web Address:

http://www.amsa.gov.au/Marine_Environment_Protection/National_Plan/Contingency_Plans_and_Management/Research_Development_and_Technology/Literature_Review_Project.asp

Properties of Naturally Degrading Sorbents for Potential Use in the Clean-up of Oil Spills in Sensitive and Remote Coastal Habitats (2000-2001)

Project Conducted by:

Centre for Research on Ecological Impacts of Coastal Cities, University of Sydney

Background:

NPAC 12 endorsed two projects identified by State/NT ESC's to commence in 1999/2000:

- Investigation into the Establishment of National Guidelines for the Clean-up of Oiled Foreshores (How Clean is Clean - How Dirty is Dirty?); and
- Research into the Use and Application of Biodegradable and Nutrient Enriched Oil Spill Sorbents in Sensitive and Remote Oiled Foreshores.

Following consideration of the proposals, the Committee agreed that the proposal put forward by the Centre for Research on Ecological Impacts on Coastal Cities (University of Sydney) met the evaluation criteria.

Results:

Eight key issues were identified for investigation:

- the range of naturally-occurring, biodegradable sorbents currently available (either as purpose-made products or waste-materials);
- physical and chemical actions of the sorbents on different kinds of oils;
- the rate of degradation of oils in the different sorbents and of the sorbents themselves;
- the leachability of oil from different sorbents and information on potential environmental and biological impacts;
- methods for applying the different sorbents and an assessment of whether they could easily deployed on floating slicks or oiled foreshores;
- reported advantages/disadvantages or limitations of available sorbents in oil-spill events;
- reported experiences of actual use of naturally-degrading and/or nutrient enriched sorbents in oil-spill events; and
- current indicative costs, storage requirements and shelf-lives of different sorbents.

The best types of sorbents are those with great capacity for primary absorption of oil. These are primarily sorbents formed from long fibres, such as wool, cotton and so forth. One product a wool sorbent, Wool Kmop, has the greatest IOP (initial oil pick-up) and MOP (maximal oil pick-up) of any sorbent considered. It could also be re-used a substantial number of times (in terms of laboratory tests). Wool-based sorbents have further merits. They are natural, available on a sustainable basis and handling, storage and transport of wool are routine in many parts of Australia. Other possible sorbents with useful properties were also identified, using a diverse set of criteria.

There were, however, uncertainties and limitations on recommendations. Apart form the lack of any information on several of the key issues, much of the best comparable data came from laboratory tests by Environment Canada. Comparability was reduced because techniques and methods changed from time to time. The validity of results for real use, in the field, cannot be determined from such laboratory trials (however well they are done) and no field assessments could be found.

A decision to deploy or to deploy and retrieve sorbents must be precautionary in environmental terms, regardless of the actual materials chosen. Thus, deploying a sorbent is sensible (and essential) if the ecological consequences are less than leaving the oil alone (which is not always the case in coastal marine habitats) or retaining oil is some area is of paramount importance to protect other areas. In the latter case, any degradation due to sorbents is justifiable in terms of the potentially greater damage elsewhere.

Similarly, deciding to retrieve oil-soaked sorbents must be based on knowledge that retrieval will do less damage than leaving the material on-site. This is likely not to be realistic in some habitats. Decision-making is hamstrung by a lack of field trials to determine the scale and nature of any environmental threats. It is strongly recommended that the necessary field experiments be done with any sorbent chosen for use.

The Review and Development of Guidelines for the Sampling and Monitoring of Areas Impacted by Maritime Oil and Chemical Spills (1999-2000)

Project Conducted by:

Wardrop Consulting (Australia) and the Cawthron Institute (NZ)

Background:

At NPOG 3 (November 2001), EWG identified the importance of developing nationally accepted procedures for the sampling and monitoring of areas affected by maritime oil and chemical spills, focussing on both Type I (during spill for response decision-making) and Type II (long term post-spill) monitoring.

Recognition of this requirement had also been a recurring theme amongst the ESC network for some years.

The aim of the project was to:

- determine the practical difference between Type I and II monitoring;
- provide a mechanism by which responders can evaluate the effectiveness of response strategies, for the benefit of future operations;
- prevent the States/NT from reinventing the wheel with regard to methodology following every spill; and
- improve cost recovery process and outcomes if P&I clubs are presented with costs based on uniform and nationally approved scientific methodologies.

The Wardrop/Cawthron partnership was selected through a request for tender. The tender evaluation panel included AMSA and EWG representatives.

Results:

A Background Paper, which provides guidance about the nature, justifiable scope, and scale of post spill monitoring programmes. It focuses predominantly on oil spills, although the concepts presented are generally applicable to all types of marine spills. The Background Paper defines and discusses the rationale for classifying post spill monitoring into two general types: Operational (Type I) and Non-Operational or Scientific (Type II) monitoring. It explains the significance of these terms, addresses funding and cost recovery aspects, and describes the key design aspects that must be considered when establishing a monitoring programme.

The Oil Spill Monitoring Handbook (AMSA, 2003), 106-page field handbook, which is designed to provide field guidance for the planning and execution of monitoring of oil spills for Operational purposes. A quick reference guide accompanies the Handbook.

Application of Results:

The Oil Spill Monitoring Handbook and Background Paper were distributed to State Committees in Australia and through MSA in New Zealand.

The hard copy versions are now out of print, but electronic copies are available. The Handbook is provided to Environmental & Scientific Coordinators on the ESC Training and Induction CD-ROM.

The Handbook and Background Paper are available through the AMSA website.

Web Address:

http://www.amsa.gov.au/Marine_Environment_Protection/National_Plan/Contingency_Plans_and_Management/Research_Development_and_Technology/Oil_Spill_Monitoring.asp

Research in to the Bioremediation of Oil Spills in Tropical Australia: with particular emphasis on oiled mangrove and salt marsh habitats (1995-98)

Project conducted by:

Australian Institute of Marine Sciences

AEA Technology UK

Results:

This three-year project (1995-98) assessed short term effects of commonly transported oils and in situ bioremediation on tropical Australian mangrove and salt marsh habitats. Bioremediation strategies were developed from laboratory, mesocosm and preliminary field studies.

Flask experiments demonstrated the presence of hydrocarbon degrading micro-organisms in local tidal wetland habitats, the importance of oxygen in their activity, and a lack of appreciable inhibition from mangrove pore waters.

Aeration trials showed forced aeration could appreciably increase the depth of the aerobic surface layer of sediments.

Field trials in mangroves and salt marsh habitats gave mixed results for the effectiveness of bioremediation. There was no apparent reduction in impact on mortality of vegetation in either habitat where bioremediation strategies were applied to oiled plots. However, in mangrove plots one year after oiling, canopies had greater densities of leaves in bioremediation plots, sometimes greater than control levels. Concentrations of oil and prior condition of leafy canopies, along with levels of insect folivory and densities of grapsid crabs all influenced mortality of mangrove trees. Numbers of sipunculid worms in sediments one year after oiling appeared to have largely recovered in oiled plots treated with the bioremediation strategy.

Application of Results:

Findings from these studies form the basis for improved guidelines and recommendations for the cleanup and restoration of oiled mangrove habitat around Australia, and elsewhere.

Web Address:

http://www.amsa.gov.au/Marine_Environment_Protection/National_Plan/Contingency_Plans_and_Management/Research_Development_and_Technology/Bioremediation_Mangroves.asp

National Oil on the Sea Identification Database (1995)

Project Conducted by:

Australian Geological Survey Organisation (AGSO) – now part of Geoscience Australia

Australian Government Analytical Laboratory (AGAL)

Results:

Australia's National Oil-on-the-Sea Identification Database (NOSID) contains organic geochemical data on a reference set of 30 oils that is used to characterised (or fingerprint) an oil. The data on these oils have been produced from a variety of analytical methods including isotope, UVF, GC and GC-MS (biomarker) analyses.

The NOSID database and the Oil Identification Reference Kit are the products of collaboration between the Australian Geological Survey Organisation (AGSO), the Australian Government Analytical Laboratories (AGAL) and the Australian Maritime Safety Authority (AMSA).

Web Address:

https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=36000

Oil Identification Reference Kit (1995)

Project Conducted by:

Australian Geological Survey Organisation (AGSO) – now part of Geoscience Australia

Australian Government Analytical Laboratory (AGAL)

Results:

The Oil Identification Reference Kit (OIRK) is a subset of the oils registered in Australia's National Oil-on-the-Sea Identification Database (NOSID). It's purpose is to provide laboratories engaged in oil fingerprinting with a series of well characterised reference oils and the materials, methods and reference data to support quantitative analysis of petroleum biomarkers. Biomarker methods are rapidly being incorporated in oil identification protocols as they offer several advantages over traditional methods. There is a lack of commercially available reference materials, especially those suitable for quantitative determination. The NOSID database and the OIRK are the products of collaboration between the Australian Geological Survey Organisation

(AGSO), the Australian Government Analytical Laboratories (AGAL) and the Australian Maritime Safety Authority (AMSA).

Web Address:

https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=36000