Marine Biodiversity Hub

National Environmental Science Programme

Changes in pressures on the marine environment – how has use varied over decades?

Piers Dunstan

Project C1 – Improving our understanding of pressures on the Marine Environment

10 August 2018

Milestone 6&7 – Research Plan v3 (2017)

CSIRO

Enquiries should be addressed to:
Piers Dunstan
CSIRO Oceans and Atmosphere

Project Leader's Distribution List

Department of the Environment and Energy:
Amelia Tandy
Amanda Richley
David Logan
Matt Whitting
Lin Boon
Carolyn Armstrong

Preferred Citation

Piers Dunstan (2018). Changes in Pressures on the Marine Environment – how has use varied over decades? Report to the National Environmental Science Programme, Marine Biodiversity Hub. CSIRO.

Copyright

Acknowledgement

This work was undertaken for the Marine Biodiversity Hub, a collaborative partnership supported through funding from the Australian Government's National Environmental Science Program (NESP). NESP Marine Biodiversity Hub partners include the University of Tasmania; CSIRO, Geoscience Australia, Australian Institute of Marine Science, Museum Victoria, Charles Darwin University, the University of Western Australia, Integrated Marine Observing System, NSW Office of Environment and Heritage, NSW Department of Primary Industries.

Important Disclaimer

Contents

List of Figures

1. EXECUTIVE SUMMARY

Pressures in the marine environment will change the status and trends of many different values (ecological, social and economic). However, an understanding of how pressure has changed around Australia has not been available until now. This analysis shows that pressure in all the marine regions (Temperate-East, South-East, South-West, North-West, Coral Sea and North) is highly variable and changes as a function of regulatory, social and economic interests. Pressures are analysed for the periods 1966-1970 (for anthropogenic noise) through to 2011-2015 (for all pressures). There is a general pattern of decreases in fisheries and increases in oil and gas and shipping activities throughout the Australian Exclusive Economic Zone. Increased cumulative pressure is especially evident in the South-West due to increases in some fisheries, anthropogenic noise and climate change. However, all other marine regions show increases in many combinations of pressure and climate change remains present in all marine regions. The overlaps with matters of national environmental significance (MNES) are identified and may be responsible for changes in their status. It is recommended that the next stage of this work is to identify which pressures affect each MNES (and by how much) and use this information to develop national heat maps that identify for each MNES where the cumulative pressures are greatest. The pressure data has been collated, supplied to the Department of the Environment and Energy (DoEE), is available through web services, and used in the 2016 State of the Environment (SOE) report.

2. INTRODUCTION

The Australian Exclusive Economic Zone (EEZ) and territorial seas have seen significant shifts in the way they are being used, especially in the decades since the establishment of United Nations Convention on the Law of the Sea (UNCLOS). Australia became a party to UNCLOS and exercised control over all seas from 12 nautical miles (Nm) to 200Nm in 1994. This caused significant changes in the way that Australia was able to manage its surrounding oceans and coincided with the Seas and Submerged Lands Act 1973, Environment Protection and Biodiversity Conservation Act 1999, the Fisheries Management Act 1991, the Australian Maritime Safety Authority Act 1990 and the Offshore Petroleum and Greenhouse Gas Storage Act 2006. The establishment of these Acts and subsequent regulations contribute in different ways to changing the way that the Australian EEZ and territorial seas are used and which pressures from these uses will affect biodiversity.

Since 2002 there has been a dramatic increase in the economic benefits of marine industries. From 2002 to 2014, the marine economy in Australia grew from $23,779.7 million to $73,083.3 million dollars, with the biggest increases in offshore oil and gas (AIMS index of marine industry 2016). The analysis presented here shows how the use of the Australian EEZ has changed and how that use is distributed unevenly throughout the Australian EEZ. Differences in the distribution and intensity of pressures from human use reflect both the changes in governance and changes in the opportunities to use different parts of the marine environment.

To understand both the temporal and spatial trends in the use of the Australian EEZ we have summarised use across the six different marine regions as used in the 2016 State of the Environment report. This spatial domain also largely encompass the Australian Marine Park Networks aligned with each of the marine regions. These marine regions were derived in part from the Integrated Marine and Coastal Regionalisation of Australia (IMCRA 4) and form the basis to the environmental management of Australia's EEZ. Summaries at the regional scale capture the major patterns of change and provide important context for changes that occur at smaller scales – such as at the scale of Key Ecological Features (KEF), Biologically Important Areas (BIA) and Australian Marine Parks (AMP).The same time series of data were used to calculate cumulative pressure. This provides a key tool to understanding the state and trends of pressure on the marine environment, identifies areas that are subject to many pressures, and will support an improved understanding of the potential impacts these activities may have on the marine environment, locally and nationally.

3. COMMERCIAL FISHING

Beginning in the early 1980s, there was a major expansion in Australian commercial fishing, corresponding with the establishment of the Australian EEZ, especially in the deep water trawl fisheries (Bax et al 2005). Following this there was an expansion of the long line fisheries in the eastern marine region and trawl fisheries in the South-east Marine Region (Figure 1).

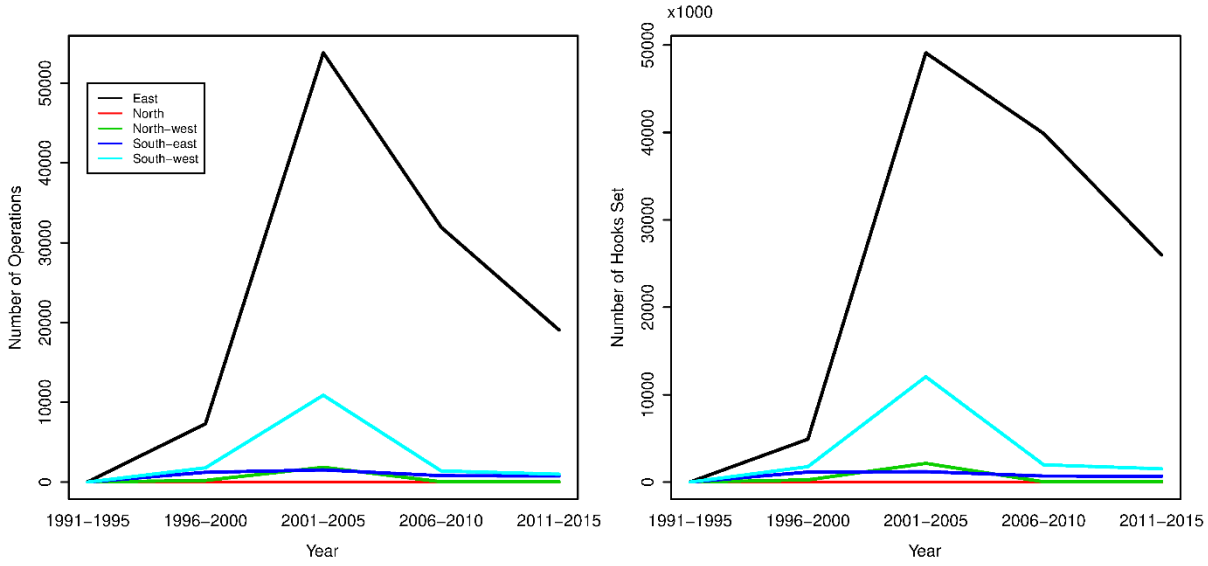


Figure 1. Change in Pelagic Long Line fisheries from 1991 to 2015. Totals are calculated for each marine region where fisheries occurred.

Also apparent is the exclusion of foreign fishing fleets from the Australian EEZ in the North and North western marine regions as UNCLOS came into force (Figure 2). Prior to the establishment of the Australian EEZ, there were extensive foreign fleets operating on the Australian shelf and slope, including fleets from Russia and Taiwan.

The peak in domestic trawl and long-line fisheries came in the early 2000's, at which point the Australian Fisheries Management Authority (AFMA) was working to develop harvest management strategies and ecological risk assessments for the ecosystem effects of fisheries for all its fisheries to ensure the long term sustainability of the stocks. Formal harvest strategies were adopted in 2006 for the South East Trawl fishery (Smith et al 2014) and were followed by a statutory requirement for AFMA to recover overfished stocks and prevent future overfishing (DAFF 2005). The development of harvest strategies and the structural buy-back of excess capacity contributed to a substantial decline in fisheries effort since their implementation (Figures 1 and 2) (Smith et al 2014). These changes were applied to all Commonwealth fisheries and are consistent over all gear types. The decline in effort was matched by a decline in the spatial footprint of fisheries.

Methods

Commercial fisheries pressure was calculated from the AFMA log book data on Commonwealth Fisheries in the Australian Economic Zone (excluding Cocos and Christmas Islands, Norfolk Island and the Sub-Antarctic Fisheries). The logbook data has been recorded and submitted to AFMA by commercial fishers. The data has been aggregated to produce summaries of total

effort by gear type (summarised across fishery), over 5 year periods and at a 0.1 degree resolution where 5 boats or more operate.

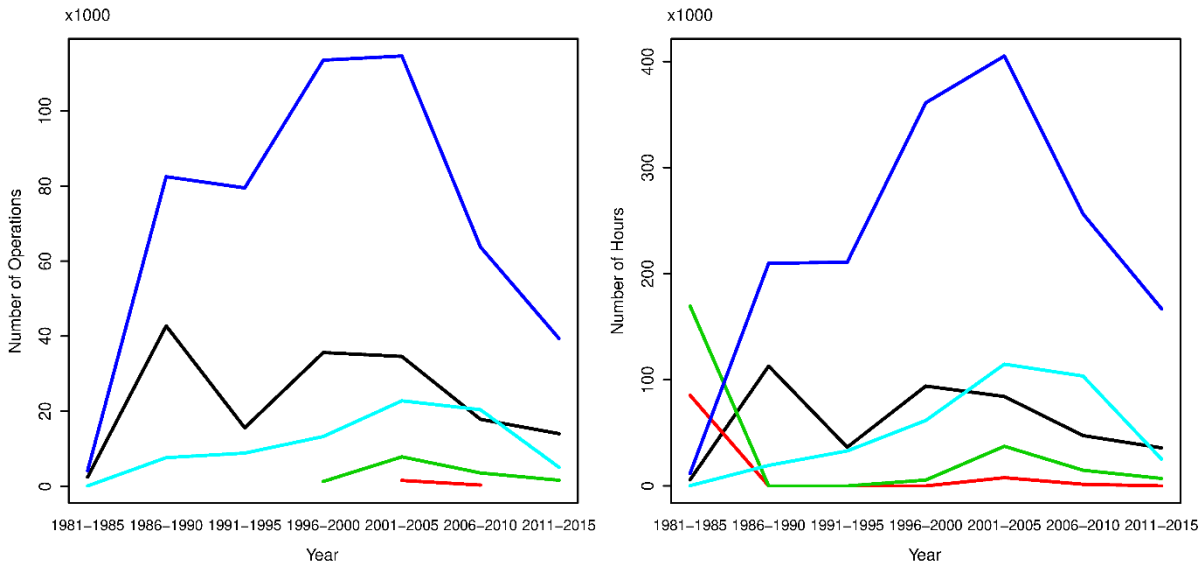


Figure 2. Change in Trawl fishery effort from 1980 to 2015. Totals are calculated for each Marine Region where fisheries have occurred.

4. MARINE VESSEL ACTIVITY

Understanding changes in the distribution in marine vessel activity is more difficult than for Commonwealth fisheries, where vessels are required to carry transponders and record activities in logbooks. Marine vessel activity is primarily reported to reduce the risk of collisions and ensure safety of life at sea (https://www.amsa.gov.au/navigation/services/ais/). From 1999 to 2011, the positions of shipping were recorded under the Australian Ship Reporting System (AUSREP), where masters of vessels were required to report their position once per day by radio. This resulted in a coarse map of tracks with a single record per day. However, since 2012, vessels have been automatically reporting their positions using the automated identification system (AIS) system, which can provide reports of locations up to every 5 seconds. Shipping larger than 300T (international transit), 500T (domestic shipping) or carrying more than 12 passengers is required to have operations Class A AIS. In addition, a large number of vessels have installed Class B AIS, which is voluntary on all vessels not meeting the Class A criteria. This has allowed unprecedented understanding of where activity is occurring in the Australian EEZ across a wide range of vessels.

To understand the changes in shipping between Marine Regions from 1999 to 2015, we examined the percent change in the total distance covered by shipping in each Marine Region (thereby standardising for differences between AUSREP & AIS). Shipping in the Temperate East Marine Region has contributed to the largest proportion of vessels for most of the time series, with increases in shipping in the North-west Marine Region leading to activity in that area exceeding the Temperate East for the first time in 2012 (Figure 3). This increase in shipping is linked to increases in exports of minerals and oil and gas. Over this time, the number of cargo vessels involved in coastal or international voyages also increased from 3291 to 5475 ships (BITRE 2016).

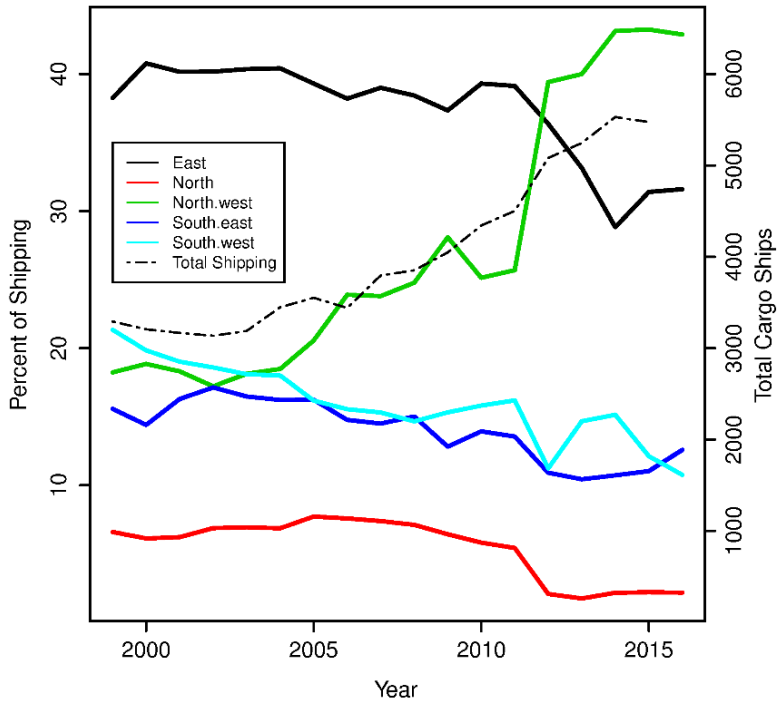


Figure 3. Change in the percentage of shipping in each Marine Region from 1999 to 2015. Changes are calculated on the percent of total movement distance within each Marine Region and combine AUSREP and AIS data. The right axis shows the number of cargo ships involved in coastal or international voyages that made port calls (Total Shipping) (BITRE 2016)

Methods

This data is a combination of records held by the Australian Maritime Safety Authority. From 1999 to 2011 Australia shipping was tracked through the Australian Ship Reporting System (AUSREP). From 2012 onward this changed to the Automatic Identification System (AIS). The data presented here are summaries of the tracks of vessels between the points identified by either AUSREP or AIS, summarised to the number of KM travelled per 0.1° grid square.

The AIS is a Very High Frequency (VHF) radio broadcasting system which enables AIS equipped vessels and shore-based stations to send and receive identifying information. AIS has a high update frequency and can be used for vessel management and collision avoidance (https://www.amsa.gov.au/navigation/services/ais/). Australian Ship Reporting System (AUSREP) is a ship reporting system designed to contribute to the safety of life at sea. Participation in AUSREP was mandatory for certain ships but most other commercial ships participate voluntarily. Shipmasters send a position report each day at a convenient time nominated by the ship, the maximum time between any two reports is not to exceed 24 hours. The data is used as reference material only, designed to indicate shipping lanes and the number of vessels moving through Australian water. (https://www.operations.amsa.gov.au/Spatial/DataServices/MapProduct)

5. ANTHROPOGENIC NOISE

Linked to shifts in shipping have been changes in the distribution and intensity of seismic surveys and development of oil and gas infrastructure. There has been extensive surveying of the Australian shelf, slope and abyss, occurring since the 1960's. A peak in both 2D and 3D activity occurred in the 1990's, with particular focus on the North West shelf. Surveys have occurred in highest numbers in the North-west Marine Region, with smaller numbers in the South-east and South-west Marine Regions. There has also been a change in the technology used. Prior to 1990, 2D survey techniques were used, where a single cable with hydrophones attached was towed behind the survey vessel. From 1990 onwards there has been increasing use of 3D surveys, where a series of cables and attached hydrophones is towed behind the survey vessel, allowing a larger area to be surveyed with each transect. 3D seismic surveys are most common in the North-west Marine Region. As noted in the 2016 State of the Environment, the total area surveyed within the Australian EEZ is significant, and almost all the shelf has been surveyed with either or both of 2D and 3D techniques.

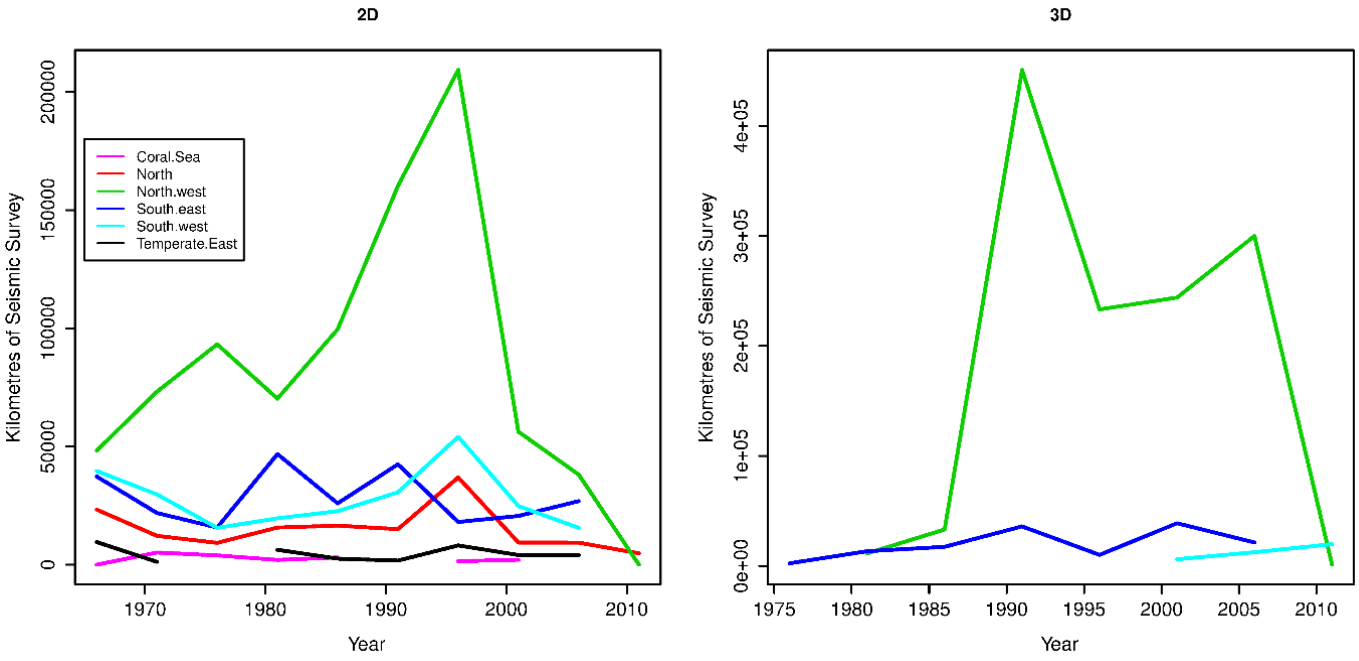


Figure 4. Change in the distance of 2D (left panel) and 3D (right panel) seismic surveys in each Marine Region from 1975 to 2015

Methods

This data set is a summary of seismic survey transects from 1961 to 2015. The data was summarised to 0.1°grids and the number of km of the grid surveyed over a 5 year period was calculated. Geoscience Australia summarised the logs of surveys from 1961 to June 2012 to produce spatial data. The spatial files have been created from a cleansed, updated collection of p190 navigation files that were submitted to GA by the surveyors. However, this was discontinued in June 2012. From June 2012, the distribution of seismic surveys was estimated using AIS spatial data and the records of vessel name and dates of surveys to identify the locations where surveys occurred and the tracks of each survey vessel as the survey was conducted.

6. OIL AND GAS PRODUCTION

The effects extensive seismic surveys can be seen in the subsequent development of oil & gas infrastructure. Early oil and gas development occurred primarily in the South-east Marine Region, but from the 1990's extensive seismic surveys informed the development of the North-west Marine Region, supporting an increase in oil and gas development as indicated by the number of wells (Figure 5). Oil and gas well drilling in the North-west is significantly greater than in any other marine region. The increases in production can also be seen by increases in shipping traffic, as noted in the section on Marine Vessel Activity. Individual wells are visible in the AIS data sets as high density aggregations of vessels.

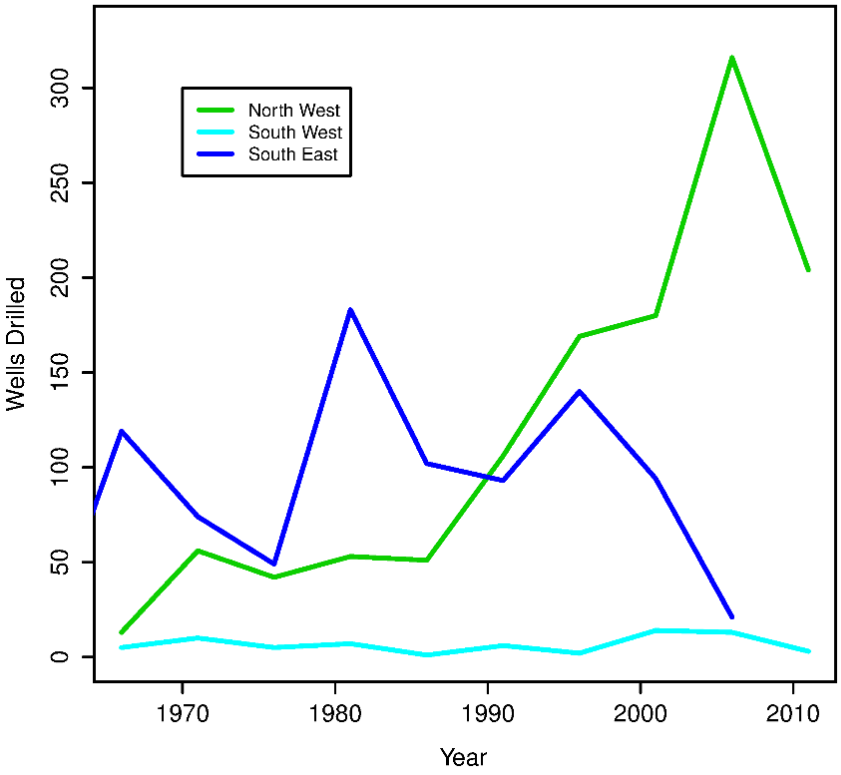


Figure 5. Number of Oil and Gas wells drilled in each marine region from 1970 to 2015

Methods

The records of the location of oil and gas wells drilled for all wells post 2011 were obtained from Australia's National Offshore Petroleum Titles Administrator. For well drilled prior to 2011 this information was also sourced from the State online archives from Queensland, New South Wales, Victoria, Tasmania, Western Australia and Northern Territory.

7. OIL POLLUTION EVENTS

The Australian Maritime Safety Authority (AMSA) coordinates the management and response of pollution incidents caused by shipping and related activities. AMSA has collected information on pollution events since 1970 and records their location and intensity. In order to understand the distribution of oil pollution events, this data has been summarised at 0.1 degree for all suspected and confirmed oil pollution events reported to, or suspected by AMSA. Data on the date, geographic location, source type and ship type was provided by AMSA. This data was summarised over the entire time period (1970-2016) and the count of the number of incidents produced. The most significant pollution events are concentrated around major ports (Figure 6). The data indicated that most pollution events occurred in the Temperate East and South-east marine regions, although there are significant numbers reported for the North-West Marine Region.

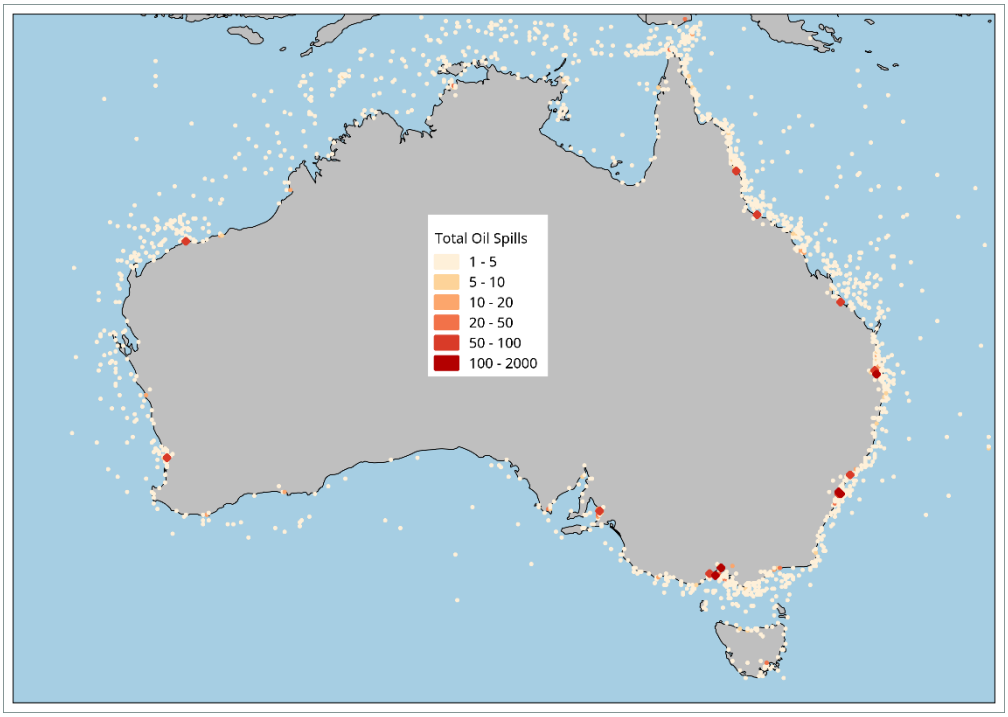


Figure 6. Total marine oil spills from 1970 to 2015

Methods

This data contains summaries at 0.1° of all suspected and confirmed oil pollution events reported to, or suspected by AMSA. Data on the date, geographic location, source type and ship type was provided by AMSA. This data was summarised over the entire time period (1970-2016) at 0.1° resolution and the count of the number of incidents produced.

8. POPULATION TRENDS

Australia's population has been increasing from 17.28 million in 1991 to 22.34 million in 2011. Most of the population growth has occurred in coastal areas. The change in population numbers adjacent to each marine region was estimated using Australian Bureau of Statistics (ABS) census data overlaid with the coastal areas 250km inland from each marine region. For the Coral Sea Marine Region, this included the coastal areas of the Queensland coast adjacent to the Great Barrier Reef. All marine regions are increasing in population. However, the increases for the Coral Sea and North Marine Region are very small, showing almost no change. The Temperate-east, South-east and South-west are increasing at approximately the same rate, but the North-west has shown a significant increase in population since 2006. This corresponds to the increase in marine shipping activity and oil and gas production.

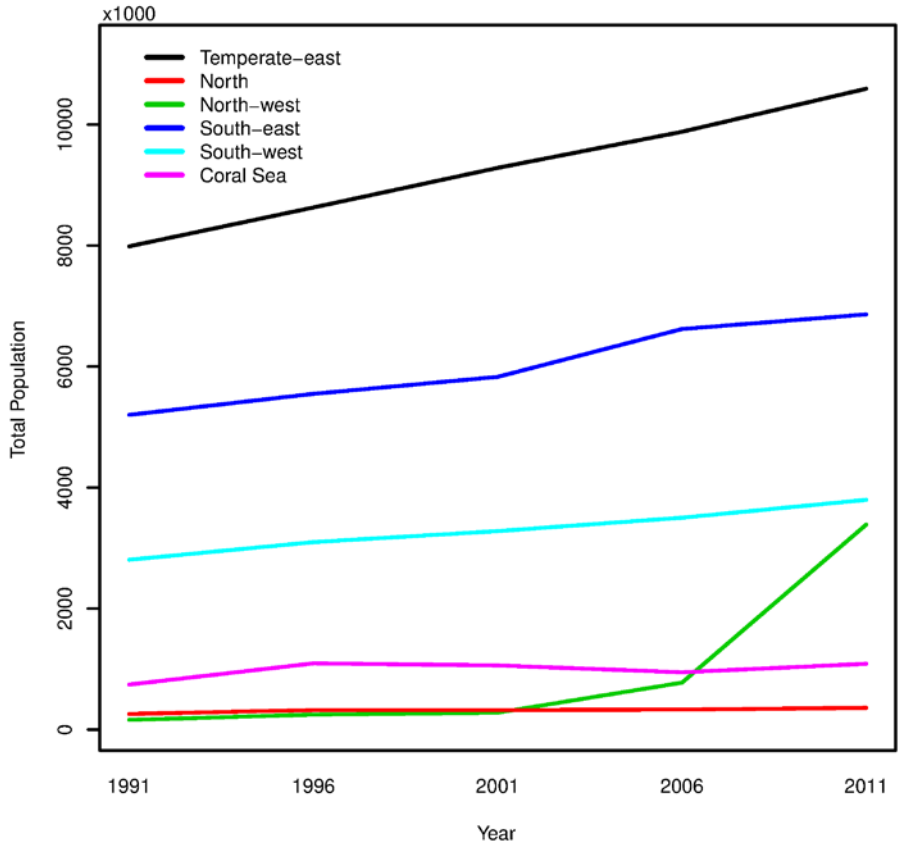


Figure 7. Change in population adjacent to each marine region

Methods

This data set contains the Australian Bureau of Statistics population data for Australian states and territories. Population data was collected as part of national census' in 1991, 1996, 2001, 2006 and 2011. Data presented is the total population for all collection districts by place of enumeration. District boundaries differed for each census and therefore were re-projected onto the 2011 population mesh blocks to standardise the spatial extent of the reporting areas. Given the focus of this project, population data was clipped by a 50km coastal buffer.

9. CHANGE IN SEA SURFACE TEMPERATURE

While most human uses occur in delimited areas, the physical properties of Australian oceans as a whole are also changing through time. To estimate the change and variability in sea surface temperature (SST), time-series data for the waters surrounding Australia, from 1999 to 2013 from satellite observations, were analysed. We partitioned variation in the SST series into annual trends, inter-annual trends, and a number of components of random variation. We used satellite data and validated the statistical summary from these data with summaries of data from long-term monitoring stations and from the global drifter program. The spatially dense results, available as maps from the Australian Oceanographic Data Network's data portal, show clear trends that associate with oceanographic features. Noteworthy oceanographic features include: average warming was greatest off southern West Australia and off eastern Tasmania, where the warming was around 0.6 0 C per decade for the twenty year study period, while there was insubstantial warming in areas consistently in the East Australian Current, although these areas did exhibit high levels of inter-annual variability (long-term trend increases and decreases with no increase overall). These results show that the South-east and South-west Marine Regions have had the largest increases in Sea Surface Temperature (SST). The changes in SST will add additional stress to marine systems that may already be affected by other activities and will add to the cumulative impacts on these systems.

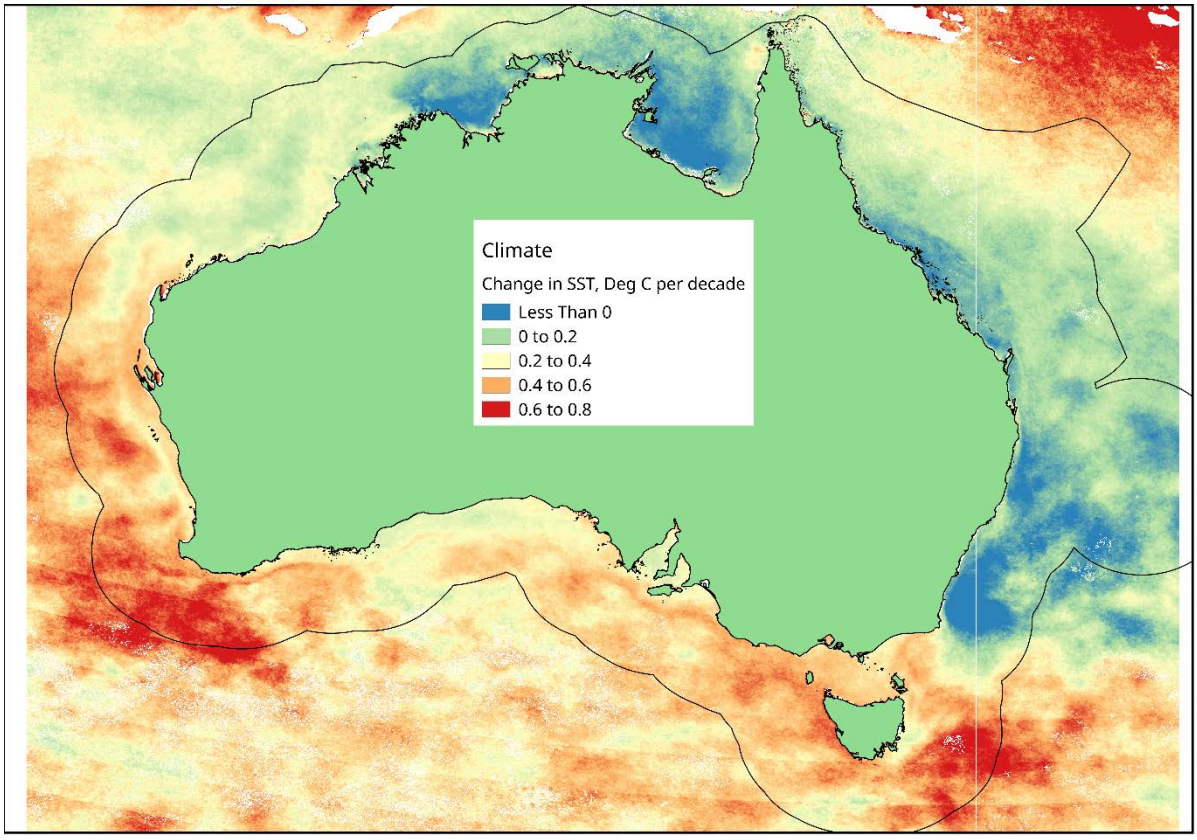


Figure 8. Change in sea surface temperature in degrees Celsius per decade in the Australian EEZ over a 14 year period from 1999 to 2013

Methods

The primary goal of the analysis was to produce a map of summaries of the observed SST change in the Australasian region. The SST data set is spatial and temporal and can be thought of as a large set of time series, one for each spatial grid cell. Each time series spans a period of approximately 20 years. The basic principle is that the temperature time-series, for any spatial location, can be decomposed into:

Inter-annual variability. This includes the long-term trend and any variability with multi-year time-scale.

Annual cycle. This is a periodic function with the same timing and amplitude every year.

Residual. All random (and some non-random) deviations from the model's expectation. It includes: a) patterns that occur on a time scale that is shorter than the 1-day data (diurnal effects – a cell is not measured at the same time each day), and 2) non-smooth trends and other model misfit issues.

10. CUMULATIVE PRESSURE ON THE MARINE ENVIRONMENT

Patterns of use in the marine environment changed by sector and across the different marine regions of the Australian EEZ. To understand how and where use changed, the proportional change in use intensity was calculated for each sector for each 5 year time period starting from 1966 when the first seismic data is available. The time periods 1996-2000, 2001-2005, 2006-2010 and 2011-2015 correspond to SOE reporting time periods.

The change in use was calculated as $\Delta Use_t = \log((Intensity\ of\ Use_t)/(Intensity\ of\ Use_{t-1}))$.

The change in use calculated in this way is unitless, enabling trends from divergent sources to be combined. To calculate the cumulative pressure the values of change were logged so that the values could be summed across the different sectors. This enables a mathematically sensible approach to looking at cumulative pressure. Rather than trying to sum different sectors that are measured in different units, this approach removes all units and standardises across the different sectors. This type of index of cumulative pressure is only possible where there is a substantial time series of use.

The patterns of cumulative pressure are highly variable between marine regions and through time (Figure 9). Several distinct patterns emerge. Cumulative pressure in the South-West Marine Region has been increasing for every 5 year period since 1981 and remains high. Examination of the components of pressure in the South-West indicates that most sectors that are operating in that region have been increasing in every 5 year block (Figure 10). Use in the South-East Marine Region is highly variable. This is a function of changing fisheries effort as different gear types are increased and then reduced (Figure 10). This is a pattern that has been occurring since 1981. The Coral Sea Marine Region is showing little change in use. The North Marine Region has not had significant increases in use, and has recently had significant decreases in the use of 2D and 3D seismic surveys. Activity in the North West Marine Region is complex. Overall, there has been a decrease in cumulative pressure. However, this is due to the substantial decrease in 2D seismic surveys, the sum of pressure excluding 2D seismic is positive. This is due to the significant increases in shipping, SST and population. Change in use in the Temperate East marine region is dominated by fishing. Contributions of other sectors in this marine region is very small compared to the variability seen in fisheries. In a similar way to the South-East, this marine region is highly variable as use of fishing gear changes.

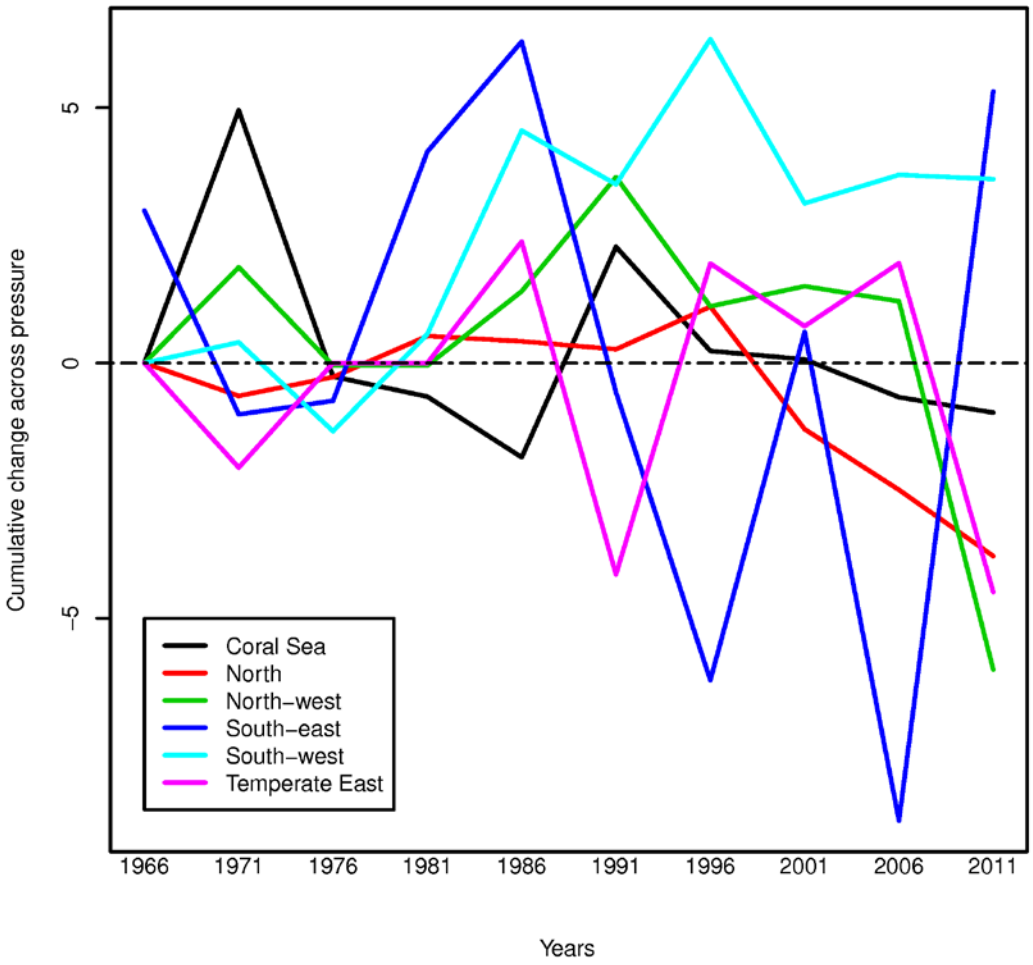


Figure 9 Cumulative pressure in each Marine Region

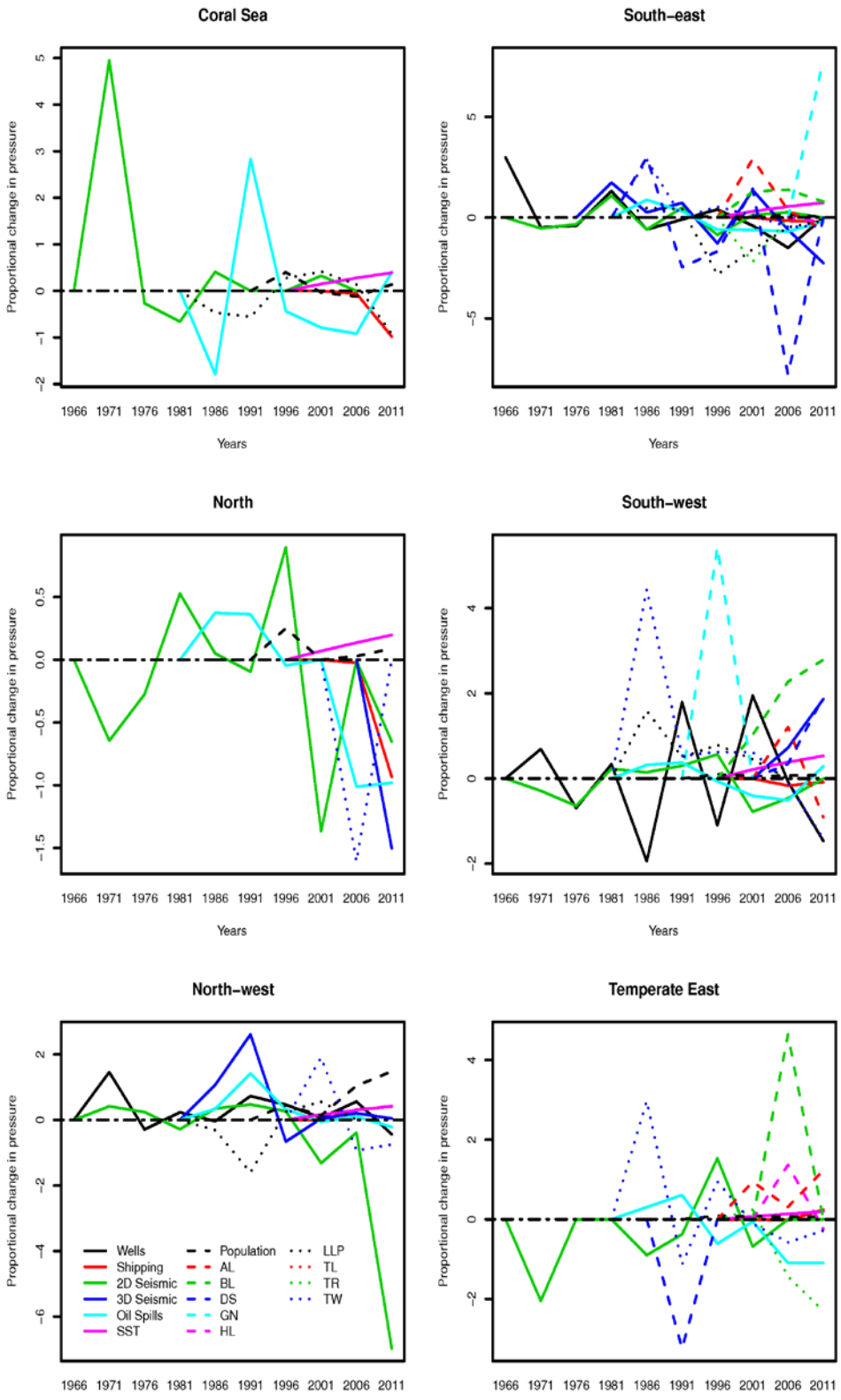


Figure 10 Change in Pressure in each Marine Region. AL Auto long-line, BL Demersal Long Line, DS Danish Seine, GN Gillnet, HL Hand Line, LLP Long Line Pelagic, TL Trotline, TW Trolling, TW Trawling

10.1 Changes in pressure by Marine Region

The use of the Australian marine environment has changed markedly over the past 30 years. Historically, the use of the Australian EEZ was primarily by fisheries. However, the introduction of fisheries harvest management strategies and increasing investment in oil and gas production, with its associated industries, has changed the use to primarily industrial production of oil and gas, shown in both the spatial footprint and the associated economic value. The distribution of pressures between Commonwealth Marine Regions is uneven, with different marine regions showing significant increases in some pressures and decreases in others. The Matters of National Environmental Significance (MNES), Key Ecological Features (KEF) and Australian Marine Parks (AMP) in each marine region will be affected in different ways, depending on the vulnerability of each MNES to each pressure. This highlights the need to move from understanding the intensity and distribution of pressure to understanding the distribution and intensity of impact on MNES, biogenic habitats and the cumulative and indirect interaction between the different sectors. A heat map that showed the likely cumulative impact of relevant pressures on each MNES around Australia is one product that could be developed. The current state and trends for each marine region are shown below. Each marine region is scored on the relative intensity of each pressure to the average intensity across the whole EEZ and the trend in pressure, derived from the analysis in Figure 10.

10.1.1 South East Marine Region

The South-east Marine Region has historically had very high levels of use compared to the rest of the Australian EEZ, due in large part to its proximity to major population centres. It has had high levels of trawl fisheries, shipping, seismic surveys and oil and gas infrastructure. However, over the last 15 years the direct use of the Commonwealth marine area from fisheries has significantly decreased (Figure 11), and seismic surveying and oil and gas production has moved to the North-west Marine Region. At the same time, the South-east Marine Region has had the largest increase in SST and associated climate effects in the Australian EEZ, and it has seen increases in shipping and pollution from both oil spills and due to increases in population.

Table 1: The relative intensity compared with other marine regions and trend of pressures in the South East Marine Region. ≈ indicates the relative trend is not changing.

Pressure	Intensity	Trend
Fishing	H	↓
Shipping	H	≈
Seismic	M	↓
Oil & Gas Wells	M	↓
Oil Pollution	H	↑
SST	H	↑
Population	H	↑

Increases in SST can be seen in all MNES, KEFs and AMPs in the South-east Marine Region. Key Ecological Features (KEF) with productivity features (e.g. the Upwelling East of Eden KEF and the Bonney Coast Upwelling) have seen increases in temperature and decreases in Chlorophyll a. All other MNES and Australian Marine Parks (AMP) within the marine region have also seen increases in SST.

Trawl and longline pelagic fisheries in the South-east Marine Region have declined over the last 15 years, since a peak that occurred from 2001 to 2005.Trawl and longline typically target different ecosystem features. Despite recent decreases in overall effort, trawl fisheries can be seen overlapping on shelf, slope, canyon and seamount MNES. Long line pelagic fisheries are concentrated in the north of the South-east Marine Region and will also overlap with the Upwelling East of Eden KEF. Gillnet fisheries have remained relatively constant over the region but are confined to Bass Strait and the coast of mainland Australia and Tasmania.

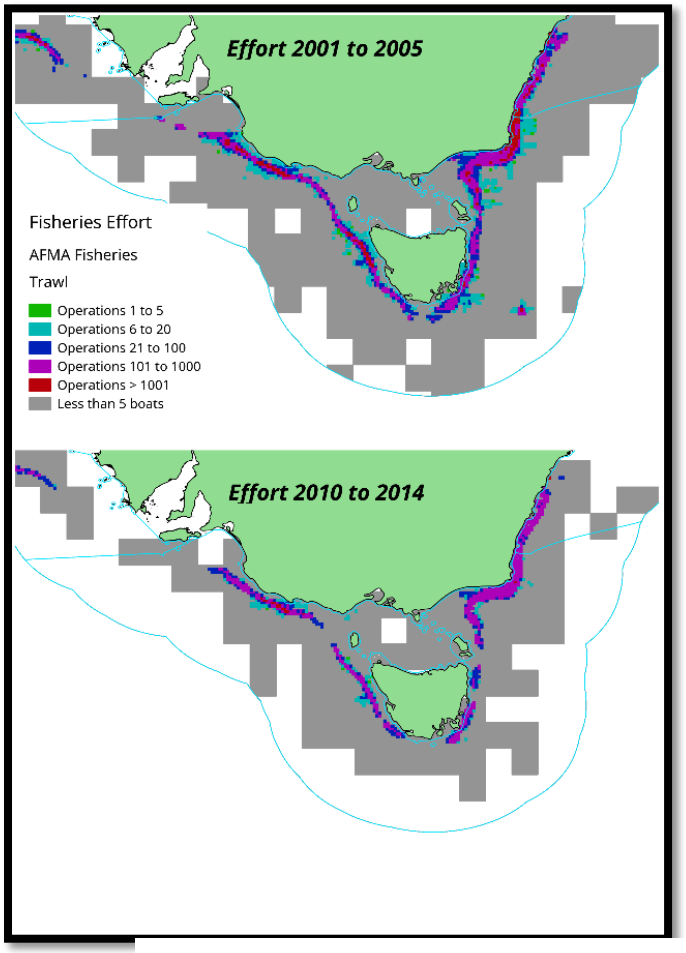


Figure 11. Changes in Trawl Effort from 2001 to 2014

Oil and gas production and seismic surveying has declined in the marine region over the last 30 years, although the decline in well drilling has only been minor. Seismic effort from 2011 to 2015 was very small and confined to an area south of Port Phillip Bay. This overlaps with biologically important areas (BIA) for seabirds and white sharks. Increases in shipping are extensive and overlapped with many MNES for cetaceans, other marine mammals and seabirds.

10.1.2 South West Marine Region

The South-west Marine Region has historically had lower levels of use than the South-east Marine Region. Both shipping and fishing levels have remained fairly constant. The trawl fisheries will intersect with the Ancient Coastline KEF. There are also small amounts of gillnet and demersal long line fishing in the coastal eastern portion of the marine region.

Table 2: The relative intensity compared with other marine regions and trend of pressures in the South West Marine Region. ≈ indicates the relative trend is not changing.

Pressure	Intensity	Trend
Fishing	L	↑
Shipping	M	≈
Seismic	H	↑
Oil & Gas Wells	M	↓
Oil Pollution	M	↑
SST	H	↑
Population	M	↑

There have been significant increases in seismic surveying, particularly in the Great Australian Bight in preparation for potential oil and gas extraction. This surveying intersects with BIAs for sperm whales and is adjacent to BIAs for pygmy blue whales. This may result in new oil and gas infrastructure but the current level of development by the oil and gas industry has been declining within the marine region (Figure 10). There has also been an increase in the levels of shipping and the major routes intersect with BIAs for cetaceans, other marine mammals and seabirds.

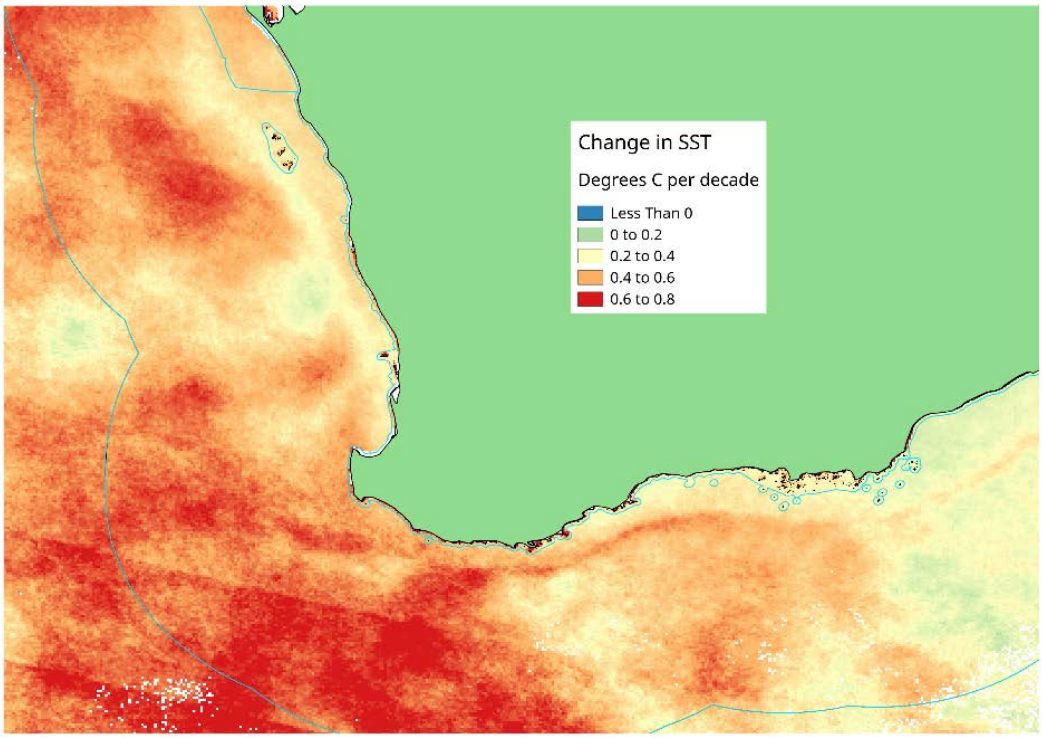


Figure 12. Change in SST in the SW Marine Region

A noticeable change in the South West Marine Region has been the increase in SST, particularly down the southern coast of Western Australia and around Cape Leeuwin, with the most obvious expression being the marine heatwaves in 2011 that have been well reported on the coast of Western Australia. The KEFS (Perth Canyon, KEFs for Western Rock Lobster and the Commonwealth Marine Environment adjacent to the coast KEF) and BIA (for multiple species of seabirds, southern right whales and sperm whales) in these areas may be vulnerable to the increases in temperature. Many seabirds forage extensively in the marine region (e.g. Great-winged petrel, little shearwater, short-tailed shearwater, white-faces storm petrel, soft plumaged petrel, Caspian tern, fairy tern) and overlap with areas of significant increases in SST. The South-east and South-west Marine Regions are both subject to the largest increases in SST in the Australian EEZ.

10.1.3 North West Marine Region

The North-west Marine Region has seen significant changes in use over the last 30 years. There has been a move from fisheries-based industries to oil and gas production industries. The marine region has seen significant increases in seismic surveying, shipping and oil and gas exploration and production. There have also been pollution events associated with this increase in production, including the Montara blow out in 2009. SST has increased within the marine region but not to the same degree as seen in the South-west or South-east Marine Regions. Population and oil pollution events have remained relatively stable.

Table 3: The relative intensity compared with other marine regions and trend of pressures in the North West Marine Region. ≈ indicates the relative trend is not changing.

Pressure	Intensity	Trend
Fishing	L	↓
Shipping	H	↑
Seismic	H	↑
Oil & Gas Wells	H	↑
Oil Pollution	L	≈
SST	M	↑
Population	L	↑

The significant increases in oil and gas production and associated industries (e.g. shipping and seismic surveys) overlap with most of the MNES and AMP in the marine region. There is extensive shipping, seismic activity, and oil and gas wells on the KEFs associated with the continental slope demersal shelf communities, canyons linking Cuvier Abyssal Plain and the Cape Range Peninsula, the Ancient Coastline at 125m depth contour and the Commonwealth waters adjacent to Ningaloo Reef. Many of the BIAs also overlap with the increases in shipping, oil and gas and seismic, such as BIAs for flatback, loggerhead and hawksbill turtles, humpback whales, wedge-tailed shearwaters, and shales sharks. Of particular note is the intersection of seismic surveys with the pygmy blue whale BIAs. The more southern MNES (eg Exmouth Plateau KEF, continental slope demersal fish communities, turtle and some seabird BIAs) will still be affected by increased temperature, but the northern MNEs (e.g. Carbonate bank KEFs, Snubfin dolphin BIAs and seabird BIAs) will only have small effects of increasing SST.

There has been an overall decrease in the Commonwealth fisheries effort in the marine region, with particularly notable decreases in longline pelagic fisheries and trawl fisheries. Most of the longline fishing effort was concentrated in the southern section of the North-west Marine Region from 2001 to 2006, but has since decreased to almost zero.

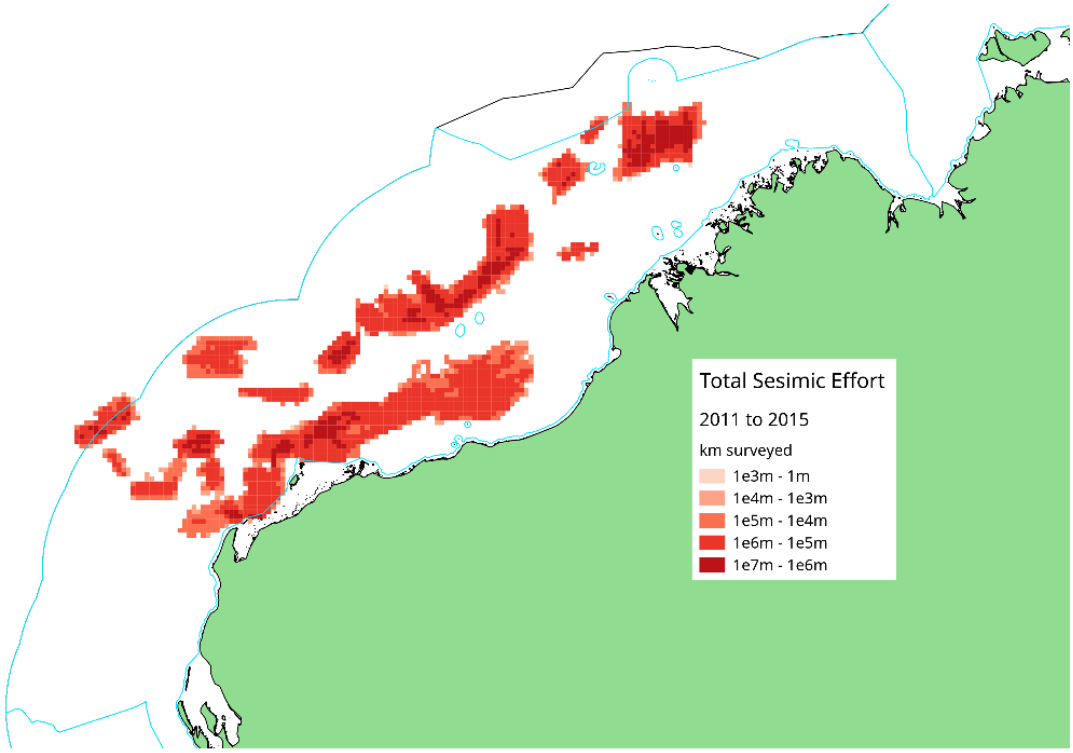


Figure 13. Seismic Surveys from 2011 to 2015

10.1.4 North Marine Region

The North Marine Region has had historically low use, as a function of the smaller population size. Trawl fisheries effort is low compared to the South-east and South-west Marine Regions and has been decreasing, with the peak in effort in between 2001 and 2005, followed by significant industry restructuring. The trawl fishery is largely focused in the Gulf of Carpentaria and intersects with the Gulf of Carpentaria coastal zone KEF. There have been small seismic surveys in the Gulf over the last 5 years. SST in the North Marine Region is stable or decreasing in some areas. Most of the North Marine Region has stable population densities. The marine region is a major shipping route that abuts the Torres Strait Particularly Sensitive Sea Area (PSSA) and has seen increases in shipping commensurate with the increases seen around the rest of Australia. There is some interaction between the shipping routes from Weipa with flatback, green, hawksbill and olive ridley turtle BIAs. There is also potential for interaction in the western section of the marine region with BIAs for green, flatback, hawksbill, leatherback and olive ridley turtles.

Table 4: The relative intensity compared with other marine regions and trend of pressures in the North Marine Region. ≈ indicates the relative trend is not changing.

Pressure	Intensity	Trend
Fishing	L	↓
Shipping	L	↓
Seismic	L	↓
Oil & Gas Wells	L	↓
Oil Pollution	L	≈
SST	L	↑
Population	L	↑

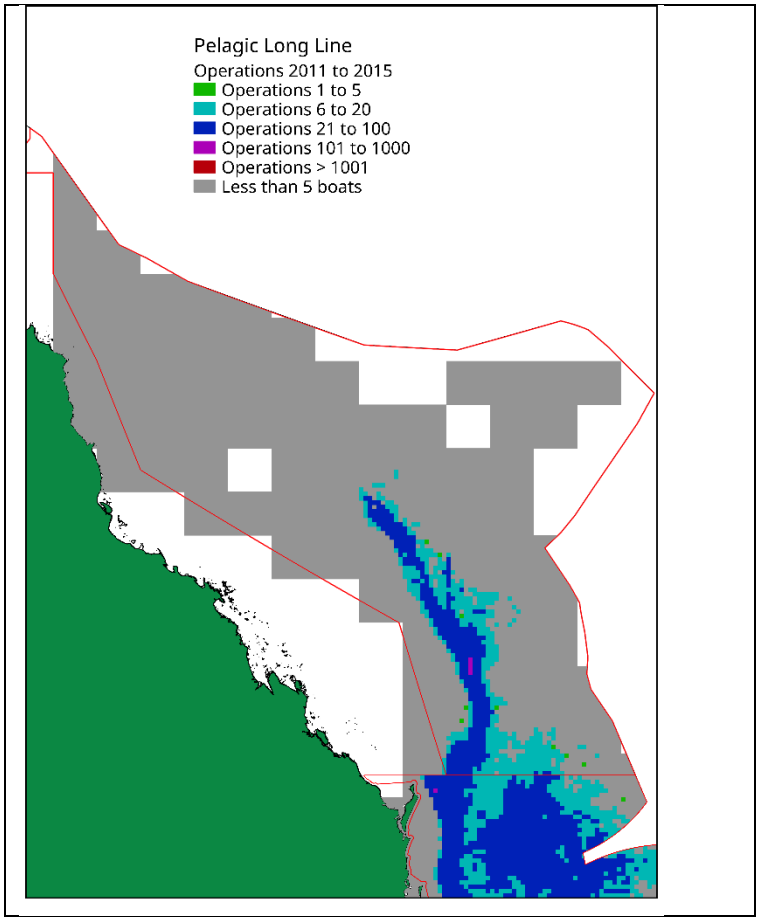
10.1.5 Coral Sea Marine Region

The Coral Sea Marine Region has supported long-term pelagic fisheries, in addition to other fisheries (auto longline, demersal longline, gillnets, handlines, minor line, purse seine, trotline, trolling). The additional fisheries are either at very low effort levels or are no longer occurring within the Coral Sea Marine Region. The longline fishery peaked between 2001 and 2005 and has declined since then. The Coral Sea Marine Region overlaps with major international shipping routes. The density of shipping in the Coral Sea Marine Region has steadily increased from 1999 and contains the main shipping routes from southern Australia and Queensland.

Table 5: The relative intensity compared with other marine regions and trend of pressures in the Coral Sea Marine Region. ≈ indicates the relative trend is not changing.

Pressure	Intensity	Trend
Fishing	M	↓
Shipping	M	↑
Seismic	L	↓
Oil & Gas Wells	L	↓
Oil Pollution	L	↑
SST	H	↑
Population	L	≈

The current distribution of the fishery is restricted to the southern end of the marine region with a much reduced effort and overlaps with BIAs for common noddy, black noddy, masked booby, sooty tern, wedge-tailed shearwater, flesh-footed shearwaters, white sharks and humpback whales.



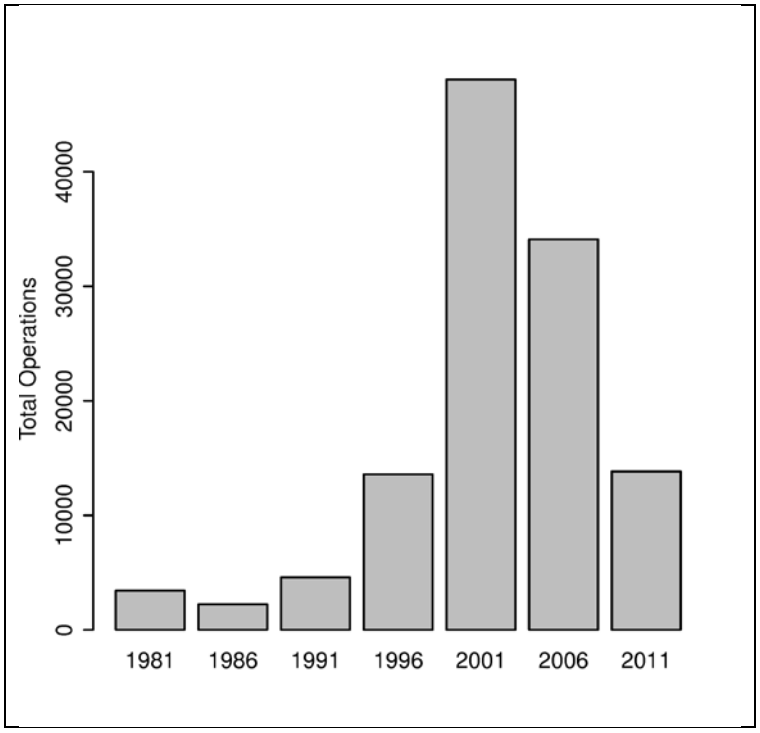


Figure 14. Change in Effort and current Distribution of Long Line Pelagic Fisheries

There are historical records of 2D seismic surveys occurring within the Coral Sea Marine Region. However these are sporadic through time and there are no records of any current seismic surveys within the marine region's boundary. There are no records of oil or gas wells drilled within the bounds of the Coral Sea Marine Region. The marine region has an extensive history of oil spills from vessels that have occurred across the entire extent of the marine region since 1970. There are more recorded spills close to the coast than further out to sea.

The Coral Sea Marine Region has had an increase in SST of 0.33°C per decade since 1993. The greatest increases are offshore in the central Coral Sea, overlapping with the Tasmantid Seamount Chain and Reefs, and the Cays and Herbivorous Fish of the Queensland Plateau KEFs. These areas also contain BIAs for common noddy, masked booby, black noddy, black naped tern, bridled tern, brown booby, great frigatebird, lesser frigatebird, red-footed booby, red-tailed tropicbird, sooty tern, wedge-tailed shearwater and green turtle.

10.1.6 Temperate East Marine Region

Table 6: The relative intensity compared with other marine regions and trend of pressures in the Temperate East Marine Region. ≈ indicates the relative trend is not changing.

Pressure	Intensity	Trend
Fishing	H	↓
Shipping	H	↑
Seismic	L	↓
Oil & Gas Wells	L	↓
Oil Pollution	H	↑
SST	H	↓
Population	H	↑

The Temperate East Marine Region has had the highest rate of historical use of the Australian EEZ. Effort from all types of fisheries has been high in Commonwealth waters. Especially prominent is the effort by longline pelagic fisheries in the northern section of the marine region overlapping with seabird BIAs for black petrel, flesh-footed shearwater, Wilsons storm petrel, black-browed albatross, Campbell albatross great-winged petrel, Indian yellow-nosed albatross, northern giant petrel, southern giant petrel, and wandering albatross and BIAs for loggerhead turtle, grey nurse shark and white shark. The trawl fishery on the shelf and slope overlaps with benthic KEFs (Canyons on the eastern continental slope and the pelagic KEF the upwelling East of Eden). The trawl fishery also overlaps with BIAs for albatross (antipodean, black-browed, Campbell, Indian yellow-nosed, wandering and white capped), petrels (black, great-winged, northern giant, southern giant, Wilsons storm and white-faced storm), shearwaters (flash-footed, short-tailed, wedge-tailed), grey nurse shark, Indian/Pacific spotted bottlenose dolphin, humpback whale and white shark. Although there has been significant pressure historically from fishing in the marine region the total fishing effort has been decreasing since 2006.

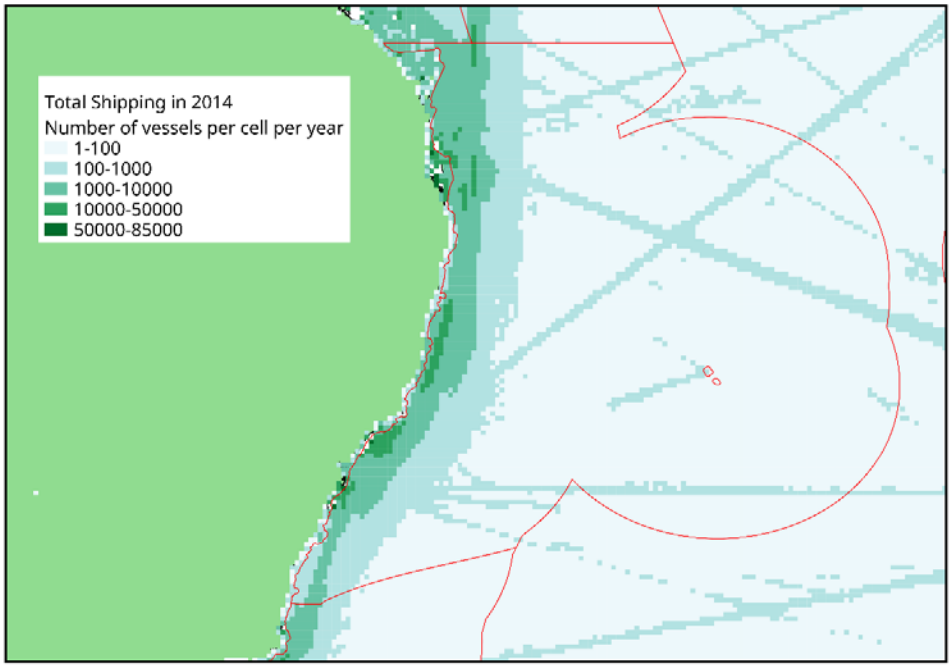


Figure 15. Total Shipping in 2014

There has been limited seismic surveying in the marine region over the last 30 years, and no surveys over the last 5 years. Shipping has increased in absolute terms, but declined as a proportion of shipping occurring in the Australian EEZ. The areas of highest shipping activity overlap with BIAs for humpback whales, Indo-Pacific/spotted bottlenose dolphin, grey nurse shark, white shark and numerous seabird species. There is also extensive shipping in the Upwelling East of Eden, Tasman Front and Eddy Field KEFs.

This area is unique around Australia in having pronounced decreases in average SST over the last 20 years. This is due to the extension of the East Australia Current southwards to the South East Marine Region which has brought cooler water to the Temperate East Marine Region. This affects the Tasman Front and Eddy Field KEF by increasing the productivity within the KEF, and will change the circulation patterns.

11. CONCLUSION

This report shows how the distribution and intensity of marine pressures through the Australian EEZ has changed through time. There are 3 key points.

1. The utilisation of the Australian EEZ has changed significantly through time and continues to change. New industries are being developed and we cannot predict exactly where they will occur. The changes are very dynamic, even at the scale of marine regions and are a response to both new economic opportunities and changes in regulation to ensure sustainable use.
2. The Temperate-East and South-East have the highest continual levels of utilisation, but increases in the South-West Marine Region may soon bring it to similar levels of utilisation. All these regions are the most heavily impacted by increases in SST and the cumulative, synergistic impacts on marine biodiversity may be significant.
3. Declines in the North and North-West region in total cumulative pressure mask the increases in Oil and Gas Production and Marine Vessel activity. This highlights that specific combinations of pressure and value need to be identified in order to estimate potential impacts and risks and that the cumulative impact will likely be significant in areas where multiple pressure are increasing.

The overall conclusion is that pressures in the Australian EEZ are changing and many are regulated based on the principles of ecologically sustainable development. However, due to the absence of information linking pressures and values, the status and trends of biodiversity that may be impacted remains unclear.

All pressure data used in this report are publically available with associated metadata (Annex 1), supporting ongoing updates and summaries of pressure data in Australian EEZs. This will enable presentation of synoptic pressure data in future State of Environment reporting and answering specific questions in reference to future developments within and external to MNES. Additional assessment of cumulative impacts and hotspots analysis would further support future decisions on changing use in the EEZ.

12. REFERENCES

Bax, N.J., Tilzey, R. Lyle, J., Wayte, S.E., Kloser, R. and Smith, A.D.M. (2005). Providing management advice for deep sea fisheries: Lessons learnt from Australia's orange roughy fisheries. Pages 259-272 in Shotton, R. [Ed.] Deep Sea 2003. Conference on the Governance and Management of Deep-sea fisheries. Part 1: Conference reports, Queenstown Dec 1-5, 2003. FAO Fisheries Proceedings No 3/1. Rome FAO. 718p.

Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, Yearbook 2016: Australian Infrastructure Statistics, Statistical Report, BITRE, Canberra ACT.

DAFF. 2005. Securing our Fishing Future—Ministerial Directive to AFMA. Department of Agriculture, Fisheries and Forestry, Canberra. http://www.mffc.gov.au/releases/2005/05248m.html.

Smith, A. D. M., Smith D. C., Haddon, M., Knuckey, I., Sainsbury, K. J., and Sloan, S. 2014. Implementing harvest strategies in Australia: 5 years on. – ICES Journal of Marine Science, 71: 195–203.

13. ANNEX 1: DATA AND METADATA

Sector	Class	year	metadata url	geoserver wms url
Population Trends		1991	http://marlin.csiro.au/geonetwork/srv/eng/search#!c8b09cef-c645-48aa-8658-22ece782365f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:1991_enumeration_proj&styles=&bbox=112.689445495605,-43.8,159.3,-13.5821924209595&width=768&height=497&srs=EPSG:4326&format=application/openlayers
		1996	http://marlin.csiro.au/geonetwork/srv/eng/search#!c8b09cef-c645-48aa-8658-22ece782365f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:1996_enumeration_proj&styles=&bbox=112.690399169922,-43.90,159.3,-11.4064111709595&width=768&height=535&srs=EPSG:4326&format=application/openlayers
		2001	http://marlin.csiro.au/geonetwork/srv/eng/search#!c8b09cef-c645-48aa-8658-22ece782365f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:2001_enumeration_proj&styles=&bbox=112.838668823242,-43.9,159.3,-10.8348007202148&width=768&height=546&srs=EPSG:4326&format=application/openlayers
		2006	http://marlin.csiro.au/geonetwork/srv/eng/search#!c8b09cef-c645-48aa-8658-22ece782365f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:2006_enumeration_proj&styles=&bbox=105.389190673828,-43.9,159.3,-9.57798004150391&width=768&height=488&srs=EPSG:4326&format=application/openlayers
		2011	http://marlin.csiro.au/geonetwork/srv/eng/search#!c8b09cef-c645-48aa-8658-22ece782365f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:2011_enumeration_proj&styles=&bbox=112.69034576416,-43.9,159.3,-11.3029308319092&width=768&height=537&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
Oil and Gas Production	Titles	1950-2016	http://marlin.csiro.au/geonetwork/srv/eng/search#!836b1a1d-19d8-4f66-b12f-88e4ce9ba19c	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:oil_lease_areas&styles=&bbox=109.69881439209,-41.4979438781738,153.9,-8.8&width=768&height=566&srs=EPSG:4326&format=application/openlayers
	wells	1950-2016	http://marlin.csiro.au/geonetwork/srv/eng/search#!2eddbe26-0276-4468-a210-0c00ada8bf39	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:wells_oil_gas&styles=&bbox=111.385116577148,-42.2979736328125,153.7,-9.2&width=768&height=598&srs=EPSG:4326&format=application/openlayers
	pipelines		http://www.marlin.csiro.au/geonetwork/srv/eng/search#!19d8f59a-b918-442f-8e2c-d80125600868	
	cables - decommissioned		http://www.marlin.csiro.au/geonetwork/srv/eng/search?hl=eng#!b8824a13-8e0b-4172-9678-dabccdedeeb7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:cables_deco_hydro_proj&styles=&bbox=96.9485663213794,-35.938547447484,159.4,1.0&width=768&height=454&srs=EPSG:4326&format=application/openlayers
	cables - active		http://www.marlin.csiro.au/geonetwork/srv/eng/search?hl=eng#!b8824a13-8e0b-4172-9678-dabccdedeeb7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:cables_active_hydro_proj&styles=&bbox=103.403879995103,-41.0368526383182,164.3,1.0&width=768&height=530&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
Anthropogenic Noise	2D	1961-1965	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic2d_sum_1961to1965&styles=&bbox=112.796493530273,-41.1,153.9,-7.43300008773804&width=768&height=630&srs=EPSG:4326&format=application/openlayers
	2D	1966-1970	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic2d_sum_1966to1970&styles=&bbox=111.887496948242,-44.2810020446777,175.0,-7.71&width=768&height=444&srs=EPSG:4326&format=application/openlayers
	2D	1971-1975	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic2d_sum_1971to1975&styles=&bbox=108.035491943359,-43.7865028381348,161.4,-6.1&width=768&height=541&srs=EPSG:4326&format=application/openlayers
	2D	1976-1980	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic2d_sum_1976to1980&styles=&bbox=110.908500671387,-40.9570045471191,149.5,-9.2&width=768&height=629&srs=EPSG:4326&format=application/openlayers
	2D	1981-1985	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic2d_sum_1981to1985&styles=&bbox=112.447998046875,-49.5010032653809,163.3,-8.8&width=768&height=612&srs=EPSG:4326&format=application/openlayers
	2D	1986-1990	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic2d_sum_1986to1990&styles=&bbox=110.077995300293,-44.0750007629395,154.2,-8.7&width=768&height=605&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
	2D	1991-1995	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic2d_sum_1991to1995&styles=&bbox=102.143989562988,-57.3535041809082,174.8,-6.1&width=768&height=546&srs=EPSG:4326&format=application/openlayers
	2D	1996-2000	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic2d_sum_1996to2000&styles=&bbox=109.86449432373,-51.049503326416,177.6,-0.65&width=768&height=571&srs=EPSG:4326&format=application/openlayers
	2D	2001-2005	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic2d_sum_2001to2005&styles=&bbox=111.117492675781,-44.4820022583008,168.1,-7.7&width=768&height=494&srs=EPSG:4326&format=application/openlayers
	2D	2006-2010	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic2d_sum_2006to2010&styles=&bbox=106.819000244141,-41.8635025024414,163.5,-8.8&width=768&height=446&srs=EPSG:4326&format=application/openlayers
	3D	1976-1980	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic3d_sum_1976to1980&styles=&bbox=148.09999999999,-38.5999999999994,148.3,-38.04&width=460&height=768&srs=EPSG:4326&format=application/openlayers
	3D	1981-1985	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic3d_sum_1981to1985&styles=&bbox=115.699999999992,-38.5999999999994,148.5,-11.7&width=768&height=625&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
	3D	1986-1990	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic3d_sum_1986to1990&styles=&bbox=113.927001953125,-39.0380020141602,148.8,-11.1&width=768&height=612&srs=EPSG:4326&format=application/openlayers
	3D	1991-1995	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic3d_sum_1991to1995&styles=&bbox=113.82649230957,-40.1479988098145,148.8,-10.2&width=768&height=655&srs=EPSG:4326&format=application/openlayers
	3D	1996-2000	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic3d_sum_1996to2000&styles=&bbox=113.633499145508,-21.7590007781982,127.0,-9.8&width=768&height=681&srs=EPSG:4326&format=application/openlayers
	3D	2001-2005	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic3d_sum_2001to2005&styles=&bbox=112.516998291016,-40.7510032653809,149.4,-10.2&width=768&height=633&srs=EPSG:4326&format=application/openlayers
	3D	2006-2010	http://marlin.csiro.au/geonetwork/srv/eng/search#!17249677-2be0-43a0-a9b5-da01e0be3fa7	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:seismic3d_sum_2006to2010&styles=&bbox=111.212493896484,-42.6655006408691,149.3,-9.2&width=768&height=677&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
Sea Surface Temperature	Long Term Trend	1993-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8f48127-495e-42e6-8d53-db3c56ee3a7f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ALTT_31July2014&styles=&bbox=107.97999945148223,-46.9798988032319,160.9839974357248,-7.955899841787632&width=768&height=565&srs=EPSG:4326&format=application/openlayers
	Long Term Trend SE	1993-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8f48127-495e-42e6-8d53-db3c56ee3a7f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ALTTSE_31July2014&styles=&bbox=107.97999945148223,-46.9798988032319,160.9839974357248,-7.955899841787632&width=768&height=565&srs=EPSG:4326&format=application/openlayers
	Long Term Trend RMSE	1993-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8f48127-495e-42e6-8d53-db3c56ee3a7f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:trendRMSE_31July2014&styles=&bbox=107.97999945148223,-46.9798988032319,160.9839974357248,-7.955899841787632&width=768&height=565&srs=EPSG:4326&format=application/openlayers
	Annual RMSE	1993-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8f48127-495e-42e6-8d53-db3c56ee3a7f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:annualRMSE_31July2014&styles=&bbox=107.97999945148223,-46.9798988032319,160.9839974357248,-7.955899841787632&width=768&height=565&srs=EPSG:4326&format=application/openlayers
	e-fold time	1993-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8f48127-495e-42e6-8d53-db3c56ee3a7f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:efold_31July2014&styles=&bbox=107.97999945148223,-46.9798988032319,160.9839974357248,-7.955899841787632&width=768&height=565&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
Marine Debris		2015	http://marlin.csiro.au/geonetwork/srv/eng/search#!DA83B0E3-2B75-48A2-8FDD-874EDD9DBDBF	http://www.cmar.csiro.au/geoserver/web/wicket/bookmarkable/org.geoserver.web.data.resource.ResourceConfigurationPage?name=marine-debris-count_density_size1_360&wsName=ebsa http://www.cmar.csiro.au/geoserver/web/wicket/bookmarkable/org.geoserver.web.data.resource.ResourceConfigurationPage?name=marine-debris-count_density_size2_360&wsName=ebsa http://www.cmar.csiro.au/geoserver/web/wicket/bookmarkable/org.geoserver.web.data.resource.ResourceConfigurationPage?name=marine-debris-count_density_size3_360&wsName=ebsa http://www.cmar.csiro.au/geoserver/web/wicket/bookmarkable/org.geoserver.web.data.resource.ResourceConfigurationPage?name=marine-debris-count_density_size4_360&wsName=ebsa
Oil Pollution Events	Oil	1970-2015	http://marlin.csiro.au/geonetwork/srv/eng/search#!2ff40822-a773-4788-aedd-232639142cde	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:oil_spills_sum&styles=&bbox=95.7405014038086,-54.7594985961914,168.0,-2.3&width=768&height=554&srs=EPSG:4326&format=application/openlayers
Cyclones		1900-2015	http://marlin.csiro.au/geonetwork/srv/eng/search?hl=eng#!9fb32adf-f8e8-4b38-8e23-1c6e847b6a91	https://www.cmar.csiro.au/geoserver/ebsa/wms?service=WMS&version=1.1.0&request=GetMap&layers=ebsa:cyclones_sum_1900to2015&styles=&bbox=-181.800003051758,-69.7,181.8,73.7&width=768&height=330&srs=EPSG:4326&format=application/openlayers
Marine Vessel Activity		1999	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_1999&styles=&bbox=105.0,-49.0,165.0,-5.0&width=768&height=563&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
		2000	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2000&styles=&bbox=105.0,-49.0,165.0,-5.0&width=768&height=563&srs=EPSG:4326&format=application/openlayers
		2001	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2001&styles=&bbox=105.0,-49.0,165.0,-5.0&width=768&height=563&srs=EPSG:4326&format=application/openlayers
		2002	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2002&styles=&bbox=105.0,-49.0,165.0,-5.0&width=768&height=563&srs=EPSG:4326&format=application/openlayers
		2003	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2003&styles=&bbox=105.0,-49.0,165.0,-5.0&width=768&height=563&srs=EPSG:4326&format=application/openlayers
		2004	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2004&styles=&bbox=105.0,-49.0,165.0,-5.0&width=768&height=563&srs=EPSG:4326&format=application/openlayers
		2005	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2005&styles=&bbox=62.7999999999947,-69.2999999999995,176.399999999988,34.5&width=768&height=701&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
		2006	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2006&styles=&bbox=-179.3,-76.8999999999991,179.699999999988,35.1&width=768&height=330&srs=EPSG:4326&format=application/openlayers
		2007	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2007&styles=&bbox=55.1999999999946,-77.699999999999,178.599999999988,34.9&width=768&height=700&srs=EPSG:4326&format=application/openlayers
		2008	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2008&styles=&bbox=11.599999999994,-69.4999999999995,178.399999999988,57.0&width=768&height=582&srs=EPSG:4326&format=application/openlayers
		2009	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2009&styles=&bbox=37.8999999999943,-68.5999999999995,174.799999999988,39.1&width=768&height=604&srs=EPSG:4326&format=application/openlayers
		2010	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2010&styles=&bbox=20.8999999999941,-69.3999999999995,176.999999999988,30.8&width=768&height=492&srs=EPSG:4326&format=application/openlayers
		2011	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ausrep_shipping_2011&styles=&bbox=61.9999999999947,-69.2999999999995,174.099999999988,10.6&width=768&height=547&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
		2012	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	nan
		2013	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ais_shipping_2013&styles=&bbox=105.0,-49.0,165.0,-5.0&width=768&height=563&srs=EPSG:4326&format=application/openlayers
		2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ais_shipping_2014&styles=&bbox=105.0,-49.0,165.0,-5.0&width=768&height=563&srs=EPSG:4326&format=application/openlayers
		2015	http://marlin.csiro.au/geonetwork/srv/eng/search#!b8135966-33c6-4a1c-bcbc-d797c2a1155f	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:ais_shipping_2015&styles=&bbox=-180.0,-90.0,180.0,90.0&width=768&height=384&srs=EPSG:4326&format=application/openlayers
Commercial Fishing	Auto Long Line	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:csq_al_20112014&styles=&bbox=128.830001831055,-45.1450004577637,163.169998168945,-15.8549995422363&width=768&height=655&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
	Demersal Long Line	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:csq_bl_20112014&styles=&bbox=128.889999389648,-46.072681427002,151.110000610352,-31.3913440704346&width=768&height=507&srs=EPSG:4326&format=application/openlayers
	Danish Seine	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:csq_ds_20112014&styles=&bbox=125.870002746582,-44.060001373291,152.130004882812,-31.9400005340576&width=768&height=354&srs=EPSG:4326&format=application/openlayers
	Gill Net	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:Fish-csq_gn_20112014&styles=&bbox=130.899993896484,-47.2722854614258,151.100006103516,-31.3853759765625&width=768&height=604&srs=EPSG:4326&format=application/openlayers
	Hand Line	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:csq_hl_20112014&styles=&bbox=113.0,-44.0,160.0,-15.0&width=768&height=473&srs=EPSG:4326&format=application/openlayers
	Pelagic Long Line	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:csq_llp_20112014&styles=&bbox=133.855178833008,-40.1349983215332,163.10758972168,-12.8649997711182&width=768&height=715&srs=EPSG:4326&format=application/openlayers
	Pole and Line	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:csq_pl_20112014&styles=&bbox=114.0,-42.0,156.0,-21.0&width=768&height=384&srs=EPSG:4326&format=application/openlayers

Sector	Class	year	metadata url	geoserver wms url
	Purse Seine	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:csq_ps_20112014&styles=&bbox=131.0,-39.8741681199796,157.0,-29.0&width=768&height=330&srs=EPSG:4326&format=application/openlayers
	Trotline	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:csq_tl_20112014&styles=&bbox=150.724561110685,-35.0,151.0,-34.2252477174074&width=330&height=768&srs=EPSG:4326&format=application/openlayers
	Trolling	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:csq_tr_20112014&styles=&bbox=134.0,-46.0,151.0,-9.36516669151941&width=356&height=768&srs=EPSG:4326&format=application/openlayers
	Trawl	2011-2014	http://marlin.csiro.au/geonetwork/srv/eng/search#!aa53a4df-7fe6-46d1-93b7-2d3732f4883e	https://www.cmar.csiro.au/geoserver/nerp/wms?service=WMS&version=1.1.0&request=GetMap&layers=nerp:csq_tw_20112014&styles=&bbox=114.76000213623,-46.1831741333008,163.240005493164,-9.18199253082275&width=768&height=586&srs=EPSG:4326&format=application/openlayers

www.nespmarine.edu.au

Contact:
Piers Dunstan
CSIRO

Address | GPO Box 1538, Hobart, Tasmania, 7001
email | piers.dunstan@csiro.au
tel | +61 3 6232 5382